ISCTE IUL

Instituto Universitário de Lisboa

Industrial Transformation and Upgrade Model of Local Industrial Clusters: The Case of Zhongshan City, China

PEI Jing

Thesis submitted as partial requirement for the conferral of the degree of

Doctor of Management

Supervisor:

Prof. Álvaro Augusto da Rosa, Assistant Professor, ISCTE University Institute of Lisbon

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Prof. AI Xingzheng, Professor, University of Electronic Science and Technology of China, School of Management and Economics

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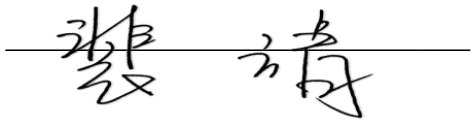
Signed 

Abstract

This thesis focuses on the difficulties of transforming and upgrading Zhongshan specialized town and solutions for development. Under the background that the economy of Zhongshan has entered into the post-industrialization era, innovation-driven development has become the inevitable way to transform and upgrade Zhongshan specialized town economy. The purpose of the dissertation is to seek and crack the development dilemma of the transition between old and new momentums and find feasible solutions.

Firstly, the thesis describes how Zhongshan used to be an industrial-based traditional specialized town which mainly depended on rural competition, and how this traditional and characteristic economic development and factor-based growth model became unsustainable. Afterwards, we have done a comparative analysis of the current positioning, resource and endowments of Zhongshan in the Guangdong-Hong Kong-Macao Greater Bay Area. We also explain in the study the mechanisms and historical evolution of the cluster economy of Zhongshan specialized towns through a cluster analysis. Then, we developed a case study on Zhongshan lighting town Guzhen town and its specialized town intellectual property right protection mechanism as an example of innovation and high-tech enterprises fixation.

Finally, we use a framework with four dimensions, which are Guangdong-Hong Kong-Macao Greater Bay Area urban agglomerations, Zhongshan clustering economy, traditional industry knowledge economy, and innovation entities (high-tech enterprises) to develop a model of transformation and upgrading for Zhongshan.

Keywords: High-tech enterprises; Specialized towns; transformation and upgrading; Zhongshan

JEL: O18; R11

Resumo

A presente dissertação foca nas dificuldades de transformação e elevação do nível de desempenho de Zhongshan, uma região tecnológica altamente especializada do sul da China. Tendo em conta que a economia de Zhongshan entrara na era pós-industrial, o elemento da inovação tornou-se inevitável no desenvolvimento e recapacitação da sua economia. O objeto principal deste trabalho está na descoberta de novas soluções de desenvolvimento regional e na quebra do dilema de transição entre a velha e a nova economia industrial.

A parte inicial do trabalho descreve como tem sido o desenvolvimento de Zhongshan que partira de uma base industrial tradicional de âmbito rural e que se tornou insustentável devido ao esgotamento do modelo de crescimento baseado em factores. Desenvolvemos, ainda, um estudo comparativo com base em cluster analysis a respeito do posicionamento estratégico e dos recursos, contrapondo Zhongshan e as mais importantes cidades da grande área da baía de Guangdong que incluem Hong Kong e Macau. Seguidamente, desenvolvemos um caso de estudo sobre a cidade de Guzhen da região de Zhongshan. A cidade de Guzhen é especializada em iluminação, protegida em termos de direitos de propriedade intelectual e colonizada por um vasto leque de empresas de base tecnológica inovadora.

Por fim, construímos um modelo de análise e prospetiva baseado em quatro dimensões, a saber, a aglomeração urbana de Área da Grande Baía de Guangdong – Hong Kong – Macau, a economia em cluster de Zhongshan, a economia industrial tradicional e a inovação tecnológica para desenhar um modelo de desenvolvimento transformacional e de elevado desempenho para a região de Zhongshan.

Palavras-chave: High-tech entreprises; Specialized towns; transformation and upgrading; Zhongshan

JEL: O18; R11

摘要

本文聚焦于中山市专业镇转型升级的困境及解决办法。在中国经济新常态，中山经济步入后工业化时代的背景下，创新驱动发展成为中山专业镇经济转型升级的必由之路。论文的目的就是目求破解新旧动能模式转换的发展困境，并找到可行的解决路径。

论文首先从过往中山市以工业为基础，镇域竞争为主，形成的传统专业镇特色经济发展结构，要素式增长模式难以为继，提出专业镇发展转型升级模式的内在需求与发展困境。随后围绕专业镇、产业集群、集群创新、企业家精神的理论基础研究上，结合当前中山在粤港澳大湾区建设中的定位与资源禀赋进行了比较分析，紧接着通过聚类分析对描述了中山市专业镇集群经济的形成机理与历史沿革。随即以中山古镇灯饰特色专业镇知识产权快速维权机制为典型案例，以及通过对中山高新技术企业这一创新主体绩效分析这一维度，描述了中山专业镇经济创新驱动转型升级的现状。

从而形成了粤港澳大湾区城市群、中山特色集群经济、传统产业知识经济、创新主体（高新技术企业）四个维度的分析框架模型，为传统产业集群转型升级，尤其是中山自身经济转型提供了有利的参考模型。

关键词: 高新技术企业；专业镇；转型升级；中山

JEL 分类: O18；R11

Acknowledgements

With the completion of the thesis , my doctoral career has come to the end as well. Looking back to the career of studying in these years, I have so many feelings. 2013 is a year that I had been through a lot, made many friends and chose The University of electronic science and technology of China to study for my Doctorat of Management of The Portugal Lisbon University Institute. It was same year that my life was changed since my precious daughter came to our family as an angel. I felt happy but overwhelmed. The decision to slow down my work and start to learn opened a new chapter of my life. I had found my spiritual belonging. I'm not willing to wandering disorderly and the faint light ahead is guiding the director of my life.

As an government official who had been engaged in science and technology management section for 20 years, I believe that choosing science and technology is embracing the future. Perhaps it is beautiful, but always unreachable as well. Maybe no matter how hard you try. The only thing left is A wisp of fragrance.

C'est la vie. But why not a Doctorat degree is a new starting point? You'll never know where is the final destination and you can't even imagine the latitude that you might reach...

First of all, I would like to thank the Chinese instructor associate Professor Ai Xingzheng, Portuguese instructor professor Álvaro Augusto da Rosa. These two mentors are noble in morality, rigorous in scholarship, and knowledgeable. They have not only gave me academic guidance systematically, but also warm encouragement in my life and work. Due to my working experiences, I chose a broad proposition and it caused many troubles for myself and the mentors. However, during the writing of the thesis, these two instructors guided and taught me carefully and their kindness and patient made me feel warm. Professor Ai devoted a lot of effort to the selection of topics, content of every chapter, research framework, and the improvement about each chapter, even provide suggestion about the references and format of the thesis. Professor Álvaro Augusto da Rosa from The Portugal Lisbon University Institute was wise and rigorous. The communication with him benefited me a lot and inspired me during the writing period of this thesis. Prof.Álvaro Augusto da Rosa mentored and guided me

in several aspects which includes research direction, research methods, quantitative analysis and so on. He was not only provide many guidances to the content, but also proposed amendments and suggestions to the translation of the thesis.

Thanks to all the instructors of the University of electronic science and technology of China and The Portugal Lisbon University Institute, your profound knowledge, sagacious insights and charisma always benefited me in my study career and my work. These professors are not only taught me knowledge, but also taught me how to study. Thanks to Associate Professor Xiao Wen, Director of the IDMgt project; Professor Virginia Trigo, Director of China Programs of Portugal Lisbon University Institute. All related information were notified promptly and explained well by these professors during the process of thesis opening, mid-term defense, and thesis submission which it save me a lot of trouble and able to concentrate to conduct my research.

Thanks to all the students in the DBA class, especially Qiao Shiping, we both had completed the thesis under the guidance of Prof.Álvaro Augusto da Rosa and Associate Professor Ai Xingzheng. You inspired me and made me more motivated. Thanks to the my classmates, the discussion in the classroom and the communication after-class made me have a in-depth understanding of the theoretical knowledge and my life as well.

Thanks to my leader, Director Yin Ming who are the good example to me, Your encouragement and supervision not only gave me the power of progress and keep moving forward in my life and work, but also provide me the platform to broaden my horizon and display my talent.

My special thanks to my family. I can not finish my studies without your company, your understanding, support, encouragement and help. Everything I do become more meaningful because of you. You are also the reason that I have courage and confidence to pursue progress.

致谢

论文行至末尾，也意味着即将结束博士生生涯，回首这些年的求学生涯，不禁心生感慨。机缘巧合，2013 年结实了很多朋友，发生了很多故事，而正是在这一年我选择了来到电子科技大学，攻读葡萄牙里斯本工商管理学院管理学博士学位，也是在这一年我迎来了人生的转变初为人父，女儿如天使般的降临让我手舞足蹈不知所措，而缓政从学让我开启了人生事业上的第二片天地，寻觅到了精神领域的归宿，我不愿再无序的漂泊，前方微弱的光亮指引着生命的航向。

作为在政府从事科技管理快二十年的我而言，选择科技创新就是选择了未来的曙光，也许她美轮美奂、炫彩多姿，但总是那么的遥不可及，无论你怎样努力，能留下的却只是一缕余香……

也许人生就是如此，但博士学位又何尝不是一个新的起点！你永远不知道终点在哪，也永远无法想象你所能企及的高度……

首先感谢论文中方指导老师艾兴政副教授和葡方导师 Prof. Álvaro Augusto da Rosa。两位导师品格高尚、治学严谨、学识渊博，在学术上给予了系统的指导，在生活和工作中也给予了温馨的鼓励。由于工作关系，我选择了这样一个宏大的命题，为自己找了麻烦，也给导师们出了难题，但论文写作过程中，两位老师悉心指导、亦师亦友般的教导，让我倍感温馨，艾老师对论文选题、章节内容、研究框架、每一章节的完善都倾注了大量的精力，甚至对参考文献、论文格式等都给予了悉心指导。葡萄牙里斯本工商管理大学 Prof.Álvaro Augusto da Rosa 教授睿智严谨，跟他的交流让我受益良多，对论文写作中的启发意义重大，在论文写作中 Prof.Álvaro Augusto da Rosa 教授就论文研究方向、研究

方法、数量分析等方面进行了多次密切指导，还对论文翻译提出了修改意见。

感谢电子科技大学和里斯本工商大学的所有授课老师，你们渊博的学识、睿智的见解和人格魅力让我在论文写作和工作中一直受益。这些老师不仅教会了我专业知识，教会了我如何学习。感谢 IDMgt 项目主任肖文副教授，葡萄牙里斯本工商管理大学中国项目部主任 Virginia Trigo 教授。论文写作过程中，两位老师在论文开题、中期答辩、论文提交等过程中，对相关安排与要求及时通知并解释相关情况，让我在论文写作过程中省去了不少的麻烦，能够精心开展相关研究。

感谢 DBA 班的所有同学们，尤其是谯世平同学，我们都是在 Prof.Álvaro Augusto da Rosa 教授和艾兴政副教授两位导师的指导下完成论文撰写的，有你的榜样精神让我走的每一步都充满的动力，感谢同学们在课堂的讨论和课后的交流，让我在课程学习中对理论有了更深入的理解，对生活有了更深刻的体会。

感谢我的领导，尹明局长有您的榜样精神和鞭策、提点，让我在工作中和学业上都有了深层的压力和进步的动力，以及开阔的视野和施展的平台。

特别要感谢的是我的家人，学业完成过程中离不开你们陪伴，离不开你们的理解、支持、鼓励和帮助，正是因为有了你们，我所做的一切才更有意义，也正是因为有了你们，我才有了追求进步的勇气和信心。

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Chapter 1: Introduction

1.1 Background

1.1.1 Brief introduction to Zhongshan City

Known as "Xiangshan" in ancient times, Zhongshan is located in the west of the Pearl River Delta. Zhongshan is the hometown of Dr. Sun Yat-sen (a forerunner of Chinese democratic revolution honored as "the Father of the Republic of China") and one of the five prefectural cities without a municipal district in China. Zhongshan City covers an area of 1783.67 square kilometers, has 3,142,300 permanent residents, and governs five neighborhood offices and 18 towns. In 2016, the GDP of Zhongshan City reached EUR 438.74 billion, and more than 800 thousand natives of Zhongshan resided in more than 80 countries and regions worldwide, Hong Kong, Macao and Taiwan. The Pearl River Estuary looks like the capital letter "A", on the top of which Guangzhou is located, in the east of which Dongguan, Shenzhen and Hong Kong are located in turn, and in the west of which Foshan, Zhongshan, Zhuhai and Macao are located in turn. The Pearl River Estuary separates Zhongshan from Shenzhen known as an innovative city in China. The proposal of the construction of "Guangdong-Hong Kong-Macao Greater Bay Area" in 2017 highlights the important position of Zhongshan in the construction of the Greater Bay Area.

In the 16th century, the new era of world ocean trade began. Macao in Xiangshan rented by Portuguese in 1533 soon developed into an international trade center in the Orient. Merchant ships from various countries arrived at Macao after long-time navigation on the sea, and sailed to Humen via Zhongshan and Zhuhai in the Greater Xiangshan Region, and then to Huangpu Port in Guangzhou for trade. Zhongshan was always an important link in the trade of Greater Bay Area. After the 1911 Revolution, this region was officially renamed Zhongshan County in memory of Dr. Sun Yat-sen on April 15, 1925 (the 14th year of the Republic of China). After 1949, Zhongshan was subordinated to Zhujiang, Central Guangdong and Foshan Prefecture in turn. On December 22, 1983, upon the approval of the State Council, Zhongshan County was updated to be a county-level city, temporarily subordinated to Foshan City. On January 7, 1988, Zhongshan was updated to be a prefectural

city, highlighting the designation of the hometown of the great man.

1.1.2 The historic evolution of the economic development of Zhongshan

Based on development of dozens of years, the local industrial clusters (also known as "specialized towns") of Zhongshan have gone through the phases of "incubation - experiment and demonstration - rapid development". In this brand-new transformation and upgrade period, the concentrated development of "industry-supply-sales serialization and science-industry-trade integration" based on "the three-processing and one compensation"has evolved into the innovation-driven development of "one town one product, one town one policy, transformation and upgrade". The administrative division setup of "the direct administration of the municipal level over towns" of Zhongshan City has determined the development character of Zhongshan with towns as units, and has also triggered the clustering form of "one town one product, one town one policy". Mr. Coase proposed in *How China Became Capitalist*: The competition among local governments or the popularly called "county competition model" of China is one of the important boosters of Chinese economic development. For a city like Zhongshan without an administrative county, towns became basic units of the competition among local governments. The purpose of competition is to Figureht for capital investment. What town governments can offer is a kind of organization service, namely, organizing all production factors to be used by enterprises (capital) more desirably. In Zhongshan, the vacuum of industrial organizations is filled up by towns as the most grass-roots administrative organizations, which exert a huge energy in transferring resources. Along with the gradual intensification of competition, they have soon become aware that: they must have their own feature and orientation in park construction in order to more effectively attract investment, and they must select an industry with a long-term benefit for centralized development, rather than developing all industries evenly. This has given rise to the localized economy of industrial clusters or specialized towns. Through the supply-demand relationship of three price scissors, Chinese economy has gone through a development opportunity period of thirty years of reform and opening-up. Zhongshan as a city on the southeastern coast of China is no doubt an epitome of Chinese economic development in this period.

1.1.2.1 Reform and opening-up have laid the development pattern of Zhongshan dominated by industrial economy (1978-1993)

In 1984, marking the fifth year of Chinese reform and opening-up, confronted with such questions as "Is China a socialist or capitalist country?", Deng Xiaoping (the chief designer of Chinese reform and opening-up) decided to thoroughly inspect southern China. Deng Xiaoping first paid a visit to Shenzhen and Zhuhai, and finally came to and stayed at Zhongshan Hot Spring Resort. On the morning of January 27, Deng Xiaoping proposed to climb Luosanmei Hill behind Hot Spring Resort. Downhill, an entourage said, "Uncle Deng, let's return by the way we came, because the other way is not convenient for walking." Deng waved his hand, "We will not retrace our steps", which caused a reverberation throughout China and set the mind of all the people who responded to the call of reform and opening-up at rest. The development in this phase should be chiefly attributed to the recovery of the consciousness of Chinese self-owned property right. In the basic theory of modern economics, private property right is one of the prerequisites for stimulating entrepreneurship and normalizing market behaviors. Township enterprises and foreign-funded enterprises have become the main force for the economic development in regions on the southeastern coast of China, especially in Zhongshan City. The recovery of township enterprises and freehold constituted the bud of the industrial economy of Zhongshan. In the meantime, "hunger and thirst for investment" injected gusts of capital sources into the development in the coastal regions in southeastern China, thus giving rise to the development phase of "high-probability investment return" in which investors could immediately enjoyed returns. Concentrated on industrial development, Zhongshan proposed the strategic change from "establishing and strengthening the city by the secondary industry" to "strengthening the city by various industries". Township enterprises developed vigorously in this period.

In this phase, Zhongshan boosted the industrial development of its villages and towns through "the three-processing and one compensation" by emphatically developing the light textile industry. Zhongshan took over the industrial transfer from Hong Kong. Although the enterprises were small-scaled and distributed sporadically, Hong Kong-funded enterprises brought valuable capital, technology and management experience, fostered industrial technicians and triggered the development of state-owned and collective economy. From 1978 to 1988, the GDP of Zhongshan increased from EUR 78.9 million to EUR 516.6 million, by about 10 folds, with an annual growth of 65.4%. From 1990 to 1995, the GDP of Zhongshan

increased from EUR 596.6 million to EUR 2405.4 million. The industrialized development model of Zhongshan took its initial shape. In 1988, the per-capita GDP of Zhognshan exceeded USD 800, and Zhongshan was designated by the State Statistics Bureau as one of the first 36 Chinese cities which had reached the moderately-prosperous level. In the same year, Zhongshan was upgraded from a county-level city to a "prefectural city with directly-administered towns (districts)". From 1994 to 2000, Zhongshan started its industrial clustering by seizing the opportunity of the international transfer of electronic information industry and relying on its specialized towns. In 1994, Zhongshan carried out economic restructuring according to the uniform policy of the central government, reformed and transferred its ownerships on a large scale and aroused the vigor of nongovernmental forces. Various towns (districts) successively launched industrial parks, gradually giving rise to the development model of local industrial clusters.

1.1.2.2 The high and new tech industry took its initial shape (1993-2010)

The leaders of Zhongshan also actively boosted the development of the high and new tech industry. In 1988, Zhongshan High and New Tech Zone became one of the first 27 national high and new tech industrial development zones and one of the first four national high and new tech zones entitled "Torch" (Zhongshan, Weihai, Xiamen and Haikou). In 1991, upon the approval of the State Council, Zhongshan High and New Tech Zone officially became a High and New Tech Development Zone under the National Torch Program. "Torch Program" is a guiding program for developing the high and new tech industry in China, which is implemented under the organization of the Ministry of Science and Technology, with the purpose of implementing the strategy of " developing the country through science and education", and promoting the commercialization of high and new tech achievements, the industrialization of high and new tech commodities and the internationalization of high and new tech industry. As can be inferred from its purpose, the development planning of the state for the high and new tech industry is a development process of "achievements-commodities-industry-internationalization". As China gradually joined WTO, the demand of foreign trade market became one of the major economic boosters for cities on the southeastern coast of China, and the continuous rise of the demand of overseas markets, especially Hong Kong and Taiwan trade agency, for production environment, product quality and production technology promoted the technological upgrade and access threshold of industries, especially OEM and ODM. The effect of scale economy emerged initially, and

high and new technology also developed vigorously. National Torch Center defined the development in this period as a phase of entrepreneurship. In this phase, high and new tech zones in various parts of China focused on investment promotion, and Zhongshan was no exception. Please note that, in 1994, the Ministry of Science and Technology of PRC, the People's Government of Guangdong Province and the People's Government of Zhongshan City jointly established "National Industrial Base of Health Science and Technology" in the High and New Tech Zone, reserving a huge development space and a leading industrial orientation for the sustainable development of the High and New Tech Zone.

1.1.2.3 The proposition of "three-suitable" cities and the gradual expansion of the economy of local industrial clusters (2000-2016)

After 2008 financial crisis, the demand of international market weakened, so that enterprises shifted the focus of their attention to domestic market. Exactly because of the policy orientation of the state to the real estate market in this period, the economic development model of local industrial clusters of Zhongshan concentrated on home life and supportive products and services came into being. The management system of enterprises not only relies on production quality, but also needs to be supported by functionary departments on the other end of the Smile Curve including an independent brand, marketing and channel operation. From the orientation of the economic management books in this period, we can also clearly notice that the emphasis and orientation were already shifted from production planning, assembly line management, quality control, inventory management and other internal affairs to marketing, CI design and customer relation management.

In 2001, Zhongshan officially proposed the objective of building "three-suitable" new-type cities: "suitable for entrepreneurship", "suitable for residence" and "suitable for innovation", actively boosted economic restructuring and achieved an obvious effect. The GDP of Zhongshan increased from EUR 4.244 billion in 2000 to EUR 43.874 billion in 2016, by 10.34 folds.

As shown in Figure 1-1, before 2013, the economic aggregate of Zhongshan City always maintained a two-digit growth, showing a desirable growth trend, and ranking the fifth place in Guangdong Province for many successive years. Since 2013, the growth of GDP of Zhongshan based on comparable price has been slowing down obviously (less than 10%).

Since the GDP exceeded RMB 200 billion in 2011, the growth has always been declining, which is exactly a typical case of "new normal state" proposed by Chinese government in

2014. As can be inferred from Table 2-1-1 (Table 2-1-1 in Appendix 2), the per-capita GDP of Zhongshan City already reached EUR 13995 in 2016; among the three big industries, the percentage of the secondary industry, the service industry and agriculture accounted for 52.3%, 45.5% and 2.2% respectively, while the ratio of light and heavy industry was 56.94: 43.06; and the urbanization level reached 88.2%. As judged according to the phased indicator system of economic development phases, Zhongshan is exactly in a transitional phase from the later period of industrialization to the period of post-industrialization and knowledge-based economy. The future model of economic development of Zhongshan will be adjusted thoroughly.

Figure 1-1 2006-2016 Zhongshan GDP and Growth

As indicated by the data of the municipal statistics bureau in the same period, the GDP of the 16 provincial local industrial clusters in Zhongshan reached euro 17.525 billion in 2012, accounting for 57.5% of the total GDP of the city. Therein, the decorative lighting of Guzhen Town, the redwood furniture of Dayong Town and the hardware of Xiaolan Town had a market share of more than 50% in domestic market. Such a high market share achieved by local industrial clusters of Zhongshan City was not an overnight success. The concentration of industries went through a development process of more than ten years. In this process, some local industrial clusters achieved glorious development achievements, while “a new normal state” occurred to some local industrial clusters to different extents after the glory. Why could some local industrial clusters develop and expand continuously and gradually become

regional brands? Why did some local industrial clusters gradually fall into oblivion in their growth process? Based on due study, we have found out that each round of explosive market growth was closely related to "innovation". For example, the redwood furniture industry of Dayong Town already reached a certain scale in the early 1990s. However, due to the restriction of the drying technology, the shackle of large-area deformation and crack tended to occur to redwood furniture products exposed to the dry weather in northern China. Exactly after Dayong Town became a local industrial cluster of redwood furniture in 2000, a public R & D platform of redwood drying was established, which developed a complete set of fast drying production devices through cooperation and collaborative innovation with universities. The devices were popularized in the whole town, so that the redwood furniture products of Dayong not only had a better quality, but also seized a vast market of northern China by spanning the Yangtze River, and developed and grew rapidly along with the boom of Chinese real estate market. Nowadays, under "a new normal state" marked by the growth slow-down of Chinese economy, a new shackle has occurred to the redwood furniture industry of Dayong. How to break through the bottleneck and build a brand-new situation is also the research significance and purpose of this thesis. From Table 2-1-2 (Table 2-1-2 in Appendix 2), we can notice that the local industrial clusters of Zhongshan have basically developed in the fields of home life and supportive products and services.

1.2 The difficulty

In such a context, we urgently need to conduct systematic analysis and research to the development model of local industrial clusters of Zhongshan. The transitional process from factor driving to innovation driving is a process of superposition and aggregation. Only when the innovative factors act upon the existing resource factors for fusion and promotion, can the connotation of innovation driving in boosting industrial transformation and upgrade be brought into full play. It is no doubt a pseudo-proposition to merely rely on information technology, Internet, intellectual property right and other innovative factors to drive the transitional development of economy by stripping the analysis of the resource factors. Only combining the two effectively and achieving the combination of "1+1＞2" is the only realistic approach. Since 2013, the phenomenon of a new normal state has also occurred to the economy of Zhongshan. However, Zhongshan has been continuously attempting to organically integrate the original characteristic industrial economy of local industrial clusters

with advanced domestic and overseas financial factor resources including information technology, Internet +, intellectual property right and biotechnology, trying to extend its industrial chain upstream and promote industrial transformation and upgrade.

In the meantime, Zhongshan still faces a lot of problems. First, limited development space. At present, the land of Zhongshan is seriously "overused". Zhongshan has been designated by the Ministry of Land and Resources as an emphatically monitored city. Zhongshan is also the only city in the Pearl River Delta which has clearly proposed reduced planning in its overall urban plan, which forces Zhongshan to have been trying to promote the vitalization and utilization of low-efficiency industrial land in recent years, so as to promote the intensive utilization efficiency of land. This has also tremendously raised the land use cost. Second, the innovative support capacity needs to be reinforced urgently. For a long time, Zhongshan is short of large research institutes, the capacity of fundamental research and original innovation, major innovative platforms, major scientific engineering projects, disruptive innovation and key and core technology. Third, insufficient innovative and highly-skilled talent. At present, the talent competition among cities in the Pearl River Delta is more and more intense. Zhongshan is short of core competiveness in attracting and retaining talent. The development plight of the difficulty in introducing and retaining talent seriously restricts the development stamina of Zhongshan.

1.3 Research object

With the specialized towns in Zhongshan City as the basic research object, this thesis conducts research and analysis in such four dimensions as "9+2" regional economic agglomeration of Guangdong-Hong Kong-Macao Greater Bay Area, 15 provincial-level specialized towns in Zhongshan City, IPR case study on specialized towns in Decorative Lighting Industry of Guzhen Town and hi-tech enterprises in order to better reflect the economic development status and future development space of Zhongshan.

1.4 Research questions

The 18th CPC National Congress proposed the accurate positioning of "letting the market play a decisive role in the allocation of resources". How to make the market play a decisive role in the allocation of resources requires clear guidelines and clear bottom line in the

methodology of policy formulation. In the top-level design, we must guide the basic standards and cognitive judgments in our daily work on two principles of guiding the direction and drawing the line. In the process of implementing innovation-driven development strategies, we must focus on the property rights system and fully realize the positive role of "As to the people, if they have a certain livelihood, they will have a fixed heart; if they have not a certain livelihood, they have not a fixed heart" and fully understand the profound implications of "implementing knowledge-value-based allocation policies". The main economic line in the development of human history is the gradual transition to the "era of knowledge-driven economy", i.e. the mainstream of today's world along the "agricultural economy era—the era of industrial economy—the era of information technology economy". The main symbol of the era of knowledge-driven economy is that knowledge can be quantified as capital to enter into the social and economic activities, and that knowledge as the property rights appears in the sequence of capital in the form of intangible assets. Only by "putting into implementation the allocation policy based on knowledge value" can the overall progress of social economy be promoted, letting China really step into the modern economic system with high quality-development. The difficulty of this proposition lies in people's deep-rooted mindset when taking economic behaviors under economic growth kinetic energy model inherent in the rapid development process of society and economy since the reform and opening up, as well as the Tucidide struggle between the high-speed and stable economic growth allocation system which has come into being and will survive in a fairly long period and the new allocation system guided by knowledge value. Without extraordinarily superb wisdom and rational knowledge, we cannot complete this historical mission. To this end, the thesis proposes the research questions from four aspects:

1. What is the theoretical basis for the formation of local industrial clusters in Zhongshan City? What kind of development path was adopted for industrial clusters in the past?

2. In the face of the new normal of economic growth and the constraints of the factor-driven development model, what kind of development path has been adopted by Zhongshan for industrial transformation and upgrading? Why was such a development path adopted? And what is its theoretical basis?

3. How to build a research model to systematically analyze the economic transformation and upgrading model for specialized towns in Zhongshan?

(1) Is there a macro-level strategic opportunity period for the economic transformation

and upgrading of specialized towns in Zhongshan City? What is it? What are the strengths and weaknesses?

(2) What is the economic structure of the specialized towns in Zhongshan City? Is it possible to study it through analytical method in a systematic and theoretical manner?

(3) Where are breakthroughs in the economic transformation of specialized towns in Zhongshan City and whether there are feasible real-life cases?

4. What are strengths of the economic innovation subject for the specialized towns in Zhongshan City? How can they be systematically analyzed and utilized?

1.5 Research methods and framework

1.5.1 Research methods

There are four main research methods in this thesis:

1.5.1.1 Historical and theoretical analysis

This thesis reviews the historical evolution of the economic development of specialized towns in Zhongshan City, combines with the theoretical research on specialized towns, industrial clusters, innovation and entrepreneurship, etc., and summarizes the formation mechanism and status quo of specialized towns. Through the qualitative analysis methods from the historical and theoretical perspectives, we can better understand the historical evolution of the economic development of specialized towns in Zhongshan at the macroscopic level, and systemically analyze the formation mechanism and current development status of industrial clusters in specialized towns of Zhongshan through domestic and foreign literature.

1.5.1.2 Comparative analysis

This thesis sorts out the related data indicators of the seven cities in the Pearl River Delta (Guangzhou, Shenzhen, Foshan, Dongguan, Zhuhai, Zhongshan and Huizhou) during the period from 2013 to 2015, and selects six indicators that can desirably reflect the city's innovative capacity (per-sq. km GDP, R & D % in GDP, invention patent holding per 10,000 people, total export, per-capita education budget outlays and annual per-capita electric power consumption). A comparative analysis was conducted over the seven cities in the Pearl River Delta. At the same time, this thesis sorts out the related data about the innovation-oriented cities in 2015 and performs a comparative analysis of the advantages and disadvantages

between these cities and Zhongshan. The comparative analysis method was used to comparatively analyze the resource endowments of Zhongshan City in Guangdong-Hong Kong-Macao Greater Bay Area at the city level, and thus the comparative advantages and potential opportunities for development of Zhongshan in comparison with its neighboring cities could be better clarified. This method is derived from SWOT analysis.

1.5.1.3 Case analysis method

Taking the intellectual property protection of specialized towns in Guzhen lighting industry as an example, this thesis emphatically analyzes the sole IPR case of the World Intellectual Property Organization in China, and proposes that Zhongshan should increase intellectual property protection, build a business environment appropriate to the modern economy and open the door to the era of knowledge-driven economy.

The selection of Guzhou for the case study on the transition from traditional industrial clusters to innovative industrial clusters helps us to describe this process from the perspective of modern economic intellectual property protection and market equity mechanisms.

1.5.1.4 Empirical analysis

(1) Cluster analysis. This thesis summarizes the economic indicators of 15 specialized towns in Zhongshan over the years, observes and compares the changes by cluster analysis before summary analysis. The economic model for specialized towns in Zhongshan has been an objective fact, and has been recognized by the functional departments of Guangdong Province. The cluster analysis can be used to academically cluster the given model for specialized towns from the perspective of various economic indicators of the specialized towns, observe their changes to find out the intrinsic law of development.

(2) Data Envelopment Analysis (DEA). This thesis reviews the development course of hi-tech enterprises in Zhongshan City, i.e. the innovation subject and sorts out the related data. DEA is adopted to analyze the performance of hi-tech enterprises in Zhongshan City as a whole. The author has collected multi-variable historical data about hi-tech enterprises, and uses DEA to better reflect the company's performance capacity between scale effect and technology effect, thus evaluating the innovation capacity of hi-tech enterprises, the innovation subject in the industrial transformation and upgrading process of specialized towns in Zhongshan City and embodying the overall situation of innovation-driven development of Zhongshan.

(3) Regression analysis. The thesis conducts regression analysis on the total factor productivity (TFP) contribution of hi-tech enterprises in Zhongshan with the aim of evaluating the innovation capacity of Zhongshan City in a multi-dimensional and comprehensive manner through quantitative regression analysis on contribution of hi-tech enterprises.

1.5.2 Research framework

The research framework is shown in Figure 1-2. This thesis, based on the concept of specialized towns, conducts analysis from such four dimensions as "9+2" regional economic agglomeration of Guangdong-Hong Kong-Macao Greater Bay Area and the positioning of Zhongshan City, the development history of specialized towns in Zhongshan and the cluster analysis, case study on the Rapid IPR Protection Center of the Decorative Lighting Industry of Guzhen Town and DEA performance analysis on hi-tech enterprises, to form a systematic analysis framework, which provides theoretical support and reference for the development of transformation and upgrading of specialized towns in Zhongshan City, and provides a reference for the theory of industrial clusters, especially the case analysis on regional industrial clusters in the Pearl River Delta.

1.6 Structure

The thesis mainly divides into eight parts. The first chapter reviews the general circumstances of Zhongshan economic development, propose the research question, determine the research objects and categories, selects appropriate research methods and research framework. The second chapter is literature review section, mainly focusing on theoretical development of specialized town, industrial cluster, industrial clusters and specialized town, specialized town transformation and upgrading model and innovative industrial clusters. Chapter three will focus on the evaluation and analysis of Zhongshan positioning and innovation capabilities in the Guangdong- Hong Kong-Macao Greater Bay Area. Chapter four will use cluster analysis method to produce annual statistical data of 15 specialized towns. The fifth chapter applies historical analysis method to review the development process of specialized towns in Zhongshan and analyzes the three major advantages and disadvantages of Zhongshan during the transition period through using comparative analysis. The chapter sixth is about the case study of specialized town

intellectual property protection in Zhongshan Lighting Town. The chapter seven uses the DEA (Data Envelopment) analysis of the historical statistical data of the high-tech enterprises in Zhongshan; the final chapter is the research conclusion of the whole thesis.

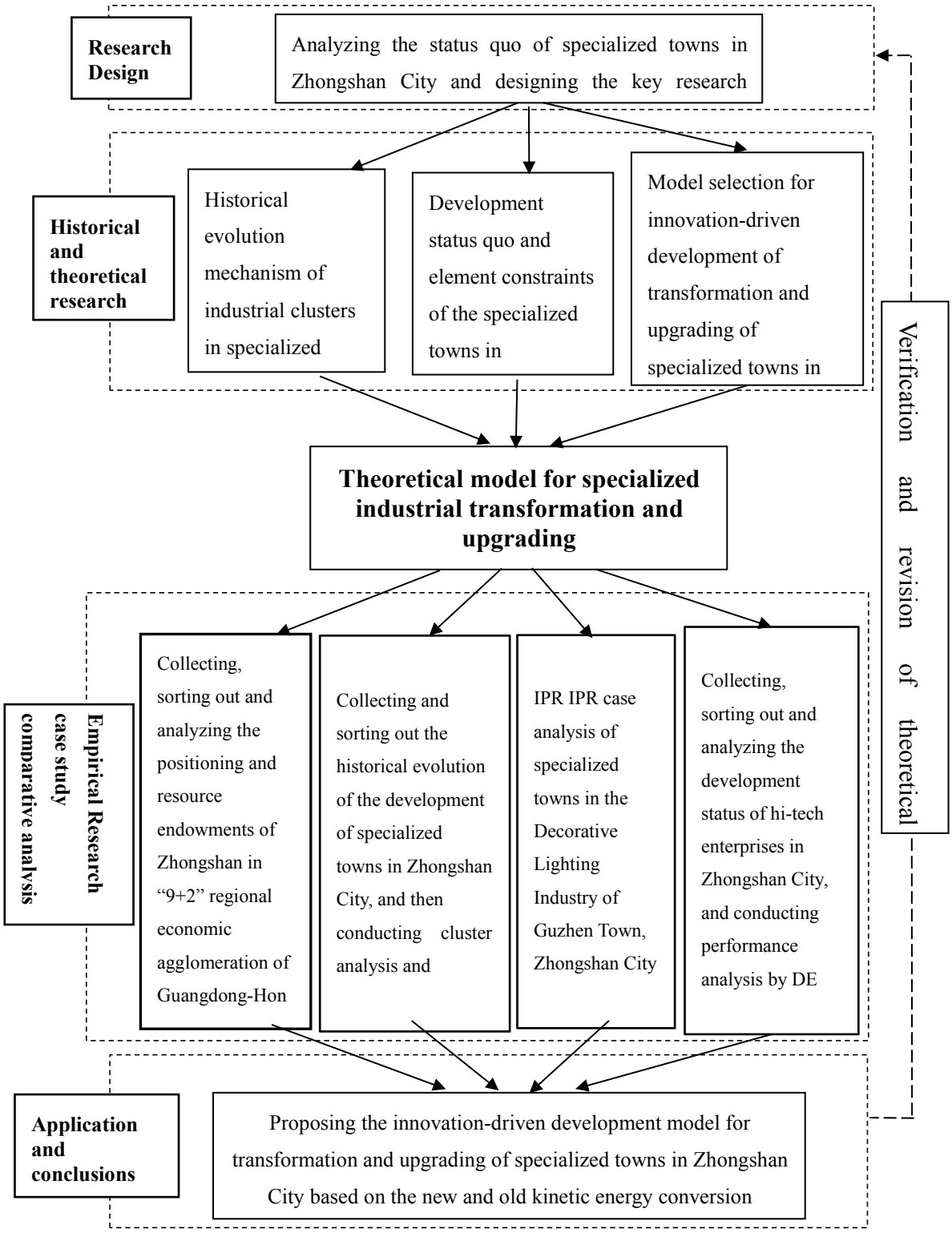

Figure 1-2 Research Framework of Industrial Transformation and Upgrading Model for Specialized Towns in Zhongshan City

Chapter 2: Literature Review

2.1 Theoretical review of industrial cluster development

2.1.1 The definition and development status quo of local industrial clusters

The concept of "specialized town" was first proposed by the scholars of Guangdong Province in the middle and late 1990s to solve such problems as Chinese rural urbanization and agricultural industrialization. Against the boom of township economy in the Pearl River Delta in Guangdong Province, the scholars of Guangdong Province began to study the causes of the boom of township economy, so as to discuss and summarize local development experience. So far, specialized town has become a major development model of town-level economic units in the Pearl River Delta. Among the 404 organic towns in the Pearl River Delta, about 100 obvious specialized towns have come into being, accounting for about 25%.

In response to "specialized town" in China, Western scholars define the phenomenon of a lot of enterprises gathering in a specific area according to a certain urgent relationship as "industrial cluster". Japanese large enterprises assemble a lot of small enterprises around themselves through a subcontracting relationship, thus reducing the risks of market trading and the management expenses of enterprises. Japanese auto enterprises have an exclusive supply relationship with part and component manufacturers. For example, Honda outsources 70% of its auto parts and components to suppliers, supplying production devices and technology to suppliers, and demanding suppliers to build warehouses near its production line, so that a geological and technological cluster has come into being between the manufacturer and its suppliers. Another example is Sassuolo, a town in Italy. The ceramic tiles produced in this town account for 30% of the total output of ceramic tiles in the world and 60% of the total export of ceramic tiles in the world. The inherent advantage for this town to acquire such a large market scale lies in the organic labor division relationship that has come into being among local small and medium-sized enterprises in such aspects as mold manufacturing, raw-material production, packing material, design, transportation and logistics. This kind of regional clustering has tremendously reinforced its competitive advantage.

A lot of domestic scholars studied the phenomena of Chinese "specialized towns" (i.e.

local industrial clusters). Zeng (2003) held the opinion that the extension and improvement of industrial chain and corresponding service chain was the core for the development of industrial clusters, and classified industrial clusters into four types (industrial transfer, advantage expansion, industrial radiation and integrated development) according to different periods for the formation of industrial clusters and the level of local economic development. Li (2002) held the opinion that the enterprises in the Pearl River Delta fell into three categories: enterprise clusters having come into being historically; enterprise clusters having come into being along the global commodity value chain, and innovative network clusters, and respectively interpreted the generation of enterprise clusters in the Pearl River Delta from such perspectives as historical factor, endowed conditions, entrepreneur talent, change of product value chain, the internationalized transfer of industry and entrepreneurship. Zha (2015) held the opinion that the industrial clusters in Guangdong Province had come into being spontaneously on the market along with the intensification of international division of labor and in the process of industrial transfer, with the following four characteristics: dominance by non-public economy, reliance on specialized markets, dominance by labor-intensive industries and dominance by simple and applicable technology.

Jiang (2002) proposed that the competitiveness of industrial clusters came from the complementary and collaborative enterprise network which had come into being internally. Pu and Yan (2004) classified industrial clusters into horizontal integrated industrial clusters of small and medium-sized enterprises and vertical integrated industrial clusters of large enterprises. By investigating the industrial clusters in Foshan City, they summarized the economic characteristics of industrial clusters as: specialized production, the agglomeration of small and medium-sized enterprises, dominance by products of traditional and mature industries, and the orientation of the spatial distribution of industrial clusters to specialized market and traffic corridor. Shen and Chen (2005) held the opinion that industrial cluster was an economic situation of rural township which dominated the economic development and employment pattern of towns, and attributed the development of industrial clusters in the Pearl River Delta to excellent location conditions, local open and innovative enterprise culture, the entrepreneurship of local government and the degree of local market orientation. By analyzing the leading types of industrial clusters, Shen and Tian (2005) classified industrial clusters into three types: production and processing, trade and circulation, and production and sales integration. Wang (2000) held the opinion that industrial clusters had three sources: manufacturing matching products according to the production and consumer demand of large

cities; forming a large batch of businesses and enterprises of "three-processing and one compensation" by introducing foreign capital; dragging the growth and development of local industrial cluster economy by relying on local specialized markets. In terms of the correlation of enterprises, some industrial clusters manufacture the same product, while some industrial clusters have the relationship of upstream and downstream products. Wang (2002) held the opinion that a vast majority of industrial clusters in Guangdong Province were dominated by the relationship of the horizontal integrated division of labor, which had come into being due to adjacency to market, simple technology and production organization, simple imitation and follow-up and the effect of estimation and diffusion. Xue (2008) held the opinion that the industrial clusters in Guangdong Province were classified into three types: labor-intensive, technology-intensive and dominated by agricultural product processing and logistics, exhibition and other service industries.

2.1.2 Theoretical analysis of industrial clusters and specialized towns

Overseas scholars interpreted the causes of industrial clusters from the perspective of economic integration and industrial organization theory.

Overseas economists hold the opinion that industrial clusters are closely related to economic integration and trade liberalization. Hanson (1998) studied the impact of economic integration with US on the employment rate of Mexican state-owned enterprises. Based on due research, he found out that trade freedom had a major impact on industrial selection, so that enterprises in northern Mexico near the border with US had benefited from the clustering economy. Forslid et al (1999) simulated the impact of economic integration on industrial site selection and agglomeration through the large-scale CGE model. As indicated by the research findings, with regard to industries whose returns to scale increase progressively and which are correlated internally, the low trading cost resulting from economic integration would promote the integration and centralization of industries. Venables (1996) studied the site selection of the industry whose upstream and downstream industries are bothincomplete competition markets. As indicated by the research findings, the reduction of transportation cost can promote the agglomeration of industries in the process of regional integration. Head et al (1994) verified the industrial effect of clustering economy by analyzing the foreign investment data of Japan from 1980 to 1992. Barrell and Pain (1999) comparatively analyzed the relative importance of industrial clustering and local labor policy through the panel data of

American enterprises in European investment areas, with their empirical results indicating that the potential possibility of industry clustering would attract more overseas direct investment. Markusen and Venables (2000) studied the site selection of transnational enterprises, and found out that the same production activity would cluster in the same country or region due to the existence of trading cost, thus giving rise to transnational enterprises.

Chinitz (1961) analyzed the phenomenon of industry clustering from the perspective of industrial organization at the earliest time. He held the opinion that industrial organization was the crucial factor that determined industry clustering and had an impact on the path of regional development, the innovation of enterprises and the behaviors of entrepreneurs. Brülhart and Torstensson (1996) studied the impact of the progressive increase and regional clustering of returns to scale on the industrial site selection, and found out that the progressive increase and regional clustering of returns to scale would also impact the trading in the industries. The industrial specialization of EU countries in the 1980s verified the theoretical prediction. Ciccon (2002) studied the industry clusters of France, Germany, Italy, Spain and UK, and found out that the industrial clusters of the above-mentioned countries were similar to those of US. Krugman (1991) held the opinion that industry clustering was the result of manufacturers pursuing the scale economy and reducing the transportation cost. Based on Krugman (1991) , Forslid (1999) considered the impact of human capital and tangible capital on industry clustering, and found out through research that the clustering of human capital would facilitate industry clustering, while the clustering of tangible capital could not result in industry clustering. Based on the fact that flexible specialization results in reinforcement of social division of labor, Sabel (1999) interpreted the formation of industrial clusters by introducing the trading cost. Specialization results in clearer and clearer division of labor among enterprises, while flexible production demands a higher trading frequency and a longer lead time, and the huge trading cost resulting from this makes enterprises tend to seek upstream and downstream enterprises locally (in a certain concentrated area), so that industrial clusters can come into being gradually. With the externality of human capital as the centripetal force of industry clustering, Palivos and Wang (1996) set up a dynamic balance of spatial interaction, and found out through research that the overflow effect of knowledge could tremendously promote industry clustering.

Domestic scholars also proposed their own theoretical interpretation to industry clustering. Huang and Chen (2006) held the opinion that the externality of technology and the

externality of currency were the causes of the formation of industrial clusters. Under the framework of the new economic geography, Zhou (2006) discussed the spatial balance of clustering and diffusion and the conditions of industrial outsourcing as a new model of industrial diffusion. He held the opinion that industrial diffusion and agglomeration coexisted, dependent on the interaction of the effect of market expansion and the effect of crowding.

In connection with the theory of new economic geography and urban economics, Chen et al (2009) proposed a theoretical framework of the clustering of productive service industry, and conducted empirical analysis to the cross-section data of 222 cities at the preferential level and above in China, and found out through research that knowledge intensity, information technology level, urban and governmental scale had a significant impact on the clustering of productive service industry and showed some regional difference. However, in contrast with manufacturing clustering, the clustering of productive service industry was not subject to the geographic factor. Yin (2009) summarized the basic impacting factors of industry clustering as scale economy, consumer preference, spatial cost and psychological expectation. Zhang (2012) summarized the impacting factors of the clustering of financial industry as geo-location, economic effect, trade demand, government boosting and infrastructures, and verified the positive impact of economic effect, trade demand, government support and geo-location on the clustering degree of financial industry through the sample data of 31 provinces and cities from 2000 to 2009.

As can be inferred from above-mentioned researches, the focus of attention of industry clustering lies in the cluster formation of characteristic industries, and the industry clustering process of specialized downs relies on the industry clustering within the administrative division scope oriented to local governments. Therefore, we can define local industrial clusters as a development form of clustering economy with the basic units of administrative towns (districts), relatively centralized leading industries, a large economic scale, wide market coverage and a high degree of specialized supporting coordination. What needs to be emphatically explained here is the concept of the administrative areas of specialized towns. As the most grass-roots administrative organization in the Chinese administrative system setup, the town directly governs the specific affairs of local residents, enterprises and other practitioners, and undertakes the most grass-roots management in terms of the specific industrial organization and the implementation of policies. That is to say, the town undertakes complicated, specific and multiple management affairs. It is also the most grass-roots

organization to be assessed. It is an administrative unit which gets in touch with economic entities the most often. Therefore, studying the industry clustering of grass-roots administrative areas is not only a realistic urgent need for analyzing the process of Chinese economic growth and the future transformation and upgrade of Chinese economy, but also has a very high value for theoretic research.

2.1.3 The competitive advantage of local industrial clusters

The earliest researches on industrial competition were focused on the national level. However, along with continuous attention to the importance of industry clustering, a lot of scholars began to pay attention to regional industry clustering.

Porter (1990) conducted analysis from the perspective of international competition. He held the opinion that competitive advantage came from factor condition, demand condition, related and supported industries and enterprise strategy. The system consisting of the above four aspects determines the key factor of industrial competition: the availability and capacity of resources. Porter (1990) pointed out that the inherent factor that boosted the process of industry clustering was the exchange and flow of information among enterprises. Based on the theory of competitive advantage theory of Porter, Padmore and Gibson (1998) considered the factors of regional infrastructures and market at the same time, and set up a scoring system to describe and appraise the advantage and disadvantage of industrial clusters. Based on the advantage in such aspects as specialized labor force, intermediate products and knowledge externality, Krugman (1991) set up the theory of regional specialized industries. According to this theory, both scale economy and scope economy would weaken along with market fluctuation and technological innovation. However, industry clustering can achieve the minimization of trading cost through the horizontal and vertical division of labor and collaboration in the clusters, thus compensating for the economic loss brought by demand fluctuation and technological innovation. Baptista and Swann (1998) found out through 8-year investigation into 248 manufacturing enterprises in UK that, enterprises inside strong industrial clusters had stronger innovative capacity than enterprises outside the clusters. Baptista and Swann (1999) found out by comparatively studying American and British computer industry clusters that, strong industrial clusters could attract new entrants more easily, and enterprises inside industrial clusters developed more rapidly. Capello（1999） held the opinion that cluster learning was a marked feature of SME clusters, and found out through

empirical study of Italian high-tech enterprises that, cluster learning could help SME clusters to promote the production efficiency of factors and support product innovation. The above-mentioned researches verify the positive impact of SME clusters on the production efficiency and product innovation of SME.

Lundvall et al (1998) held the opinion that innovation was a process of interaction between users and product designers, Regional clustering connects enterprises through information exchange and knowledge overflow and reinforces them through the internal circulation of labor market. Duranton and Puga (2004) identified three micro-foundations of urban clustering economy: sharing, matching and learning mechanism. In terms of sharing, urban clustering economy can share indivisible facilities, and the scale economy and risks brought by a lot of diversified suppliers and city diversification. In terms of matching, urban clustering economy can promote the expected matching probability and matching quality and alleviate the hold-up problem. In terms of learning mechanism, urban clustering can promote knowledge accumulation and product innovation. By comparatively studying American Silicon Valley and the No. 128 Highway Area, Saxenian (1994) found out that the sustainable technological innovation of Silicon Valley could be attributed to a lot of informal exchange among enterprises in Silicon Valley, thus achieving information transfer and knowledge sharing among small companies. In contrast, the weak innovative capacity of the No. 128 Highway Area could be attributed to the rigid culture which encouraged stability and self-dependence.

Domestic scholars also conducted a lot of investigation and empirical research to the competitive advantage of local industrial clusters. Fu (2003) held the opinion that SME clustering could promote the production efficiency and innovative capacity of enterprises, and could seek optimal differentiation by unifying promotion, normalizing quality standards, identifying specific technology and popularizing common trademarks. The agglomeration of Chinese SME can refer to the Italian model: boosting vertical division of labor and flexible specialization; clustering enterprises set up a joint goal, establishing a relationship of trust and cooperation. Xu (2001) held the opinion that the formation of Chinese industrial clusters had an inherent logic relationship with the open economy, and we should further exert the advantage of industrial clusters in specialized division of labor and achieve higher industrial efficiency.

2.2 The model analysis of transformation and upgrade of local industrial clusters

2.2.1 Theoretical foundation of transformation and upgrade of local industrial clusters

The upgrade mechanism of industrial clusters is classified into two types: (1) The interpretation from the perspective of collective efficiency. Sehmitz (1995) held the opinion that the joint action pursued by occasional and unconscious external economies and various conscious actors in the clusters--vertical and horizontal relations can generate "collective efficiency. The size of this efficiency determines the upgrade potential of clusters. Another type of literatures conducts analysis from the perspective of global value chain, holding the opinion that clustering enterprises achieve cluster upgrade by reinforcing association with the outside of clusters. Therein, international buyers, manufactures, etc. play a role in promoting cluster upgrade.

Based on the impacts of internal and external association of clusters on the innovative impetus and capacity of industrial clusters, Wang et al (2008) classified the innovative mechanism of clusters into two types: endogenous and exogenous, summarized four types of innovative mechanism and path in the industrial clusters of specialized towns in Guangdong Province, and pointed out the government role and function in the upgrade process of specialized towns in Guangdong Province. In the globalized context, Humphrey and Schmitz (2002) proposed four models of industrial cluster upgrade from the perspective of global value chain: the upgrade of technical process, product upgrade, function upgrade and interdepartmental upgrade. The governance structure of industrial clusters includes governmental agencies, commercial institutions, service centers, the bank system, universities and scientific research institutes, syndicates and key and leading enterprises. The major means of industrial cluster transformation and upgrade lies in the rise of competitiveness of industrial clusters, and can be discussed generally from the perspectives of structure, capacity and factor. From the perspective of structure, Gong (2007) held the opinion that the competitiveness of industrial clusters was the integration of competitiveness at such layers as enterprises, clusters and government. Sun and Li (2006) further classified the competitiveness at these layers into the core level, auxiliary level and external level. From the perspective of capacity, Zhang (2006) held the opinion that the rise of the competitiveness of industrial clusters was embodied as the optimization of the performance of industrial clusters, and the

emphasis should be laid on the highly-efficient development, allocation and utilization of internal resources and the promotion of the competitiveness of industrial clusters in such aspects as innovative capacity, integrating capacity and learning capacity. From the perspective of factors, Porter (1998) held the opinion that the competitiveness of industrial clusters depended on the level of such factors as production factor, demand condition, relevant supporting industries, enterprise strategy, structure and competitor performance, as well as the influencing effect of government and opportunity. Therefore, Han and Wang (2005) held the opinion that industrial clusters needed to exert the function of government planning to continuously acquire competitive advantage and achieve transformation and upgrade and properly integrate and adjust organizational resources, functions and skills inside and outside industrial clusters.

2.2.2 The countermeasure research of transformation and upgrade of local industrial clusters

Against the urgent need of transformation and upgrade of domestic industrial clusters, a lot of domestic scholars have conducted a lot of researches on the implementation paths of transformation and upgrade.

Fu (2003) held the opinion that the modernized transformation of clusters involved conscious management actions. After occupying the market through the cost leading strategy, clusters need to enrich product differentiation through technological innovation, and cultivate market and boost brand construction through marketing. Collective learning can change the solidified cognitive model of entrepreneurs in the clusters and flexibly adapt to the dynamic and changeable external environment. Li et al (2015) summarized the factors influencing the innovative capacity of industrial clusters as the capacity of innovative R & D and management, the capacity of innovative environmental construction, the capacity of innovative contribution and the international competitiveness of products, and held the opinion that scientific and technological policies should show proneness toward the weaknesses of the innovative capacity of local industrial clusters in Guangdong Province. Lin (2015) held the opinion that local industrial clusters faced numerous problems and challenges in terms of innovation driving, including: enterprises and industries are not completely adapted to the rapidly-changing market demand and commercial model; the interdepartmental and interregional barriers in the administrative system considerably restrict the allocation and

flow of resources; the service function of the innovative platform system fails to completely meet the development requirement of enterprises and industries in terms of pertinence and specialization; the development contradiction of industries, towns, society and ecology becomes more conspicuous, with a higher difficulty of governance.

Against such problems as the SME dominance and insufficient innovative capacity of local industrial clusters, Wu (2005) proposed that building a regional platform of technological innovation was an important means of boosting the upgrade of SME industrial clusters. The platform of technological innovation refers to the integration of a series of shared factors in an area, including knowledge, information, talent, policy and their correlation. Xue (2003) held the opinion that the low grade of products and industrial structure, insufficient innovative capacity and lack of core and key technology were common problems faced by all enterprises in industrial clusters, while the innovative capacity construction of enterprises in industrial clusters served as an important orientation for promoting the overall competitive advantage of industries in Guangdong Province. With industrial clusters as an effective organization for breaking the technological innovation restriction of SME, Yao (2007) held the opinion that the government should support the research and development of common technology in industrial clusters, provide the policy orientation of technological innovation of industrial clusters, change the original proneness of preferential policies toward regions to proneness toward technology and industries, boost the exchange and cooperation between enterprises in clusters and enterprises and institutions outside clusters, and promote the innovative capacity of clusters.

During researches on the transformation and upgrade of local industrial clusters, a lot of scholars paid attention to the transformation and upgrade of industrial clusters in Guangdong Province. Gao (2016) selected Zhongshan City and Dongguan City as the representatives of endogenous clusters and exogenous clusters, and by analyzing their difference in labor input, level of utilization of foreign direct investment, foreign trade and market demand, arrived at the conclusion that endogenous industrial clusters should implement talent strategies, cultivate high-quality and high-skill talent, vigorously attract foreign capital, create proprietary brands and explore domestic market, and embedded industrial clusters should emphasize the improvement of talent quality, reinforce embeddedness and expand the domestic and overseas market share. Against problems with the industrial clusters in Guangdong Province, including serious homogenization among towns, weak independent

innovative capacity, weak industrial service system and SME difficulty in financing, Zha (2015) proposed that the transformation and upgrade of industrial clusters in Guangdong Province under innovation driving should be started from such three aspects as improving the technological innovation system of clusters, perfecting the industrial service system and exerting government functions. Gu and Su (2015) built evaluation indicators of development capacity of industrial clusters in such four aspects industrial competitiveness, independent innovative capacity, sustainable development capacity and government's leading and organizing capacity, stratified the agricultural clusters, clusters of the secondary industry and service-oriented clusters in Guangdong Province, and put forward construction strategy analysis and suggestion for clusters at various layers.

With 19 prefectural cities in Guangdong Province (excluding Shenzhen and Shaoguan) in Guangdong Province as their research objects, Guan et al (2016) applied the method of principal component factor analysis and the method of DEA, and comprehensively evaluated the influencing efficiency of the regional innovative environments of various preferential cities toward the innovative performance of industrial clusters. Based on analysis of empirical results, they proposed that local governments should dedicate themselves to building a desirable regional innovative environment and energetically promote their innovative capacity. By studying the 2006-2013 panel data of 56 industrial clusters of Dongguan City and Zhongshan City in Guangdong Province, Liang et al (2016) found out that the transformation and upgrade of industrial structure of industrial clusters could boost the process of urbanized construction, and the longer the surviving period of industrial cluster is; the higher effect the optimized adjustment of its industrial structure would have on the rise of urbanization level. Ouyang Jun and Zhang (2009) compared the industrial clusters (i.e. specialized towns) with overseas industrial clusters, and found out that their similarity lay in the agglomeration of SME producing and operating the same industry or related industries in large quantity in geographic space, and the gradual development of the relationship of division of labor and cooperation among them. However, they also found out that there existed a wide gap between the specialized towns in Guangdong Province and overseas industrial clusters in such aspects as the regional industrial technology level, the development of intermediate service and the form of cooperation and division of labor. Shen and Tian (2005) held the opinion that the development of Chinese industrial clusters bore the following basic characteristics: First, the leading position of characteristic industries is prominent although the industrial level is not high in general; Second,the scale of enterprises is relatively small although the specialized

markets and production enterprises are highly centralized; Third, the trend of cooperation is very obvious although the internal economic competition of industrial clusters is prominent; Fourth, non-public economy is the theme of the economy of industrial clusters.

Wang (2002) held the opinion that the social and economic division of labor in Guangdong Province had evolved from the mutual division of labor among different products and industries among industrial clusters to the division of labor on different production links among enterprises inside industrial clusters, namely the shift of production organizations from horizontal integration to vertical integration. The actualization of the change of vertical integration involves the entry of network resources dominated by large enterprises, the network relationship between self-growing large enterprises and SME and the establishment and improvement of corresponding institutional rules. Existing industrial clusters in Guangdong Province are dominated by traditional and labor-intensive industries, with few emerging industries including electronic information, biomedicine and creative design, little R & D investment and weak R & D capacity. Wu and Li (2014) proposed that we should solve the transformation and upgrade problem of the industrial clusters in Guangdong Province from the perspective of R & D and upgrade of core technology. From the perspective of building a complete and efficient modern agricultural industry chain, Xu et al (2015) proposed that the transformation and upgrade of agricultural industry clusters should be dedicated to integrating the agricultural industry chain, thus increasing the length and width of agricultural industry chain. Lai et al (2016) paid attention to the innovation of the construction model of the service platform of medium, small and micro enterprises in the industrial clusters in Guangdong Province, and according to the different economic development foundation, government support degree, scientific and technological level, function positioning and other factors of industrial clusters, proposed five types of new service platforms of medium, small and micro enterprises: productivity promotion centers in various forms, platforms of public technology R & D and innovative service, platforms of integrated agricultural service, platforms of information service and chambers of commerce.

2.3 Relevant theoretical researches of innovation, entrepreneurship and cluster innovation

2.3.1 Innovation, disruptive innovation and entrepreneurship

The research on the relationship between innovation and industrial change is the core content of Joseph Schumpeter research. In 1934, in his classic work entitled *Theory of Economic Development*, he defined innovation as "conducting 'creative destruction' to existing production factors, and accordingly 'actualizing a new combination'". He also defined innovation in the following five aspects: (1) Product innovation; (2) Technological innovation; (3) Market innovation; (4) Resource innovation; (5) Management innovation. In the eyes of Joseph Schumpeter, the function of "entrepreneur" as the "soul" of capitalism was actualizing "innovation", and introducing "a new combination". The so-called "economic development" means that the entire capitalist society continuously actualizes this "new combination". Furthermore, he first broke through the innovativeness of entrepreneur. However, he firmly believed that entrepreneur was a very unstable state, and innovation was the only standard for judging entrepreneurs. Based on development and verification of nearly a century, we can notice that the works of Joseph Schumpeter have made an outstanding accomplishment, guiding our cognition to "innovation" and pointing out the core role of innovation in economic development. Joseph Schumpeter also pointed out the most fundamental two production factors - labor and land service, and held the opinion that labor force played a leading role in production, and land was passive, and he classified labor into guiding labor force and guided labor force. During their daily labor, people usually both have guiding labor and guided labor, although the guiding labor and guided labor performed in different periods, on different occasions and in different roles have different proportions, which exist in the form of dynamic changes. Accordingly, management in its narrow sense has come into being. In my opinion, innovation comes into being when we generate a new combination with guided labor and leading land and other production factors during guiding labor. Such innovation is exactly the essence of management, and is also the core booster of economic development.

In 1985, Peter Ferdinand Drucker published *Innovation and Entrepreneurship*, which defined the category of entrepreneurship for us more clearly: the essence of entrepreneur is purposeful and organized system innovation; and is providing customers with value and

satisfaction by changing products and services. He classified innovation into three types: (1) Product innovation; (2) Management innovation; (3) Social innovation. Drucker expanded the category of entrepreneurship. He pointed out that not only enterprises but also social organizations, the fourth organizations and the government needed entrepreneurship. It was clearly proposed in the *Report of the Nineteenth Congress of Communist Party of China* that we should advocate and value entrepreneurship in economic work. The connotation of the socialism with Chinese characteristics proposed by Chairman Xi Jinping in the new age includes the innovation and entrepreneurship of government. During the 39 years of reform and opening-up, we have been continuously carrying out institutional reform, having provided core driving force for the economic development in the primary stage of socialism. By 2020, we will have built a moderately-prosperous society in an all-round way. By 2050, we will have actualized socialist modernization. The government is required to, with an entrepreneurial vigor and measure, boost the tide of innovation and entrepreneurship of the whole society and promote the formation, development and expansion of the new economy.

In 1995, Clayton M. Christensen proposed disruptive innovation, and studied hard disc, excavator and other industries in his book entitled the *Innovators' Dilemma*, and proposed RPV models (Resources, Procedure and Value) based on the study of value network. He held the opinion that the value network of large companies was relatively solidified, with much difficulty in providing the necessary soil and environment for disruptive innovation. New concepts and technology are usually initiated by large companies, but eventually the small companies incubated by and derived from large companies form a disruptive network of innovative value. His core meaning is that the new combination of resources needs different value network judgments to build the environment and soil, and cultivate the value network system of disruptive innovation by integrating resources and management processes. Large companies have much difficulty in breaking such a shackle in the intrinsic value network system, and the government also has such a problem. Take Zhongshan for an example. The value network which previously came into being in the specialized towns of economic development was labor-intensive and light-industry-dominated scale-effect industrial-clusters which came into being on the basis of the transfer and agglomeration of overseas technology and around traditional industries. How to break through the intrinsic value network not only requires the marginal innovation of small enterprises oriented to main market players and derived new companies, but also requires the government and social organizations to build the soil and environment, encourage and guide the diversion of resources, form the new value

network and actualize disruptive innovation. Take Ali, Jingdong, Tencent, Huawei and other emerging industry tycoons represented by knowledge-based economy for an example. All of them formed a new business type and a new value network system and formed the new economy of disruptive innovation from small enterprises and new companies and new development enterprises derived from related industries.

2.3.2 Innovation of industrial clusters

Cui and Huo (2016) held the opinion that building a network of knowledge collaborative innovation could promote the knowledge innovation of industrial clusters, and proposed that the knowledge collaborative innovation network of industrial clusters chiefly included four coordination mechanisms: strategic collaboration, organization collaboration, resource collaboration and institutional collaboration. Chen et al (2016) classified the integrated innovation of industrial clusters into technological integration, organization integration, knowledge integration and strategic integration, and built the game model based on the integrated innovation of industrial clusters. Based on the empirical study of integrated innovation of Liaoning Province, Chen et al (2016) pointed out that the integrated innovative cooperation among enterprises in industrial clusters should be considered in the long run, and a long-term and stable development strategy should be established.

Against the instability, openness and other organizational features of innovative network of industrial clusters, Helian Zhi and Xing (2017) described the evolution process of innovative network of industrial clusters with their self-organized dynamic mechanism equation, and identified the key factors influencing the evolution process. Wang and Fan (2017) studied the chain-fission innovative model of industrial clusters, and held the opinion that the innovation of industrial clusters mainly came from the introduction of new technology and the internal spontaneous innovation. Luo et al (2017) defined the interaction between industrial clusters and external knowledge sources as the open innovation of industrial clusters, and portrayed the relationship between open innovation and innovative performance of industrial clusters with the structural equation model. Based on research, they found out that interactive learning had an important impact on the innovative performance of industrial clusters, while internal and external horizontal and vertical cooperation, industry-learning-research combination and public service platform had a positive impact on the innovative performance of industrial clusters.

Against the supply-chain industrial clusters, Wang and Chen (2016) analyzed the technological innovation in industrial clusters with the method of dynamic game, and found out through research that supply chain enterprises had the act of hitch-hiking when there existed technological overflow, while cooperative innovation was strictly superior to independent innovation; and when there existed intense competition among core enterprises, the shrunken technological overflow would force enterprises to participate in technological innovation. With the mold industry cluster of Kunshan as a sample, Qiu and Shen Zhi (2017) studied the technological innovative mechanism of industrial clusters under the global value chain, and found out that a perfect regional innovative system and the leadership of enterprises in the clusters were major factors that guaranteed the internal innovation of industrial clusters.

2.4 Summary

As we can infer from relevant literatures, local industrial clusters emerge in the form of traditional industrial clusters in a sense, while the transformation and upgrade of traditional industrial clusters must be conducted by and around innovation driving as a main line. Innovation means a new combination of resources, management process and value network. In the specialized towns of Zhongshan, with regard to whether traditional industrial clusters must adhere to transformation and upgrade to high and new tech industrial customers, economic development has its own law. However, both the central government and the local governments have clearly proposed the principles of supply-side reform, restructuring and emphasis on the quality and structure of economic development since the Eighteenth Congress of Communist Party of China, instead of blindly pursuing the speed of economic development, as well as the overall objective of carrying out the innovation-driven development strategy and building an innovative country and innovative cities. Therefore, a higher requirement has been posed for how the government guides the transformation and upgrade of local industrial clusters under the new normal state, and the essence of transformation and upgrade is doing a good job of stock and increment on the basis of original resource endowment.

In the following, the 15 local industrial clusters in Zhongshan will be clustered by the method of clustering analysis in the quantitative analysis and according to the development situation of local industrial clusters. In addition, two parallel path suggestions will be

provided for the traditional industrial clusters of Zhongshan in connection with the positioning of Zhongshan in Guangdong-Hong Kong-Macao Greater Bay Area, the DEA performance analysis of the inputs of high and new tech enterprises and the typical case study of the intellectual property right decorative lighting specialized town.

(1) Based on the resource endowment of traditional characteristic industry foundation, reinforce the development of intelligent manufacturing, create the cluster region of equipment manufacturing in the west of the Pearl River Delta, optimize the industrial structure of traditional industrial clusters and improve the quality of industrial development.

(2) Start a new era of knowledge economy development of Zhongshan according to the development characteristics of knowledge economy and in connection with its own strength.

Both the above two points must rely on the main line of innovation-driving, to vigorously advocate entrepreneurship. Just as advocated by Edmund S.Phelp in his book *Flourishing*, "The flourishing of a nation depends on the breadth and depth of innovative activities, while the flourishing of a country comes from the innovation universally participated in by its people."

Chapter 3: Analysis of the Innovative Capacity of Zhongshan City in Guangdong-Hong Kong-Macao Greater Bay Area

3.1 The proposition of the concept of "Guangdong-Hong Kong-Macao Greater Bay Area"

It was proposed in *2016 Guangdong Government Work Report* that, "Launch the upgrade campaign of the cities in the Pearl River Delta, and create Guangdong-Hong Kong-Macao Greater Bay Area jointly with Hong Kong and Macao". It was clearly proposed in *Government Work Report* by Premier Li Keqiang at the two congresses (NPC and CPPCC) in 2017 that, "Formulate the Development Plan of Urban Agglomeration in Guangdong-Hong Kong-Macao Greater Bay Area after due research". Thus, the construction of Guangdong-Hong Kong-Macao Greater Bay Area was upgraded to be a national strategy, rivaling the three greater bay areas in the world, namely New York Bay Area, San Francisco Bay Area and Tokyo Bay Area, becoming a new engine of Chinese and even world economic development. The world-class urban agglomeration of "Guangdong-Hong Kong-Macao Greater Bay Area" consists of "9+2" cities, namely an urban agglomeration consisting of 9 cities (Shenzhen, Guangzhou, Foshan, Dongguan, Zhuhai, Zhongshan, Huizhou, Jiangmen and Zhaoqing) and 2 special administrative regions (Hong Kong and Macao). As the leader of Earth Observatory Team of National Geophysical Data Center, Elvidge proposed, "You can obtain a lot of information from the urban night lamplight of a country, e.g. population, economic growth, foreign investment, war and economic recession."

Please refer to Figure 3-3-1 (Figure 3-3-1 in Appendix 3) "NASA" 2016 Satellite Contrast Night Pictures of New York Greater Bay Area and Chinese Southeastern Coast. The left picture is the night picture of New York Greater Bay Area, and the right picture is the night picture of Chinese southeastern coast. We can obviously notice that Guangdong-Hong Kong-Macao Greater Bay Area on the lower left corner of the right picture looks like a bright star in the night sky as an engine of Chinese economic growth. In 2016, the economic aggregate of Guangdong-Hong Kong-Macao Greater Bay Area was nearly EUR 1.3 trillion, continuing to rank the first in the economic aggregates of various provinces, autonomous and

municipalities. “Guangzhou-Shenzhen-Hong Kong” is the ridge of the urban agglomeration of Guangdong-Hong Kong-Macao Greater Bay Area. Along with the launch of Shenzhen-Zhongshan channel, Hong Kong-Zhuhai-Macao Bridge, Shenzhen-Maoming Railway and Guangzhou-Foshan-Zhuhai Intercity Light Rail, the entire Pearl River Delta has formed an urban agglomeration like San Francisco Greater Bay Area, with a much higher radiating impact on the passenger flow, material flow and capital flow in surrounding urban areas. At the first Forum of Guangdong-Hong Kong-Macao Greater Bay Area, Tencent CEO Ma Huateng proposed “The future trends of scientific and technological development, namely the trinity of software, hardware and service, none of which is dispensable, are exactly the advantages of Guangdong-Hong Kong-Macao Greater Bay Area. If we can integrate these three advantages, we can make great achievements in the future.” In the past 20 years, Guangdong-Hong Kong-Macao Greater Bay Area has cultivated a large batch of leading enterprises including Huawei, ZTE, Tencent, Gree, Midea, SF Express, DJI and BGI..

On July 1, 2017, Framework Agreement for Intensifying the Cooperation Among Guangdong, Hong Kong and Macao and Boosting the Construction of the Greater Bay Area was signed in Hong Kong. The Greater Bay Area with “cooperation and win-win” as its theme will certainly again raise the flag of reform and innovation and boost its transitional development in the following four aspects:

(1) Interconnection: The cooperative development of all international first-rate bay areas is based on the sufficient and smooth material, passenger, information and capital flow in the areas, which not only requires a developed rapid transit network and public traffic organization, but also should break the policy barrier of information and capital flow and fully actualize the interconnection inside the bay areas.

(2) Opening-up and guidance: “One country, two systems” is the most important background for the development of Guangdong-Hong Kong-Macao Greater Bay Area. How to intensify the cooperation with Hong Kong and Macao under the CEPA framework, carry out the strategy of “The Belt & Road” on the premise of maintaining the long-term prosperity and stability of Hong Kong and Macao, and guide the economic development and opening-up of Pan-Pearl-River-Delta region and even the whole country, is a major mission that the state has bestowed upon Guangdong-Hong Kong-Macao Greater Bay Area.

(3) Innovation-driving: The development of modern industries needs to be driven by scientific and technological innovation. Pure investment pull and export processing cannot

meet the future development demand of Guangdong-Hong Kong-Macao Greater Bay Area any longer. Scientific and technological innovation requires the accumulation of talent, technology and other innovative resources and the creation of the innovative environment, thus forcing the government to make innovation on systems and mechanisms.

(4) High-quality life: The work targets of the government are creating a desirable residential environment and building a high-quality life circle according to the requirements . In addition, a desirable ecological environment, perfect public service and diversified cultural and leisure facilities are also important measures for the greater bay area to attract innovative talent amidst talent competition.

3.2 Analysis of innovative capacity of seven cities in Pearl River Delta

By trimming Guangdong Statistics Information Network, we can sum up the relevant data indicators of the seven cities in Pearl River Delta from 2013 to 2015 (Guangzhou, Shenzhen, Foshan, Dongguan, Zhuhai, Zhongshan and Huizhou). Through standardized treatment of data, we can obtain six important indicators that can desirably reflect the innovative capacity of the seven cities in Pearl River Delta: per-sq. km GDP, R & D % in GDP, invention patent holding per 10,000 people, total export, per-capita education budget outlays and annual per-capita electric power consumption. The selected six indicators representatively represent the development quality and innovative capacity of regional economy. Therein, per-sq. km GDP, total export and annual per-capita electric power consumption desirably reflect the economic development level and development quality of a region, while R & D % in GDP, invention patent holding per 10,000 people and per-capita education budget outlays can desirably reflect the innovative capacity endowment of this region.

After standardized treatment of data in Table 2-3-1 (Table 2-3-1 in Appendix 2), we can obtain the standardized data of six innovative capacity indicators of seven cities in Pearl River Delta from 2013 to 2015 as shown in Table 3-2. The detailed treatment method is: summing and obtaining the annual average of the indicator data of the three years, and obtaining the benchmark values of the four indicators including per-sq. km GDP, invention patent holding per 10,000 people, per-capita education budget outlays and annual per-capita electric power consumption of seven cities in Pearl River Delta with the land area and annual average year-end permanent population as the denominator. R & D % in GDP and total export take the

annual average as their benchmark values. Then, based on standardized treatment, we can obtain the standardized data sheet of six innovative capacity indicators of seven cities in Pearl River Delta from 2013 to 2015 as shown in Table 2-3-2 (Table 2-3-2 in Appendix 2).

Because of the large absolute value of the data of Shenzhen and Guangzhou, in order to more vividly indicate the relevant data pictures of nine cities in Pearl River Delta, this thesis categorizes Shenzhen and Guangzhou as Type A, and categorizes Foshan, Dongguan, Zhongshan, Zhuhai and Huizhou as Type B, and conducts comparative analysis with a radar map respectively.

3.2.1 Evaluation and analysis of six innovative capacity indicators of Shenzhen and Guangzhou from 2013 to 2015 with a radar map

Just as shown in Figure 3-1，2013-2015 Guangzhou and Shenzhen Innovative Capacity Evaluation Radar Map, Shenzhen is superior to Guangzhou in various innovative capacity indicators, which is an important system for Shenzhen to have become one of the cities with the most outstanding level of innovative capacity development in Guangdong-Hong Kong-Macao Greater Bay Area and even the whole world through acceleration and surpassing in recent years, and in particular, Shenzhen is far ahead of Guangzhou in such four indicators as R & D % in GDP, per-sq. km GDP, total export and invention patent holding per 10,000 people. As the capital of Guangdong Province, Guangzhou also has a good performance in annual per-capita electric power consumption and per-capita education budget outlays. In particular, considering that Guangzhou has a big base Figureure of population, Guangzhou is one of the three cities with the largest land areas among the nine cities in Pearl River Delta, and Guangzhou still ranks the first in the whole province in terms of the absolute value of economic aggregate GDP, Guangzhou, Shenzhen, corresponding to Hong Kong and Macao, are the four central cities in Guangdong-Hong Kong-Macao Greater Bay Area, which drive and influence the cities in and around Pearl River Delta, forming an innovation-driven development pattern of “4+5+2”. Although more scholars prefer to choose the “9+2” form to describe the bay area with administrative characteristics, namely: nine cities in Pearl River Delta + Hong Kong and Macao special administrative regions, the statement of “4+5+2” conforms to the facts all the more in terms of the economic driving pattern of innovation-driven development.

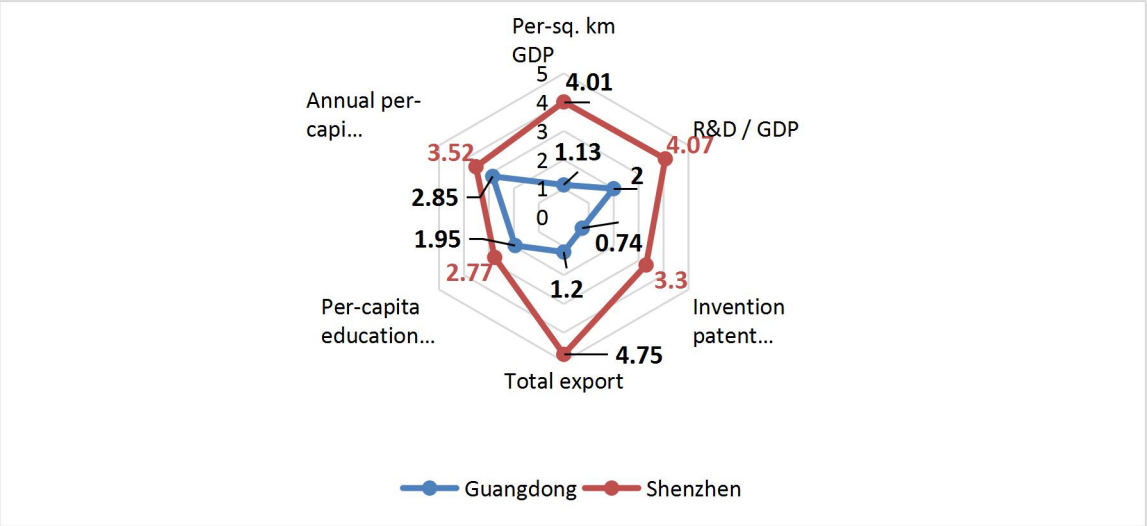

Figure 3-1 2013-2015 Guangzhou and Shenzhen Innovative Capacity Evaluation Radar Map

3.2.2 Evaluation and analysis of six innovative capacity indicators of Zhongshan from 2013 to 2015 with a radar map

As a “bridgehead” for the innovative resource matchmaking of Zhongshan-Zhuhai West Bank of Guangdong-Hong Kong-Macao Greater Bay Area, Zhongshan should not only exert its geological advantage, but also play its pivot and transformation role in innovative resources. Creating the equipment manufacturing cluster region on the western bank of Pearl River is one of the core positionings of the CPC Committee and People’s Government of Guangdong Province. As the “bridgehead” on the western bank of Pearl River, Zhongshan has laid a solid and firm foundation of industrialization, and will certainly seize the opportunity of taking over the overflow of excellent innovative resources of Guangzhou and Shenzhen and further reinforce the development and growth of equipment manufacturing in the future. The second echelon of the nine cities in Pearl River Delta represented by Foshan, Dongguan, Zhongshan, Zhuhai and Huizhou will also become one of the new momentums for the innovative development of Guangdong-Hong Kong-Macao Greater Bay Area. We have mentioned in the above paragraph the integration of the three key words “hardware, software and service” proposed by Ma Huateng to the development of Guangdong-Hong Kong-Macao Greater Bay Area. Then in the aspect of “hardware”, Guangzhou and Shenzhen will devote more effort to and more focus on the two points of “software and service” along with the development of their own economy and the premium of land, human and other innovative resources. As the second echelon, Foshan, Dongguan, Zhongshan, Zhuhai and Huizhou will

certainly take over the overflow of the "hardware" resources of Guangzhou and Shenzhen. Therefore, studying the mutual competition among these cities especially the four cities including Foshan, Dongguan, Zhongshan and Zhuhai and the innovative capacity foundation of Zhongshan in this process of competition has become the focus of attention of this thesis, and has also provided research reference for the regional advantage endowment at the municipal level of the transformation and upgrade model of local industrial clusters of Zhongshan.

From Figure 3-2, we can notice that the annual per-capita electric power consumptions of these four cities are basically equal to one another, while Zhongshan has a good foundation in the two indicators including R & D % in GDP and per-capita education budget outlays, and still needs to further reinforce the three indicators including per-sq. km GDP, total export and invention patent holding per 10,000 people. In terms of the listed companies in various prefectural cities in 2017, Shenzhen has 267 A-share listed enterprises, far ahead of other cities, and Guangzhou, Foshan, Zhuhai, Dongguan and Zhongshan have 92, 30, 27, 24 and 20 listed companies respectively. Zhongshan still needs to work hard at the scale of enterprises and the holding of listed companies.

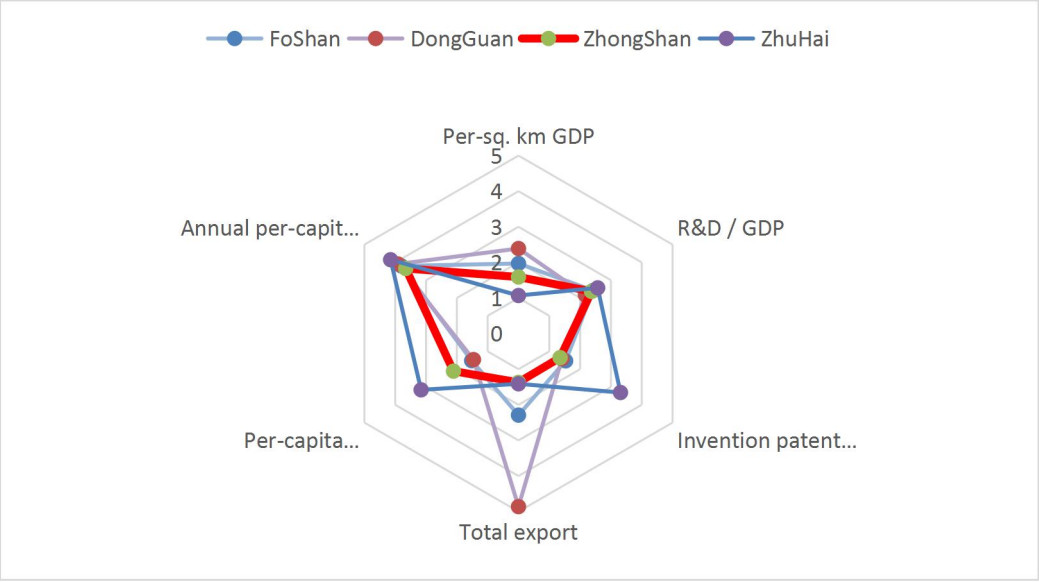

Figure 3-2 2013-2015 Foshan, Dongguan, Zhongshan and Zhuhai Innovative Capacity Radar Map

3.3 The positionings of Zhongshan in Guangdong-Hong Kong-Macao Greater Bay Area

3.3.1 An important comprehensive traffic hub in the Greater Bay Area

Along with the completion and launch of Shenzhen-Zhongshan Channel, Shenzhen-Maoming Railway, Guangzhou-Zhuhai Intercity Rail Transit, Guangzhou-Zhongshan-Zhuhai-Macao Intercity Rail Transit, Guangzhou-Macao Expressway and Nansha Port Railway and other regional traffic facilities, and the navigation of Guangdong-Hong Kong-Macao Yacht Free Travel and Zhongshan-Shenzhen Express Passenger Cruiser, the status of Zhongshan as a comprehensive traffic hub in the Greater Bay Area has come into being gradually. The improvement of the regional traffic facilities in Zhongshan has not only facilitated Zhongshan's own travel to the outside and perfected the 2-hour rapid transit network among various cities in the Greater Bay Area, but also facilitated the formation of rapid radiating channels from the core of the Bay Area to the western regions of Guangdong Province and Guangxi Zhuang Autonomous Region.

3.3.2 A demonstration area for Guangdong-Macao intensive cooperation

Zhongshan and Macao have a natural relationship in many aspects, and have a very strong complementation in development conditions and industrial structure, and have a lot of opportunities for mutual humanistic contacts and industrial cooperation. In the context of exploring Guangdong-Hong Kong-Macao intensive cooperation in the Greater Bay Area, Zhongshan and Macao can explore new cooperative models in such aspects as innovation, entrepreneurship, tourism linkage, cross-border finance and shared service, and build a demonstration area for Guangdong-Macao intensive cooperation through platform creation and policy innovation. *Guiding Opinions on Intensifying the Regional Cooperation of Pan-Pearl-River-Delta* printed and issued by the State Council in March 2016 clarifies the status of Zhongshan Demonstration Area for Guangdong-Macao All-round Cooperation as a national major cooperative platform. Zhongshan City should accordingly further boost the continuous intensification of the innovation of cooperative system and mechanism and the content and level of cooperation between Guangdong and Macao.

3.3.3 International base for advanced manufacturing

On July 4, 2017, National Development and Reform Commission and the governments of Guangdong, Hong Kong and Macao jointly signed the *Framework Agreement on Intensifying Guangdong-Hong Kong-Macao Cooperation and Boosting the Construction of the Greater Bay Area*, which clearly proposed that Guangdong should build a center for scientific and technological and industrial innovation and a base for advanced manufacturing and modern service industry. As one of the four most economically-prosperous cities in Guangdong, Zhongshan boasts a solid industrial foundation and should become a base for advanced manufacturing with an international influence. On the one hand, Zhongshan needs to accelerate transformation and upgrade for its traditional industries based on township economy, form a large regional industrial chain with cities around it and actualize its shift from "traditional processing" to "advanced manufacturing". On the other hand, according to the *Thirteenth-Five-Year Plan* requirements of Guangdong Province, Zhongshan City is now emphatically building 'a world-class base for equipment manufacturing" and "a national demonstration area for biomedical scientific and technological innovation". These two sunrise industries will add a strong impetus to the manufacturing of Zhongshan. In addition, by reinforcing industrial cooperation and innovative cooperation with Shenzhen and Nansha, Zhongshan is qualified to become an important place of undertaking and cultivation for the development of strategic emerging industries in the Bay Area.

3.3.4 A sub-center for scientific and technological innovation in the Greater Bay Area

In terms of the distribution of the scientific and technological resources of Guangdong-Hong Kong-Macao Greater Bay Area, the layout of talent, scientific research institutions, innovative enterprises and innovative capital is very centralized, and is chiefly concentrated in the three cities of Hong Kong, Shenzhen and Guangzhou, while other cities have relatively limited innovative resources. After the completion of Shenzhen-Zhongshan Channel, the contacts between Zhongshan and Hong Kong, Shenzhen and Guangzhou as the three innovative centers will be very convenient, and their innovative cooperation will also become more frequent. In terms of the construction of the innovative system of Guangdong-Hong Kong-Macao Greater Bay Area, Zhongshan with a solid industrial foundation, a short distance with Shenzhen, a strong land bearing capacity and other advantages can become a base for the achievement transformation of scientific and

technological innovation, become a sub-center for scientific and technological innovation in the Greater Bay Area, and help to create the regional innovative axis belt of "Zhongshan-Guangzhou Nansha-Shenzhen".

3.3.5 A high-quality livable city in the Greater Bay Area

Blessed with a graceful eco-environment, Zhongshan has been awarded such honors as UN Habitat Award and One of the Best Eco-civilization Cities in China, and is a model city of ecology and livability in Guangdong-Hong Kong-Macao Greater Bay Area. In the future, while creating a high-quality life circle in the Bay Area, Zhongshan also needs to further perfect its various public services oriented to the region (especially Hong Kong and Macao), offer better and more diversified life leisure service, promote residents' sense of happiness, and build Zhongshan into a new height that can attract innovative talent for gathering.

3.3.6 A center for the exchange of Zhongshan culture among Chinese and overseas Chinese worldwide

Dr. Sun Yat-sen is the core cultural brand of Zhongshan City, with his thoughts and spirit boasting a very strong influence and appeal among Chinese and overseas Chinese worldwide. While participating in international competition, Guangdong-Hong Kong-Macao Greater Bay Area should also actively boost the exchange and interaction among different civilizations worldwide. By relying on Zhongshan culture, we can not only create a platform for exchange among Chinese and overseas Chinese worldwide, but also help to promote national cohesion for residents in Hong Kong, Macao, Taiwan and other regions.

3.4 Summary

In conclusion, Zhongshan should accelerate its integration into Guangdong-Hong Kong-Macao Greater Bay Area. As can be inferred from the six functional positionings, their core purpose is to develop high-quality economic growth models, step into post-industrialization, and start a new era of the development of knowledge economy, based on the characteristic industrial economy of local industrial clusters and guided by innovation-driven development.

Chapter 4: Cluster Analysis of Specialized Towns in Zhongshan City

4.1 Basic development situation of specialized towns in Zhongshan City

After more than a decade of development, Zhongshan City has formed an economic pattern dominated by characteristic industrial clusters of specialized towns. In the next phase, technological innovation must continue to be the focus of efforts to promote the development of characteristic industrial clusters along the endogenous growth and innovation-driven track. In 2012, the annual total output value of 15 provincial specialized towns reached more than EUR 192.05 billion, accounting for 57.5% of the city's total. Among them, entertainment facilities in Gangkou Town, lighting in Guzhen Town, mahogany furniture in Dayong Town, hardware in Xiaolan Town and shower cabins in Fusha Town occupied a domestic market share of 70%, 60%, 60%, 40% and 30% respectively. The development of specialized towns is focused on traditional industrial clusters.

4.2 Cluster analysis of the development of specialized towns in Zhongshan City

To systematically distinguish the industry scale, innovation ability and other development situations of specialized towns in Zhongshan City, this thesis adopts cluster analysis. The statistical data of 15 specialized towns in Zhongshan City during the 6-year period from 2010 to 2015 are chosen for quantitative analysis and the development of the 15 specialized towns is classified using the method of cluster analysis, so as to provide effective data reference and decision-making support for the formulation of public policies.

4.2.1 Data source and indicator selection

This thesis chooses the statistical data of 15 specialized towns in Zhongshan City during the 6-year period from 2010 to 2015, and selects 23 indicators that can reflect the development of the specialized towns according to the research topic, including the regional

total output value, total industrial output value, including: total output value of enterprises above designated size, industrial added value, total agricultural output value, total amount of industrial profits, total number of staff and workers, industrial electricity consumption, number of characteristic economic enterprises, total output value of characteristic industries (RMB ten thousand), total number of workers of characteristic industries, number of scientific and technical personnel of characteristic industries, research and development (RD) personnel, total social input in science and technology of the town, governmental input in science and technology, number of patent applications of the town, number of patent authorizations of the town, number of enterprises above designated size established with R & D institutions, number of provincial and above brand products, number of provincial and above famous trademarks, number of innovative service agencies in the town, annual number of training personnel of innovative platform and number of foreign service enterprises of innovation platform, etc.

To explore the dynamic change and performance of various specialized towns in different periods of development, we intend to set two years as a cycle and carry out factor analysis. Before such analysis, because of the differences in indicator data units, it is necessary to standardize the data. Spss provides a variety of data normalization methods. Here Z normalization method is applied, namely, the difference between each variable value and its average value is divided by the standard deviation of the variable. The average value of each dimensionless variable is 0 and the standard deviation is 1, thus eliminating the influence of dimension and magnitude. This method is the most commonly used one in multivariate comprehensive analysis.

4.2.2 Factor analysis results

First, the data of 2010-2011 is analyzed as per the factor analysis steps.

4.2.2.1 Table of correlation analysis below, part of the screenshots

Correlation analysis is shown in Table 2-4-1 (Table 2-4-1 in Appendix 2). It can be seen that the correlation coefficient among multiple variables is large and the corresponding Sig value is relatively small, indicating that there is significant correlation among these variables, which in turn suggests the necessity of factor analysis.

4.2.2.2 KMO and Bartlett's test

KMO is used to test the partial correlation among variables. From Table 4-1, we can see during the calculation of partial correlation, as other influencing factors are controlled, it is smaller than the simple correlation coefficient. Generally, the best result is achieved when KMP statistic value is greater than 0.9, the result acceptable when it is 0.7 or more and if less than 0.5, it is not suitable for factor analysis. KMO value is 0.787 in this thesis, thus, factor analysis is feasible. The statistic value Sig of Bartlett's test is 0, indicating that significant correlation exists in variables, which is consistent with the conclusion reached from the correlation matrix above.

Table 4-1 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.787
Bartlett's Test of Sphericity	Approx. Chi-Square	990.710
	df	253
	Sig.	.000

4.2.2.3 Commonality of variables

The extraction column in the table 2-4-2 (Table 2-4-2 in Appendix 2) shows the commonality values of variables. The commonality interval is [0,1]. For example, the commonality of regional total output value is 0.926, indicating that the extracted common factor can explain 92.6% of the variance of regional total output value, similar to the explanation of the commonalities of other variables.

4.2.2.4 Table of Variance Explained

Table 2-4-3 (Table 2-4-3 in Appendix 2) shows the variance explained by each common factor and its cumulative value. It can be seen that the cumulative variance explained by the first four common factors reaches nearly 83%, so the extraction of these four common factors can well explain the information contained in all the original variables.

4.2.2.5 Eigenvalue Scree Plot

A diagram is made according to the figures in the "Total" column below "Initial Eigenvalues" in the above table and the eigenvalues are arranged in descending order. From Figure 3-4-1 (Appendix 3), we can see that the eigenvalue change tends to be moderate after

the fourth common factor; therefore, the selection of four common factors is relatively appropriate.

4.2.2.6 Factor Loading Matrix Before and After Rotation

The "component matrix" (Table 2-4-4 in Appendix 2) is the initial un-rotated factor loading matrix. The "rotated component matrix" (Table 2-4-5 in Appendix 2) is a rotated factor loading matrix. After rotation, the load distribution on each common factor becomes clearer. Therefore, it is easier to explain the meaning of each factor compared with non-rotation.

4.2.2.7 Component Score Coefficient Matrix

The Table of "component score coefficient matrix" is shown in Table 2-4-6 which we can see it in Appendix 2.

4.2.2.8 Overall Score Analysis

To consider the overall score of each specialized town and facilitate comparative analysis, the scores of the four common factors are weighted and summed, and the weight is the variance contribution value or the variance contribution rate. In this thesis, the variance contribution rate is taken as the weight and the variance contribution rates of the four rotated common factors are 0.238, 0.228, 0.189 and 0.172 respectively.

$$\mathbf{zF=0.238*FAC1\_1+0.228*FAC2\_1+0.189*FAC3\_1+0.172*FAC4\_1} \quad (4.1)$$

Thus, the calculation formula of the annual overall score of each specialized town is as below:

$$\mathbf{zF=0.238*FAC1\_1+0.228*FAC2\_1+0.189*FAC3\_1+0.172*FAC4\_1} \quad (4.2)$$

The 2010-2011 overall score of each specialized town is obtained. Following the same steps, we obtain the overall scores of the specialized towns in 2012-2013 and 2014-2015 in turn with the relevant data of Table 2-4-7 (Table 2-1-1 in Appendix 2).

4.2.3 Cluster analysis and results

According to the above table of overall score matrix, this thesis adopts the hierarchical clustering method. The clustering method uses the furthest neighbor elements and the measure standard uses the sum of squares of deviations method. The sum of squares of deviations refers to the sum of the squared Euclidean distance of each sample to the center of gravity of

the category. The use of this method will tend to make the sample size of each category as close as possible and the clustering effect is desirable.

The following is the clustering result of specialized towns in 2010-2011 (Table 4-2), 2012-2013 (Table 3-4-3) and 2014-2015 (Table 3-4-4):

According to the results, if the specialized towns are divided into three categories, the classification result will be:

(1) 2010-2011: Category 1: 3, 5, 8, 9, 11, 12, 13, 14, 15 (i.e. Minzhong, Dongsheng, Gangkou, Sanjiao, Fusha, Nanlang, Sanxiang, Banfu, Dayong); Category 2: 2, 4, 6, 7, 10 (Huangpu, Dongfeng, Guzhen, Shaxi, Nantou); Category 3: 1 (Xiaolan).

(2) 2012-2013: same as above, no change.

(3) 2014-2015: Category 1: 3, 7, 8, 9, 11, 12, 13, 14, 15 (i.e., Minzhong, Shaxi, Gangkou, Sanjiao, Fusha, Nanlang, Sanxiang, Banfu, Dayong); Category 2: 2, 4, 5, 6 (Huangpu, Dongfeng, Dongsheng, Guzhen); Category 3: 10 (Nantou); Category 4: 1 (Xiaolan).

4.3 Evaluation of cluster analysis results

4.3.1 Correlation between cluster analysis results and industrialization of characteristic industries

As shown in Table 4-2, the four categories of specialized towns in 2014 are denoted by four colors in cluster analysis. We can clearly see that the industrial feature of the nine specialized towns in Category 1 is basically traditional industries (namely, agricultural products, casual wear, game and entertainment, textiles, fine chemicals, tourism, classical furniture, American style traditional furniture, mahogany furniture); the four specialized towns in Category 2 are more concentrated on traditional industries and have a higher degree of industrialization (namely, food industry, small household appliances, office furniture, lighting); Nantou in Category 3 and Xiaolan in Category 4 are focused on household appliances and hardware products respectively, with a the higher industrialization requirement.

Table 4-2 Color Representation Graph of Cluster Analysis of Specialized Towns in 2014-2015

Serial number	Town	Name of provincial specialized towns in Guangdong Province	Serial number	Town	Name of provincial specialized towns in Guangdong Province
1	Xiaolan	Specialized town of hardware products	9	Sanjiao	Specialized town of textiles
2	Huangpu	Specialized town of food industry	10	Nantou	Specialized town of household appliances
3	Minzhong	Specialized town of agricultural products	11	Fusha	Specialized town of fine chemicals
4	Dongfeng	Specialized town of small appliances	12	Nanlang	Specialized town of tourism
5	Dongsheng	Specialized town of office furniture	13	Sanxiang	Specialized town of classical furniture
6	Guzhen	Specialized town of lighting	14	Banfu	Specialized town of American style traditional furniture
7	Shaxi	Specialized town of casual wear	15	Dayong	Specialized town of mahogany furniture
8	Gangkou	Specialized town of game and entertainment			

Category 1 Category 2 Category 3 Category 4

4.3.2 Cluster analysis results and enterprise agglomeration of the town

From the perspective of A-share listed companies in Xiaolan Town and Nantou Town in Category 4 and Category 3, the industrial agglomeration in these areas is obviously different from the towns in Category 1 and Category 2. As of 2017, there were 5 listed companies in Xiaolan (Tatwah Smartech, Palm Garden, Chant Group, MLS, Vatti) in Xiaolan and 2 listed companies in Nantou (Homa Electrical, Sotech Smarter), while for other specialized towns, only Sanjiao and Sanxiang Towns respectively have one listed company (Ellington Electronics, Jinsheng Aluminum).

4.3.3 Cluster analysis change results

According to the above classification results, there was no obvious change in the development of the specialized towns during the four years from 2010 to 2013, while great changes occurred to Dongsheng and Shaxi, and Nantou also stood out during the two years from 2014 to 2015. Xiaolan always maintained the first place. From the point of view of aggregate economic volume, Shaxi suffered a significant economic downturn from 2013 onwards and its GDP showed a negative growth. It was mainly because its leading industry of casual wear received a great market impact. The leading industry market of office furniture of Dongsheng recovered. The household appliance industry clusters of Nantou gradually began to grow. Among them, a number of leading household appliance enterprises such as Changhong, TCL, Homa Refrigerator showed obvious advantage of backwardness. In 2013, Nantou Town invested more than EUR 4 million to create a public service platform for household appliances radiating the entire Zhongshan City and the surrounding areas, was stationed in China Quality Certification Center (CQC), China National Electric Apparatus Research Institute (CEI) , China Household Electric Appliance Research Institute, TUV and other domestic and foreign authoritative testing organizations, and established several innovative institutions, including Household Appliance Innovation Center of Zhongshan City and Domestic Electric Appliance Technology Innovation Center of Guangdong Province. It provides testing, certification, design, training, consulting, research and development and other services to more than 3,000 enterprises every year, having formed characteristic industrial advantage with color TV, air conditioners, refrigerators and other large household appliances as the lead and with extensive range of small appliances and spare parts, to promote the transformation and upgrading of household appliance industry in Nantou Town.

Chapter 5: Strategic Analysis in Different Industrial Transformation Periods

5.1 Incubation period: “one town one policy”, investment promotion

According to the characteristics of leading industries, development level and resource endowment of the specialized towns, and by following the law of industrial economic development, we grasp the demand for transformation and upgrading through industrial ecological assessment, study and formulate the supportive development policy of "one town one policy" and the technological transformation and upgrading measures, and develop concrete roadmap for industrial technology upgrading to promote traditional industrial upgrading and product innovation. With the goal of “Beautiful Habitat in Zhongshan”, we will orderly integrate the traditional home industries such as lighting, household appliances, furniture, clothing, metal products, wood floors and shower cabins, enhance the overall competitiveness and market share of traditional competitive industries in the city, and strive to cultivate several 10 billion or even 100 billion-level industrial clusters.

5.2 Aggregation period: building public service platform and strengthening industrial technical support

Special assistance will be given to the improvement of public service platform construction in the specialized towns to form a whole chain integrated service system penetrating the whole process of enterprise development featured by close combination with the leading industries of the specialized towns and complete service functions. According to market rules, technical innovation, inspection and testing, information, intellectual property, e-commerce, industrial design, corporate finance, personnel training, entrepreneurship incubation and other comprehensive services will be provided to enterprises so as to realize an integrated public service platform which serves towns, industries and enterprises.

We have mentioned earlier in this thesis the core role the science and technology service platform has played in the past development course of the specialized towns. This platform

provides a stage and window for the technical exchange of many small-, medium- and micro-sized enterprises in the specialized towns and also an opportunity for prefecture-level cities without research-oriented universities like Zhongshan City to carry out industry-university-research collaboration with scientific research institutes outside the city and even outside the province. It also plays a good role in the spillover of technological innovation and technical knowledge.

As of 2015, Zhongshan City has completed more than 360 service platforms, 17 innovation service platforms of specialized towns (Table 2-5-1 in Appendix) and more than 30 other science and technology intermediary service agencies, covering technology R & D, appearance design, inspection and testing, certification service, science and technology information, technical patent service, personnel education and training, and SME financing guarantee, etc., having strongly supported the continuous enhancement of regional innovation ability.

By means of the "Government-Industry-University-Research" integration development path, the existing science and technology service platforms of all kinds in Zhongshan City have basically formed a point-line-plane combined science and technology service system with "1+4" (Industrial Technology Research Institute of Zhongshan City + Beijing Institute of Technology, Wuhan University, Wuhan University of Technology, South China University of Technology) regional innovation platform as the plane, high-tech zones and public innovation service platforms of the specialized towns as the line, enterprise engineering technology research and development centers as the point, branch offices of the state key laboratories and centers and academician workstations as the high-level personnel carrier, and science and technology intermediary services as the industry incubation and financing platform to serve industrial upgrading, enterprise innovation and development.

5.3 Transformation and upgrading period: "3 major advantages and 3 major disadvantages" of Zhongshan City

"3 major advantages and 3 major disadvantages" of Zhongshan City, advantages: 1. good industrial base and strong industrial advantage; 2. good population and labor force structure and technical education personnel base; 3. low wage costs of personnel, with certain competitiveness in the Pearl River Delta. Disadvantages: 1. The shortage of land for

construction use has become a core factor restricting the industrial development of Zhongshan; 2. Insufficient growth of fixed asset investment and relatively small investment and financing scale; 3. big gap in advanced manufacturing, producer services and other core industries compared with benchmark cities.

5.3.1 Main industrial base and industrial advantages

Today, Zhongshan City has basically formed such special industrial clusters as electronic information, hardware, household appliances, lighting, textile services, home furnishing, packaging and printing. The industrial output value of clusters accounts for more than 70% of the city's total. As mentioned in the cluster analysis above, the industrial clusters are mainly based on the characteristic industrial system of specialized towns, including the metal product industry in Xiaolan Town, the lighting industry in Guzhen Town, the household appliance industry in Nantou Town, the small household appliance industry in Dongfeng Town, the mahogany furniture industry in Dayong Town, the food processing industry in Huangpu Town, the textile and apparel industry in Shaxi Town, and the electronic information and auto parts of the Torch Hi-tech Industry Development Zone. From the perspective of geographical space, the east is mainly the agglomeration area of emerging industries; the north, especially the northwest is the concentration area of dominant manufacturing industries and has the basic conditions for the development of intelligent products, intelligent design and intelligent applications; the south shows a low industrial concentration, but has a certain base for the development of the electronics industry and the equipment manufacturing industry.

In Table 2-5-2 (you can see it in Appendix 2), as indicated by the comparison of the added value of industrial enterprises above designated size in the major cities of the Pearl River Delta, the proportion of added value of manufacture of electrical machinery and equipment in enterprises above designated size in Zhongshan is slightly higher than the average (13.33%) of the seven major cities in the Pearl River Delta (Guangzhou, Shenzhen, Foshan, Dongguan, Zhuhai, Zhongshan, Huizhou) and the proportions of added value of manufacture of food (6.53%), manufacture of textile garments, footwear and headgear (5.62%) and manufacture of general purpose equipment (6.88%) are higher than those of the similar industries of the other major cities of the Pearl River Delta. Therefore, compared with the other cities in the Pearl River Delta region, Zhongshan City has certain scale and advantages in the four industries of manufacture of electrical machinery and equipment, manufacture of

general purpose equipment, manufacture of food and manufacture of textile garments, footwear and headgear.

5.3.2 Personnel wage cost resource advantages

From Table 2-5-3 (Table 2-5-3 in Appendix 2), among several major industries, the average wage of manufacturing industries in Zhongshan City is also at a low level as Huizhou and Dongguan, being only about RMB 50,000 per year, and the wage of information transmission, software and information technology services with rapid growth and great development prospects is also lower than that of other cities except Huizhou, being only less than RMB 100,000. Similarly, the wage of scientific research and technical services is at the lowest level. Compared with the average level of RMB 130,000 per capita in Shenzhen, the wage in Zhongshan is less than 80,000. This is in line with Zhongshan's structure of population and employment skills. That is, Zhongshan has no disadvantage compared to the recent fast-growing cities such as Dongguan and Huizhou in terms of developing manufacturing industries; instead, it has cost advantages in undertaking information transmission, software and information technology services, and scientific research and technical services.

5.3.3 Labor force advantage

By the end of 2015, Zhongshan City had a resident population of 3.21 million, with a registered population of 1.587 million. The resident population has always maintained a net inflow status, as Zhongshan City has always kept a certain appeal to immigrant population. At the end of 2016, Zhongshan City adjusted the household registration system, issued new household registration policies and relaxed the conditions of personnel household registration, which is helpful to the increase of personnel attraction. With respect to the age structure of population, currently the population of Zhongshan clearly shows good “olive type” structure, that is, the proportion of youth and elderly population is small and the proportion of working ages is relatively big. Among the resident population of Zhongshan City, the population aged 0-14 is 449,271 accounting for 14.00%, up 2.34% over 2010; that aged 15-64 is 2,576,424, accounting for 80.27%, down 3.7% over 2010; that aged 65 and above is 183,905, accounting for 5.73%, up 1.36% over 2010. The working-age population has declined and the number of elderly people has increased. Among the resident population, the population now living in a

place inconsistent with the county (city or district) of the household registration and having left the registered address for more than half a year is 162.45 persons, accounting for 50.61%. A large number of migrant young adults are employed in Zhongshan, which has increased the proportion of the population of working ages and made the proportion of the elderly population lower than the average (8.48%) of Guangdong Province. In summary, the population structure of Zhongshan is young and has abundant labor resources. The urbanization of population in Zhongshan City is at the forefront of the nine cities in the Pearl River Delta, but the urbanization speed is gradually slowing down. In 2015, the population urbanization rate increased by only 0.05% over 2014.

In terms of technical personnel, the structure of population education in Zhongshan has been greatly improved as a whole in recent years with the relevant data of Table 2-5-4 (Table 2-5-4 in Appendix 2). However, the education level of migrant population is low and the number of high-end professionals is insufficient. According to the data from a sample survey of 1% of the population in Zhongshan in 2015, compared with the sixth national census in 2010, the number of people with university education per 100,000 people in Zhongshan increased from 7,775 to 11,322, up 46%; the number of people with senior high school education increased from 21,005 to 22,733; and the number of people with junior high education dropped from 44,981 to 35,845. Among them, the proportion of population with university education and senior high school education in Zhongshan City was higher than the average level of Guangdong Province. There were 11,014 people with university education and 19,846 with senior high school education in every 100,000 in Guangdong Province. Zhongshan had 308 and 2887 respectively more than the average level of the province. However, the proportion of those receiving junior college education or above in the total population was still at the intermediate level compared with the nine cities in the Pearl River Delta, ranking fifth only. If compared with Guangzhou, Shenzhen and other cities of talent aggregation, Zhongshan City did not vary much from the two cities in terms of the proportion of personnel with senior high school education, but its personnel with junior college education and above accounted for only a half of the two. Half of the migrant population in Zhongshan City was still mainly with junior and senior high school education. This also reflects Zhongshan's weak appeal to high-end professionals and that its population quality still needs further improvement.

5.3.4 The shortage of land for construction use has become a core factor restricting the industrial development of Zhongshan

Regarding land area, Zhongshan City has a land area of 1,784 square kilometers, ranking penultimate in the Pearl River Delta region, only higher than Zhuhai. More importantly, the land for construction use, especially the industrial land in Zhongshan City has become increasingly tense in recent years. In 2017, the total supply of state-owned land for construction was 906 hectares in Zhongshan City. Compared with 2016, the supply of land for industrial and mining storage and commercial use was declining, only the supply of residential land was increased, which cannot meet the land use needs of production expansion of enterprises and the entry of new enterprises. At the same time, from the point of view of land supply structure, the proportion of the land supply for commercial use and transportation was significantly lower than the proportion of general urban construction, indicating that development focus of the tertiary industry and producer services was not highlighted in Zhongshan and that land resources needed for transformation and upgrading were severely limited. In addition, Zhongshan City has been listed as a key monitoring city by the Ministry of Land and Resources. It is also the only city in the Pearl River Delta that has explicitly proposed to reduce planning in its overall urban planning. This in turn forces Zhongshan to aggressively promote the utilization of inefficient industrial land in recent years to improve the benefit of intensive use of land. In this way, the land cost is also greatly increased.

5.3.5 Transformation and upgrading period: insufficient growth of fixed asset investment and relatively small investment and financing scale

Zhongshan experienced rapid growth in fixed asset investment after 2006, and the fastest growth occurred in 2009. After that, the growth slowed down and some negative growth appeared in 2014. Seen from the industry breakdown of fixed asset investment, the fixed asset investment of the secondary industry was basically made in industry, but in 2014, the fixed asset investment of the secondary industry showed a negative growth of -18.5%.

After subdivision into the specific industries, manufacturing and real estate completed the largest fixed asset investment in Zhongshan in 2015. However, compared with 2014, it was such industries as farming, forestry, animal husbandry and fishery, public administration, social security and social organizations that showed the biggest increase in the fixed asset investment completed, while the fixed asset investment in scientific research and technical

services dropped dramatically. From Table 2-5-5 in Appendix 2, we can see the fixed asset investment decreased by 63.4% over 2014 in 2015. Compared with the major cities in the Pearl River Delta, the total investment in fixed assets of Zhongshan City was the smallest in 2015, only RMB 10.5541 million, while that of Guangzhou was up to RMB 54.0595 million. Among the fixed asset investments completed in the specific industries in 2015, the smallest completed amount of Zhongshan was in scientific research and technical services, transport, warehousing and postal services, and real estate, and the completed amount in manufacturing industry, information transmission, software and information technology services with great development prospects was also far lower than other major cities. In terms of the current investment in fixed assets, among the major cities in the Pearl River Delta, Foshan has the strongest investment attraction in manufacturing and Guangzhou has great attraction for fixed asset investment in various industries. There is still more space for expansion in respect of investment attraction for Zhongshan City and a great catch-up challenge compared with other cities.

5.4 Summary

In summary, Zhongshan's main economic body is a specialized town. In the past development, the specialized town had obvious industrial agglomeration effect, but relatively low industry chain and value positioning, and insufficient innovation resources and capacity, so the innovation-driven strategy is urgently needed to promote industrial transformation and upgrading, expand upstream and downstream industry chain, and enhance the value positioning of traditional characteristic industries, to achieve another leap in economic restructuring. To this end, the national, provincial and municipal governments have pointed out the direction and tasks of innovation-driven development from three aspects and gave new challenges and new missions to Zhongshan City directly under the jurisdiction of the administrative system, characterized by the unique political, economic and cultural systems. Zhongshan is expected to identify its own advantages and priorities, and focus on innovation-driven development by grasping hi-tech enterprises, technology business incubators, new R&D institutions and intellectual property to accelerate the integration into the construction of Guangdong-Hong Kong-Macao Greater Bay Area. In the paragraphs below, emphasis will be laid on studying this specialized town well-known for patented lighting products (See Chapter VI), defining the role of fast-track IPR authorization and

protection in promoting the innovative development of this specialized town with regional characteristic industries as well as the significance and role of knowledge market accumulation in opening the knowledge-based economy.

Chapter 6: Analysis on the Role of Knowledge-based Economy in Transformation and Upgrading of Zhongshan Specialized Town —a Specialized Town of Lighting Industry

Guzhen Town is the world-renowned “Lighting Capital of China” and is located in the northwest of Zhongshan City, Guangdong Province, at the junction of Zhongshan, Jiangmen and Foshan. The town covers a total area of 47.8 square kilometers, and has the resident population of about 150,000. Lighting industry is the town’s leading industry, and lighting and related industries account for 80% of the town’s total manufacturing industries. Guzhen won the title of national industrial base such as “National Torch Program Lighting Equipment Design and Manufacturing Characteristic Industrial Base”, “National New Industrialization Industrial Demonstration Base” and “National Foreign Trade Transformation and Upgrading Specialized Demonstration Base.” According to the 2014 annual report of China Association of Lighting Manufacturers, Guzhen lightings accounted for 70% of the domestic market, and its products were sold to more than 130 countries and regions in the world, concentrated in Europe and the United States, the Arabian Peninsula, Japan and South Korea and Southeast Asian regions. In 2016, Guzhen lighting industry output value exceeded EUR 2.6 billion, accounting for more than 75% of the total industrial output value of the town. With high lighting industry concentration, the town has about 18,000 enterprises involved in lighting manufacturing and sales, 100,000 lighting employees, more than 100 enterprises with the annual output value of over RMB 20 million, of which about 30 ones have over 20 years of development history. A batch of brand lighting enterprises has emerged, including 15 national, provincial famous brand enterprises, 29 products (trademarks) in total. Of them, 5 are Chinese famous brands, 9 are the famous products of Guangdong Province and 15 are the famous brands of Guangdong Province.

6.1 Characteristics of Guzhen lighting industry

Lighting industry combines the research and development, production and sales of lighting products together, and consists of product research and development, raw material

supply, parts production, finished product processing and assembly, product packaging, product sales, transportation and other enterprises. In addition to a few enterprises such as OPPLE, Liguang and other production enterprises of electric light, typically, the vast majority of enterprises have been engaging in the production and sales of lighting products, paying attention to the appearance of the products and highlighting the decorative features of products. Guzhen lighting industry has its own characteristics:

(1) High industry concentration. The spatial agglomeration of Guzhen lighting industry is particularly prominent. On this land of about 50 square kilometers, lighting enterprises, related industries and supporting agencies are highly dense. In 2016, the number of lighting and related businesses registered in Guzhen Town, Zhongshan City approximately reached 18,000, with the output value of over RMB 19 billion, accounting for 75% of the town's total manufacturing industries. With numerous lighting stores and large shopping malls of lighting products, the town boasts such large shopping malls of lighting products under construction or constructed as Star Alliance LED Lighting Center, China Arts International Lighting Mall and Oriental Baisheng Lighting Plaza, with an area of more than 3 million square meters.

(2) Complete industry value chain. Guzhen Lighting Industry has formed innovative R&D links composed of product design and R & D (including appearance design, R&D of LED and other new light sources, electronic rectifier performance, drive module, etc.), quality testing and intellectual property, formed a full range of trading and sales links composed of lighting stores, shopping malls, exhibitions, logistics, import and export trade agents, formed production and processing ancillary links composed of raw materials (including imported crystal, metal and lighting accessories, etc.), lighting electroplating, processing and assembly. A complete lighting value industry chain, i.e. "Smiling Curve Value Chain Industry System" has come into being in a town of 50 square Kilometers (Figure 6-1).

(3) Fast upgrading of products. With shorter life cycle, Guzhen lighting products change faster in their appearance and style, and their change cycle is generally 2-3 months. Such fast replacement rate is inseparable from the inherent characteristics of lighting products and market demand. The most important element of lighting products is their decorative features, so during the design of products, lighting companies will not only focus on their own artistic style, but also consider the coordination of their shape, color, lighting with the surrounding environment, which determines the continuous innovation and improvement of lighting products. In addition, consumers in different countries and regions have different aesthetic

standards for lighting design and will change their standards as the fashion trend changes. The diversity of consumer needs and aesthetic timeliness are also constantly giving birth to new design of lighting products, directly shortening the life cycle of lighting products in Guzhen.

(4) Sound public services. Taking Productivity Promotion Center as the main body, Guzhen lighting industry owns a number of lighting industry development service platforms which provide such services as innovation and entrepreneurship, intellectual property protection, personnel training, financing support, information service, marketing and quality inspection. These public platforms provide fast, high-quality public services to Guzhen lighting enterprises, especially SMEs. Guzhen pays special attention to the protection of intellectual property rights and has successively set up the "Fast-track IPRs Protection Center of Zhongshan (Lighting)", "Intellectual Property Exchange and Exhibition Center of Zhongshan City (Guzhen)", "Original Intellectual Property Center of Zhongshan City, China" and "Zhongshan Lighting Industry Intellectual Property Alliance" to provide the lighting industry in Guzhen with a full range of services associated with the creation, management, use and protection of IPRs, thus playing a non-negligible role in improving the awareness and level of IPRs protection.

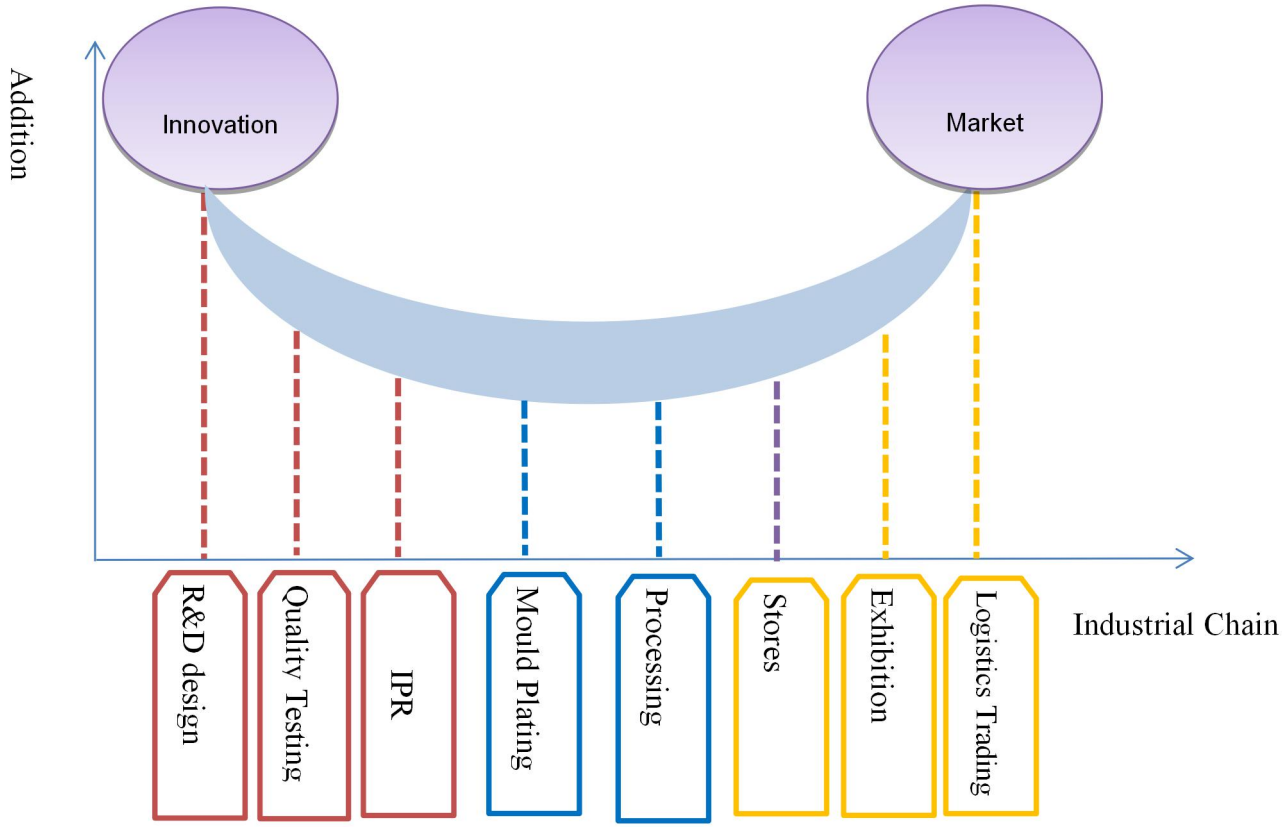

Figure 6-1 Smiling Curve Value Chain System of Guzhen Lighting Industry

6.1.1 Development process of Zhongshan Guzhen lighting industry

As mentioned above, the specialized towns of Zhongshan are dominated by the traditional industry towns, and the lighting industry town of Guzhen is one of the typical representatives. It also develops from nothing, from small to large, from weak to strong. After the germination period, agglomeration period, it is now entering the transformation and upgrading period.

6.1.1.1 Germination period

In the late 1970s, there were only sporadic lighting factories in Guzhen. In 1982, several young brick factory workers in Haizhou Village, Guzhen Town came into contact with lighting products of Hong Kong and considered that there was a market prospect. Therefore, they took the lead in setting up a lighting company and achieved great success. The motivated Guzhen people started the lighting business one after another. Throughout the 1980s, due to strong demand for domestic lighting market, causing the short supply of Guzhen lighting products, the first round of lighting manufacturing boom took place. In the early 90s, a famous lighting street was formed with about 300 lighting shops, where the lighting style varieties every three months along with the new trend. By the end of 90s, Guzhen lighting industry cluster initially took shape.

6.1.1.2 Agglomeration period

From the period of 1999 to 2010, Guzhen lighting industry achieved leapfrog development. In 1999, Guzhen successfully held the first Lighting Fair, which made great progress in product quality improvement, market environment construction and industrial service system construction, and further highlighted the industrial cluster effect. In 2002, the town won the title of “Lighting Capital of China” and completed the “first industrial upgrade” of upstream and downstream division of labor and longitudinal expansion of industrial facilities. With the construction of the National Torch Plan Characteristic Industrial Base in 2007, the extension of the lighting industry in Guzhen continued unabated, and the structural differentiated development became more apparent. In terms of the industrial chain, the development model of “one-stop production, supply and marketing as well as upstream and downstream supporting collaboration” was continuously adopted to refine the division of labor. In terms of product classification, the town accelerated its entry into efficient lighting, optoelectronic applications and other new energy fields. With the continuous expansion of its

regional influence, the lighting industry, taking Guzhen as the core, radiated to the surrounding 11 townships and districts in 3 cities, forming an industry cluster with output value of over one hundred billion.

6.1.1.3 Transformation and upgrading

Technological innovation is the endogenous driving force for transformation and upgrading of the lighting industry in Guzhen Town. For Guzhen lighting industry, the protection of intellectual property rights is to protect the innovation and to safeguard market fairness and stability. At the same time, it also offers legal channels and effective ways for knowledge spillover effect and technology diffusion of industrial clusters. From 2011 onwards, the emergence of LED light sources set off a new round of lighting technology revolution, bringing lighting industry a broader space for design. Lighting companies have introduced more diversified LED lighting products to seize the market commanding heights, and also many new lighting market and production bases appeared throughout the country. In order to cope with the fierce market competition, Guzhen government put forward the concept of "City-industry Integration" to continuously improve the lighting industry chain, optimize the functions of the city, improve the level of public services and perfect the marketing system. Meanwhile, by improving the technological innovation system and creating an independent innovation environment, Guzhen government has been striving to promote the lighting industry to extend the technology research and marketing (Figure 5-1) at both ends of the "Smiling Curve", to comprehensively enhance the industrial innovation capability and core competitiveness, and to open the knowledge-based economic era of the assessment, transactions and investment of intellectual properties.

6.1.2 Comparison of industrial designs protection system in various countries

Since the establishment of industrial designs as an independent type of intellectual property, more than 120 countries and regions worldwide have established systems for the protection of industrial designs, which can be divided into four categories: first, separate legislative protection; second, protection under the patent law as a kind of patent; third, dual protection of separate legislation and the copyright law; fourth, comprehensive protection.

The EU and Japan adopt the separate legislative protection mode. In 2001, the EU issued *the European Community Designs Act*, stipulating that registered designs will be approved for registration after passing the formal examination, with the term of protection up to 25 years.

In 1899, Japan enacted *the Design Act*, stipulating that designs must be novel and creative, and subject to substantive examination before being authorized. In addition, many countries also adopt a separate legislative mode. The United States and China mainly incorporate industrial designs into the patent law.

Pursuant to *the U.S. Patent Law*, design patents should possess novelty and non-obviousness. After substantive examination, the patent shall be granted with a term of protection of 15 years. At the same time, *the U.S. Copyright Law* protects "pragmatic artworks," *Trademark Law* and *Anti-Unfair Competition Law* protect distinctive trademarks, product appearances and decorations. Therefore, In USA, industrial designs are protected by *the Patent Law*, not exclusive of the Copyright Law, Trademark Law and *Anti-Unfair Competition Law*. China's mode of industrial design protection is similar to that of the United States (see below). France is a representative of adopting dual protection through separate legislation and the copyright Law. It has been clearly stipulated in its *Copyright Law* that all industrial designs (including designs that have been protected by *the Industrial Property Law*) are copyrighted, having formally established a dual protection mode.

In general, the majority of countries in the world mainly protect industrial designs with industrial property rights, and this protection reflects more the idea of patent protection, except that different countries have more or less introduced some other rules based on the features of industrial designs (Table 2-6-1) and do not necessarily exclude the protection of copyright laws.

6.1.3 Characteristics of China's industrial design protection system

In China, industrial designs are mainly protected by the patent law as the design patents. The shapes and patterns protected under the design patent law may also be subject to the protection of the copyright law, trademark law and anti-unfair competition law in some cases. Their advantages are compared as shown in Table 2-6-2.

By comparison, from aspects of authorization conditions, the examination deadline, the term of protection, exclusivity and infringement identification, the design patent law can provide most lighting products with sufficient protection. Only a few lighting designs of higher artistic characteristics can be copyrighted as works of art or practical works of art. In contrast, the trademark law and anti-unfair competition law apply only to the international well-known brands and trademarks. Therefore, the best protection mode of lighting designs is

"patent-based, copyright and trademark supplemented."

6.2 Formation of three-dimensional fast-track design protection mode

Zhongshan Guzhen lighting industry has been developing for more than 30 years, and the protection status of industrial intellectual property has been changing and upgrading with the development of the industry, so has the demands for IPRs protection. During the initial development of the industry when the imitation and duplication and other infringements emerged, on the one hand, enterprises considered whether and how to safeguard their rights based on the actual situation. On the other hand, government departments also considered how to fight against the infringements more effectively and help enterprises to carry out rights protection activities. With the further development of the industry, there had been the products of unique industrial characteristics with fast time-to-market and short life cycle, and thus it was necessary to establish a fast-track IPRs protection system adapted to the industrial characteristics. In order to continuously maintain or further enhance the competitiveness of the lighting industry, a IPRs protection mechanism has been established with the fast-track IPRs protection center as the core, which combines the fast-track authorization, fast-track protection and fast-track coordination together.

Zhongshan fast-track IPRs protection center is the earliest single-industry fast-track IPRs protection agency established in China with the purpose of solving various intellectual property difficulties encountered by Zhongshan Guzhen lighting industry. The center serves as the one-stop service platform integrating patent applications, rights protection assistance, mediation-based law enforcement and judicial proceedings as a whole.

6.2.1 Fast-track design authorization mechanism of Zhongshan Guzhen lighting industry

With the increasingly fierce market competition, the IPRs protection is more and more valued. Applying for the design patent protection has become one of the main means of protection against imitation and duplication of lighting products. Lighting products have the features of fast time-to-market and short life cycle, and therefore, the period of patent application authorization should be shorten to be adapted to the time-to-market of products. However, even though we have adopted formal examination system for design patents, the progress of patent examination and approval in China still lags behind the replacement of

lighting products. Thus it is necessary to establish a fast-track design authorization mechanism for the lighting industry so as to synchronize the examination and approval of the lighting-related patent application with R&D and time-to-market of lighting products. For these reasons, the State Intellectual Property Office and Fast-track IPRs Protection Center have cooperated to formally launch the fast-track authorization channel for the design patents of the lighting industry in June 2012. The fast-track design authorization mechanism of Guzhen lighting industry specifically refers to the policy-enabled channel for the eligible lighting design patent applications within Zhongshan lighting industry cluster. According to the relevant policies, these eligible applications can be pre-examined by the Fast-track IPRs Protection Center before approved by the State Intellectual Property Office, thus accelerating the patent grant.

6.2.1.1 Features of fast-track design authorization mechanism of Zhongshan Guzhen lighting industry

The key feature of the fast-track authorization mechanism is that it can achieve the quick authorization by opening up a fast-track authorization channel for the lighting industry design patents and speeding up the examination and approval of patents. If an enterprise applies for a design patent through the fast-track authorization mechanism, the authorization time will be shortened from about 6 months to about 10 working days, and even to 1 week.

6.2.1.2 Explosive growth in the number of patent applications and licenses via fast-track design authorization mechanism of Zhongshan Guzhen lighting industry

After the fast-track patent authorization channel was opened, the enthusiasm of enterprises applying for patents was greatly enhanced. Most enterprises actively used the patent system to protect their original designs. From 2011 to 2015, the numbers of patent applications and licenses in Guzhen Town, Zhongshan City, grew by double digits each year, and the numbers of patent applications and licenses have jumped to No. 1 in Zhongshan City since 2012. As shown in Figure 3-6-1 (Appendix 3), the number of design patent licenses in Guzhen rose obviously, while the increase in the number of the invention patent and the utility model patent licenses was relatively steady. It could be seen that the innovation of the lighting industry in Guzhen was mainly based on the exterior design innovation, with focus on the style development and updating of the lighting products. From 2011 to 2015, the numbers of design patent applications and licenses via the fast-track authorization channel were 5,287 and 5,261, with the authorization rate of over 99.50%. The total numbers of design patent

applications and licenses in Guzhen were 20,571 and 16,566, with the authorization rate of 80.53%. It could be seen that the rate of patent authorization through the fast-track authorization channel was higher than that of the whole system, indicating that the fast-track authorization mechanism helped to increase the patent licensing rate of enterprises. From he number of patent applications for design patents granted by the fast-track authorization channel in the township enterprises had increased significantly, indicating that the fast-track authorization mechanism was operating smoothly, and had promoted the design patent application of the lighting industry. In general, the fast-track authorization mechanism had played an enormous role in promoting the design patent application of the lighting industry in Guzhen, laying a solid foundation for the protection of intellectual property of enterprises, safeguarding the fairness and stability of the market and stimulating the entrepreneurial spirit of the innovation subjects.

6.2.2 Immediate maintenance mechanism for intellectual property rights of exterior design of lighting industry in the ancient town of Zhongshan

There is clear division of labor between upstream and downstream of the lighting industry in the ancient town. It is easy to imitate and copy the exterior design of lighting products, and in particular, those styles well-sold are often subject to infringement; while there is a short period on market and rapid change in style for lighting products. Should such infringement not be prevented timely while the products are launched on the market, it would be expanded, causing more losses to the enterprises, and thus restraining their innovative behavior. Accordingly, it is necessary to rely on the immediate response and immediate action capability of China's administrative enforcement system, to establish an immediate maintenance mechanism for exterior design meeting the requirements of lighting industry and protect intellectual property rights of the enterprises timely and effectively. In light of these conditions, the Immediate Maintenance Center has conducted cooperation with Intellectual Property Office of Zhongshan and other departments, by officially accepting the administrative enforcement authority of the Intellectual Property Office of Zhongshan and other departments within the jurisdiction of the ancient town on July 1, 2012, and expanding the maintenance and protection network for intellectual property rights to cover those at grass-root level, and solving problems in enforcing intellectual property rights thoroughly. Specifically, the immediate maintenance mechanism for exterior design of lighting industry in the ancient town refers to the policy channel through which the patent enforcement

department and the Immediate Maintenance Center in the region take certain measures for immediate processing of patent infringement dispute cases related to lighting industry in the jurisdiction, against patentee's appeals for immediate maintenance, according to relevant policies, to accelerate the case-handling process, shorten the time of processing, and promote immediate settlement of disputes.

6.2.2.1 Characteristics of the immediate maintenance mechanism for intellectual property rights of exterior design of lighting industry in the ancient town

The core characteristics of the immediate maintenance mechanism lie in that, after the delegation of administrative enforcement power to a lower level, the Immediate Maintenance Center has established simplified enforcement procedures and consolidated administrative enforcement resources and patient review resources, making administrative enforcement fast and professional, thus achieving the purpose of immediate maintenance. The process in which the immediate maintenance mechanism is used to handle a case mainly includes the case-filing stage, the investigation and evidence-seeking stage, and the hearing and closing stage. At the first stage, the Immediate Maintenance Center accepts reporting and review and determine whether a case should be established; at the second stage, after the case is filed, the Immediate Maintenance Center conducts investigation and evidence-seeking work, and requires the person reported to answer within a specific period of time; at the third stage, the center hears the case, and may consult with an infringement identifying expert according to the case requirements, perform dispute mediation, transfer the case to court, forcibly stop infringement and take other handling measures to close the case based on hearing results.

6.2.2.2 Organization and management mechanism of the Immediate Maintenance Center for intellectual property rights

As shown by Figure 6-2, the Immediate Maintenance Center of Zhongshan currently practices a director-led responsibility system, with two business departments. Leaders include Director and Deputy Director, who are responsible for leading and managing the construction and development of the Immediate Maintenance Center, and building up a channel for communication between the center and the external world. Business Department I: General Review Section made up of section chief, reviewers, and general clerks. General Review Section mainly undertakes corporate patient application, patent service and other services, provides intelligent retrieval services for exterior design patents and offline pre-review services for the patents, and assists the corporate patient application to enter the immediate

licensing channel for exterior design patents. Business Department II: Enforcement and Maintenance Section, made up of section chief, law enforcement officers, and general clerks. The key work of Enforcement and Maintenance Section lies in docking between administrative law-enforcement and maintenance of intellectual property rights. As the Intellectual Property Office of Zhongshan delegates the power of administrative law-enforcement to the maintenance center, the maintenance center has the power of administrative law-enforcement with regard to the infringement of intellectual property rights for the lighting industry within the ancient town. Through administrative enforcement of law, the Enforcement and Maintenance Section contains and combats infringement of intellectual property rights, actively mediates contradictions and disputes between parties concerned. In addition, it connects judicial, attribution and other departments, and seeks immediate resolution of disputes over intellectual property rights, playing the role of immediate maintenance of intellectual property rights.

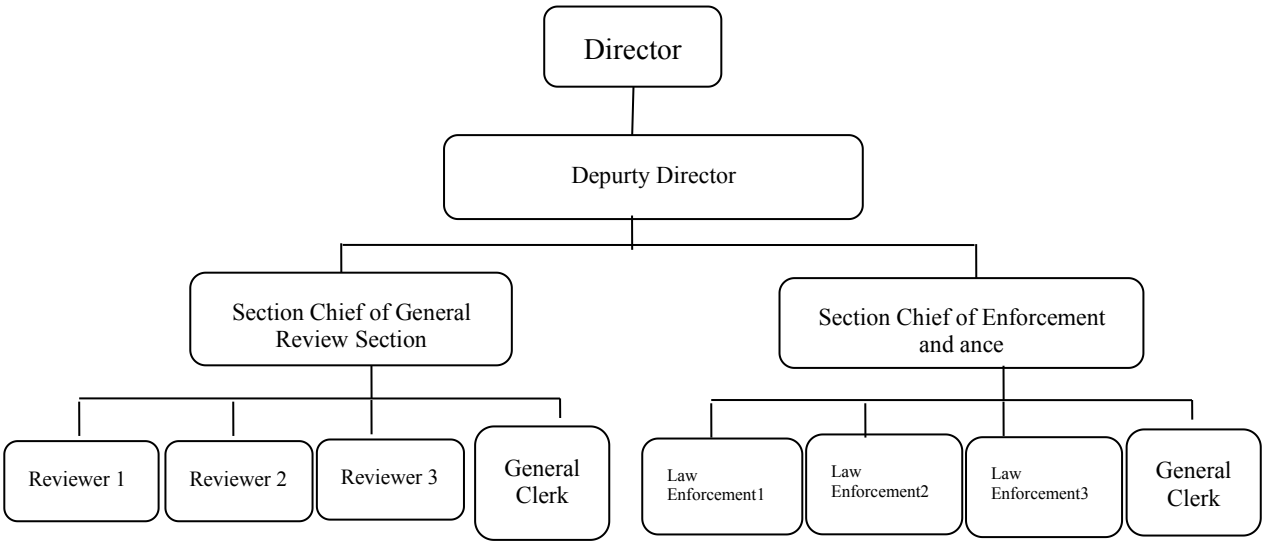

Figure 6-2 The Structure Chart of the Immediate Maintenance Center for Intellectual Property Rights (of lighting industry) in Zhongshan, China

6.2.2.3 Analysis of the situation of immediate maintenance of intellectual property rights of exterior design of the lighting industry in the ancient town

With regard to the overall situation of the immediate maintenance of intellectual property rights in the ancient town, as shown by Table 2-6-3 and Table 2-6-4 (you can see them in Appendix 2), since the establishment of the Immediate Maintenance Center and by the end of 2016, a total of 1,806 patent dispute cases had been filed through the immediate maintenance mechanism of the ancient town, 1801 of which had been closed, making a closing rate of up

to 99.7%. The Immediate Maintenance Center had ranked the first among the 75 maintenance assistance centers nationwide in terms of the number of cases filed and the closing rate. And in 2015 and 2016, the ancient town witnessed the most patent dispute cases in the whole province, accounting for 25% of the patent dispute cases of the whole province approximately. This shows the requirement of the lighting industry of the ancient town for the immediate maintenance of intellectual property rights, and also indicates the desirable performance of the immediate maintenance mechanism for intellectual property rights; meanwhile, patent dispute cases of the ancient town mainly involved exterior design, which indicates exterior design patent of the lighting industry of the ancient town as the main object protected by the immediate maintenance mechanism. Based on such mechanism, more than 60% of dispute cases were mediated successfully by the Immediate Maintenance Center. Most of the products involved in infringement cases were removed off shelves timely, while a small proportion of the cases were not solved by mediation and submitted to a court for settlement.

(1) With regard to exhibition-based immediate maintenance, as shown by Table 2-6-5 in Appendix 2, from 2012 to 2016, 77 patent dispute cases had been established by exhibition-based immediate maintenance mechanism, and 77 cases had been closed, contributing to a closing rate of 100%. And in 2016, the number of cases filed reached 33, representing rapid growth, and indicating the importance of establishing the exhibition-based immediate maintenance mechanism; in addition to cancelation of cases, work stations set up by the Immediate Maintenance Center at the exhibition had the involved items on display unshelved, showing high efficiency of immediate maintenance work. The performance of exhibition-based immediate maintenance not only embodied great importance attached by the Immediate Maintenance Center to the maintenance of intellectual property rights, but it also gained the recognition from the government and people of all walks of life.

(2) With regard to the immediate maintenance in e-commerce, the Immediate Maintenance Center explored and established a mechanism for immediate maintenance in e-commerce in 2014, only in which year, the center assisted right holders in conducting 90 cases of patent infringement complaint in e-commerce field, demonstrating the importance of establishing the mechanism for immediate maintenance in e-commerce. After the official establishment of the mechanism for immediate maintenance in e-commerce in 2016, the mechanism has been used to handle 10 cases, which 10 cases have been closed, with a closing rate of 100%. All of the infringement links have been forced to be deleted, safeguarding

legitimate rights and interests of holders, and embodying the high efficiency of the mechanism for immediate maintenance in e-commerce in maintaining relevant rights.

(3) With regard to cross regional collaboration in maintaining relevant rights, Zhongshan has worked together with Foshan, Jiangmen, and Shunde and signed agreements for cross regional collaboration-based maintenance of intellectual property rights of the lighting industry. Since 2014, about 5 to 10 cases have been emerged annually in the lighting industry of the ancient town and need be resolved by cross regional collaboration-based maintenance. In the region, more than 100 cases have been handled through collaboration, involving up to RMB Ten Million Yuan. This shows the necessity and importance of cross regional collaboration-based maintenance of intellectual property rights for right holders. As reflected by relevant enterprises, the mechanism for cross regional collaboration-based maintenance of intellectual property rights can save almost more than 50% of the time invested by the right holders, while the efficiency of law enforcement in a different region has reached 90%.

Overall, since the establishment of immediate maintenance mechanism, the ancient town has witnessed substantially increased efficiency of law enforcement on intellectual property rights, effectively combating a large amount of infringements of intellectual property rights, reducing corporate maintenance costs, and protecting the legitimate rights and interests of enterprises.

6.2.3 Departmental coordination for exterior design of the lighting industry in the ancient town of Zhongshan

The departmental coordination mechanism of the ancient town is established for the main purpose of exerting the advantages of departmental linkage and developing the synergy of joint law enforcement. Therefore, started with establishing a channel for immediate maintenance of patent, the departmental coordination refers to work cooperation conducted by the Immediate Maintenance Center with other governmental departments, including intellectual property office, public security bureau, industrial and commercial bureau, customs and other relevant departments, with which the Immediate Maintenance Center establishes a contact system, a contact conference system and information reporting system, etc, to identify contact persons and contact methods of both organization, report data and information in a regular, centralized way in the form of fixed contact and reporting, provide the other party with cooperation on law enforcement regularly or irregularly according to work need, report

relevant information, exchange relevant experience and provide two-way training.

In departmental coordination mechanism, the Immediate Maintenance Center is responsible for unveiling methods for immediate maintenance of intellectual property rights to simplify procedures for cases related to intellectual property rights, for accepting patent infringement cases, as well as working on investigation and evidence-seeking, producing evidence and defense, professional assessment, industrial mediation, administrative intervention or transfer of the cases to judicial authorities, and for accepting complaints related to copyright and trademark infringement cases and transferring the cases to relevant authority for settlement; the Intellectual Property Office of Zhongshan delegates the law enforcement power to the Immediate Maintenance Center, fully participates in and provides cooperation for law enforcement work of the Immediate Maintenance Center, and undertakes coordination with copyright and trademark management departments of Zhongshan; Zhongshan Industrial and Commercial Bureau is responsible for receiving cases transferred by the Immediate Maintenance Center, and accelerating case filing, review, and punishment procedures; Zhongshan Public Security Bureau is responsible for receiving cases of intellectual property crime transferred by the Immediate Maintenance Center and other functional departments, and providing due assistance in the event that law enforcement personnel are refused or prevented from law enforcement. For this purpose, the first reconnaissance squadron to combat intellectual property crime was established in June 2015 in the ancient town; Zhongshan Customs set up a protection office for intellectual property rights at the maintenance center on November 24, 2016, which undertakes contacting other customs to provide lighting companies with intellectual property protection together, focus on, arrange, control, and investigate into import and export links, quickly identify conditions of infringement of intellectual property rights of export-import goods, and assist relevant enterprises and other departments in investigating into infringing products.

6.2.4 Industrial self-discipline in exterior design of the lighting industry of the ancient town of Zhongshan

Intellectual property rights are protected not to curb and combat infringement but to effectively prevent such infringement from occurrence, maintain market equity and stability, promote industrial technology diffusion and encourage innovation. Industrial self-discipline's merit is precisely to prevent infringement, and corporate integrity development is the premise

of mutual recognition and benign competition within the industry. Meanwhile, industrial self-discipline contributes to development of sufficient freedom of competition in the lighting industry and to development of space for internal mediation of disputes, avoiding public power to intervene too much and thus saving administrative and judicial resources. Therefore, it is necessary to establish and perfect the industrial self-discipline mechanism for the lighting industry of the ancient town.

In order to give full play to the role of industrial self-discipline, the ancient town has done the following practices: firstly, establishing the credit system for intellectual property rights led by government, participated by enterprises and directed by industrial associations, to strengthen the construction of integrity and self-discipline system for enterprises in the industry; secondly, establishing protection and demonstration bases for intellectual property rights, to promote work on self-discipline in intellectual property rights, and develop self-discipline in intellectual property rights at a store based on merchant's signature of a letter of guarantee of self-discipline in intellectual property rights; thirdly, propagandizing protection of intellectual property rights through an intellectual property society, to strengthen communication and exchange between the industrial societies, and promote lighting enterprises' recognition of and influence on the Immediate Maintenance Center and the model of the ancient town; fourthly, fully collecting corporate opinions and suggestions through chambers of commerce, to thoroughly investigate into the ancient town's problems in intellectual property rights and its development requirements, and to gradually improve awareness of intellectual property rights of the whole town from point to area.

6.3 Innovation-driven transformation and upgrade of the lighting industry of the ancient town

While having protected market equity and stability, the use of the immediate maintenance model for intellectual property rights by the ancient town has accelerated the knowledge spillover effect of cluster value network, encouraged entrepreneurial spirit, and enhanced the sense of innovation. It has also allowed the lighting enterprises to achieve market shares and innovation gains through innovation, promoted the transformation and upgrade of the specialized town in the traditional industry, and enhanced the foundation for opening up the gate to the knowledge-based economy.

6.3.1 Change in patent applications for intellectual property rights of the specialized town in the lighting industry

Patent applications serve as an effective indicator reflecting innovation behavior of the lighting enterprises in the ancient town. Since a lighting product attracts consumers with its appearance, 90% of the patents applied for by the enterprises are those on exterior design, while inventions and utility model patents play a supporting role. The number of patent licenses granted for exterior design has increased since 2007 and at a higher speed after 2011, with an average annual growth rate of up to 81.3% from 2011 to 2015. The proportion of exterior design patents in the lighting field has climbed steadily in the region (Figure 6-3).

6.3.2 Changes in concentration of specialized town enterprises in the traditional industry

From Figure 3-6-2 in Appendix 3 , we can see that the number of specialized town enterprises in the lighting industry of the ancient town has increased from 3,554 to 4,736 within the 8 years, with an increasing range of up to 33.26%. However, negative growth also occurred twice at the same time, at -16.89% and -5.9% in 2010 and in 2013 respectively. And the town has undergone shuffling twice. In particular, the node of the first shuffling coincided with the strategic development period of semiconductor lighting LED as a new light source and the preparatory period of the work of immediate licensing and maintenance of relevant rights proposed in Guangdong Province in 2010. It was exactly because of the occurrence of negative growth to participating enterprises in the specialized town in the lighting industry that it received great attention at national, provincial and municipal levels. In order to maintain market order in a better way, make more efforts to protect intellectual property rights and promote industrial technological innovation, the Immediate Maintenance Center was officially established and put into operation in 2012. This has made desirable effects on stabilizing economic order of the regional market and advancing industrial transformation and upgrade. And in 2013, the number of lighting enterprises in the ancient town started to show a trend of high-speed growth once again. In terms of patent applications and licenses, we can see that benign changes were also occurring to the technical content and innovative resource of the enterprises.

6.4 Summary

Knowledge-based economy is represented by knowledge as capital becoming the core power driving economic development. In this chapter, we take the example of intellectual property protection of the specialized town in the lighting industry of the ancient town and emphatically analyze World Intellectual Property Organization's sole case of intellectual property protection in China.

The core point of intellectual property protection is to promote the occurrence of innovative behavior while maintaining market equity and stability, accelerate effective spillover of industrial technology and encourage the entrepreneurial spirit through regular effective protection of knowledge, to reach an overall improved level of industrial competitiveness. The level of industrial competitiveness is related to corporate competitiveness in the industry, for improved corporate competitiveness plays an important role in strengthening the overall competitiveness of the industry to which an enterprise belongs. The patent protection of exterior design may rely on improving the level of competitiveness of enterprises in the lighting industry, to promote the improvement of overall competitiveness in the industry, and achieve Pareto optimality. The enterprises in the lighting industry of the ancient town have undergone a process in which they have become strong from weak in competitiveness. At the origin and infant stage of clustering in the lighting industry, the lighting enterprises of the ancient town were weak in competitiveness; they mainly took the form of small workshop. At the stage of initial development of industrial clustering in the lighting industry, the lighting enterprises of the ancient town started to have competitiveness improved to some extent, with their number increasing sharply, contributing to the view of street lighting along a distance of ten li; then, industrial clustering of lighting enterprises entered the stage of rapid development, deriving small and median-sized lighting enterprises one after another, which started to operate their own brands and have their innovative awareness improved, contributing to substantially improved corporate competitiveness. Since 2009, the industrial clustering of lighting enterprises has remained at a mature and stable stage, with the overall competitiveness substantially enhanced. The enterprises above designated size occupy a large part of enterprises in the lighting industry, while they think highly of brand building and have strong sense of innovation. By innovating design and improve product quality, these enterprises also enhance their own management. The constantly strengthened protection of exterior design patents is conductive to improving

the sense of innovation of the enterprises and increasing corporate input to research and development, thus expanding their brand influence, promoting their overall competitiveness, and motivating their innovative vitality and entrepreneurial spirit.

Chapter 7: DEA Performance Analysis of High and New Technology Enterprises of Zhongshan

7.1 Analysis of the overall situation of high and new technology enterprises in Zhongshan

Since 2015, Zhongshan Municipal Party Committee and Government have actively promoted the innovation-drive development strategy, energetically developed the high and new technology industry, and led transformation and upgrade of traditional industries with scientific and technological strength, which have made marked success. Particularly, great progress has been made in the high and new technology industry. An overall description of the developments of high and new technology enterprises in Zhongshan from 2008 to 2016 is provided as follows.

7.1.1 A huge increase in the number of high and new technology enterprises

The data of the numbers of high and new technology enterprises in Zhongshan from 2008-2017 is shown in Figure 7-1. By the end of 2016, Zhongshan city had a total of 882 high and new technology enterprises at the national level, a net increase of 455 compared with that in 2015, contributing to an increase rate of up to 107.3%. The increase speed ranked second in the whole province, next only to Guangzhou. Since Administrative Measures for the Determination of High and New Technology Enterprises was officially implemented in China in 2008, the number of high and new technology enterprises has kept increasing; the increase slowed down between 2008 and 2014, and negative increase occurred in 2014. During an investigation by Hu Chunhua, the secretary of Guangdong Provincial Party Committee in 2015, he clearly proposed the strategic deployment of innovation-driven development, requiring Zhongshan to summarize the past development experience, and think seriously of the cause of the occurrence of negative increase in the number of high and new technology enterprises in Zhongshan, the only place at which negative increase happened in the whole province. Since 2015, Zhongshan Municipal Party Committee and Government have started to energetically carry out the innovation-driven development strategy, and take the

development of high and new technology enterprises as the nose of an ox (the key point) of innovation-driven development. As guided and promoted by the government, the year of 2015 has become the turning point of the increase in the number of high and new technology enterprises in Zhongshan, with the increase rate reaching up to 98.1% in 2015, and the number of high and new technology enterprises reaching 424. By this, the high and new technology enterprises have ushered in a new opportunity for development. This trend of growth has continued from 2014 to 2017, with the increase speed doubling for three consecutive years. The total number of high and new technology enterprises has reached 1,724. And over the decade, the number of high and new technology enterprises in Zhongshan has increased by more than ten times.

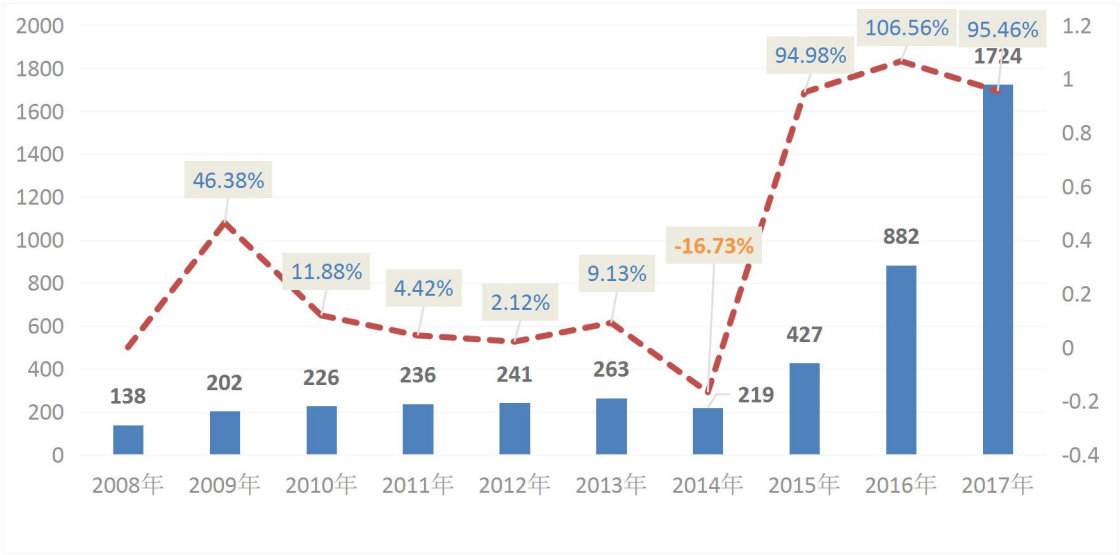

Figure 7-1 The Numbers of High and New Technology Enterprises in Zhongshan from 2008 to 2017

7.1.2 Steady expansion of high and new technology enterprises in scale

China's enterprises are divided into such four types in terms of scale as large, medium-sized, small and micro-enterprises. According to different industries, such as, agriculture, forestry, husbandry, fishery, mining, manufacturing, scientific research and technical services among other sectors, the enterprises are divided by different specific standards. Overall, however, the scale is distinguished by practitioner, operating revenue, total assets and other indicators or alternate indicators. Here we analyze the scale distribution of high and new technology enterprises in Zhongshan from 2008 to 2016 according to the enterprise's total revenue, total assets at the end of the year and number of practitioners at the end of the year, it is shown in Figure 7-2.

From gross sales revenue, the number of high and new technology enterprises which had gross sales revenue of more than RMB 0.1 billion from 2010 to 2013 have stayed at about 100. From 2014 to 2016, the number of such high and new technology enterprises was 124, 151, and 241 respectively, having increased for three consecutive years. The number of high and new technology enterprises with gross sales revenue of more than RMB 0.2 billion was 89, 102, and 143 respectively, having played an essential role in supporting and guiding the regional economic development of Zhongshan. The number of high and new technology enterprises with gross sales revenue of less than RMB 0.1 billion basically stayed at about 10 from 2008 to 2014, and reached 74 and 224 in 2015 and 2016 respectively, marking a remarkable change. Despite continuous increase in the number of high and new technology enterprises with gross sales revenue of less than RMB 0.1 billion, the percentage of the total enterprises has decreased dramatically; instead, the percentage of high and new technology enterprises with gross sales revenue of less than RMB 0.1 billion, particularly those with gross sales revenue of less than RMB 10 million, to the total enterprises, has increased to some extent.

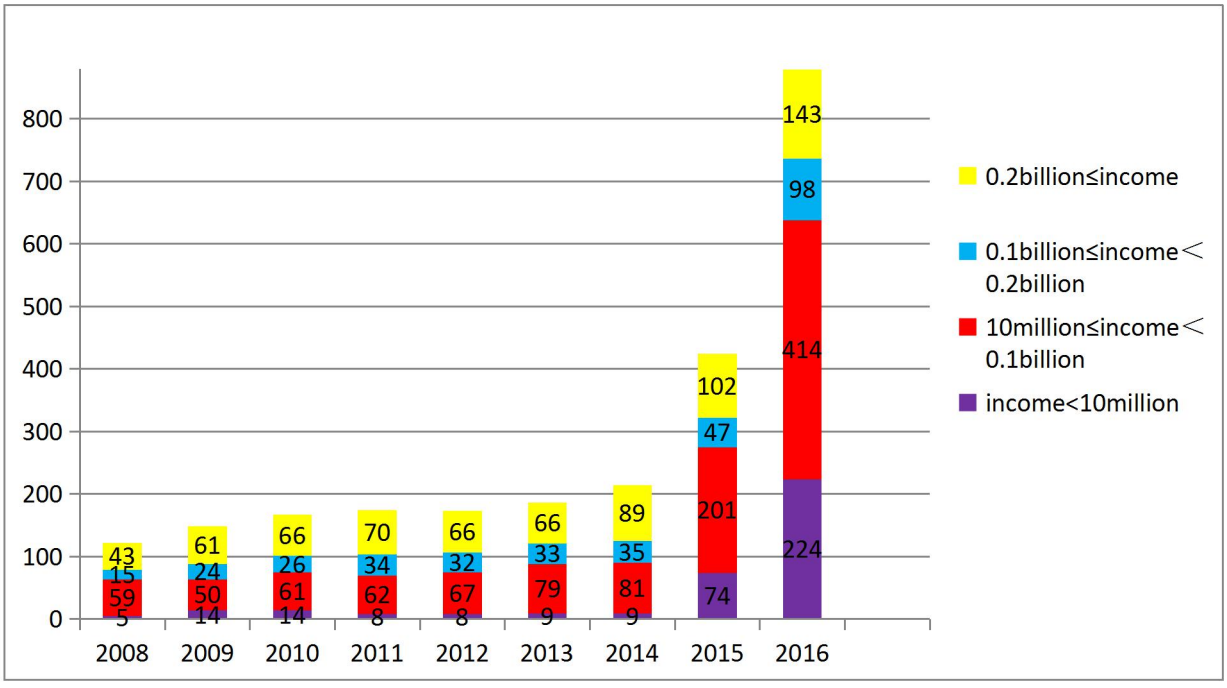

Figure 7-2 Distribution of Gross Sales Revenue of High and New Technology Enterprises in Zhongshan at Various Stages

From the year-end assets, the number of the enterprises with year-end assets of more than RMB 100 million has increased continuously, which exceeded 100 in 2014, and stood at 137 and 198 in 2015 and 2016 respectively. However, their percentage has decreased

substantially in 2016, half of that in 2015. There was relatively steady change to the percentages of the enterprises with total year-end assets between RMB 10 million and RMB 50 million and those enterprises with total year-end assets between RMB 50 million and RMB 100 million. The number of the enterprises with total year-end assets of less than RMB 10 million increased more in 2015 and 2016, being 76 and 266 respectively, and the percentage reached 30.3% in 2016. The number of the enterprises with total year-end assets of less than RMB 50 million stood at 227 and 562 in 2015 and 2016 respectively, accounting for percentages of 53.5% and 64% respectively (Figure 7-3).

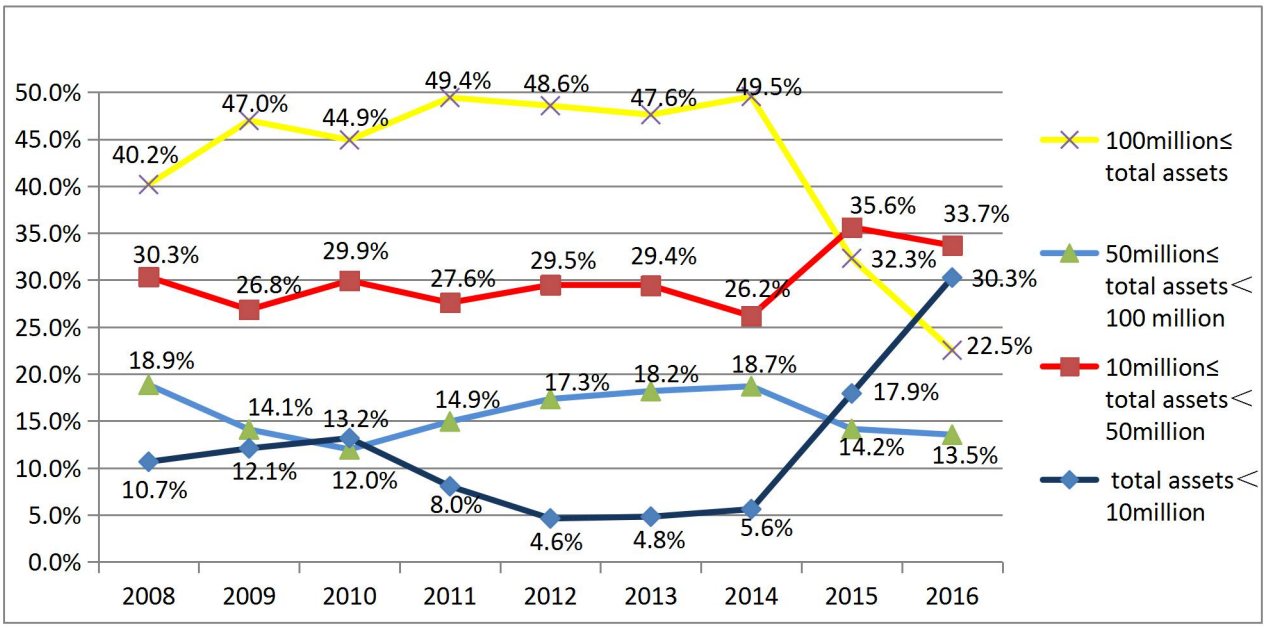

Figure 7-3 The Trend of Changes to the Percentage of Total Year-end Assets of High and New Technology Enterprises in Zhongshan at Various Stages

From the year-end number of practitioners, the number of the enterprises with less than 100 practitioners was 462 at most by 2016, with the percentage of 52.6%, an increase of 26.9% compared with that in 2015. The percentages of the enterprises with no less than 100 practitioners declined. The number of the enterprises with 500 to 1,000 practitioners was 37 and 61 in 2015 and 2016 respectively, with the percentage having declined from 17.2% in 2008 to 6.9% in 2016; in 2016, of 879 enterprises, only 38 had no less than 1,000 practitioners, with a percentage of 4.3% (Figure 7-4).

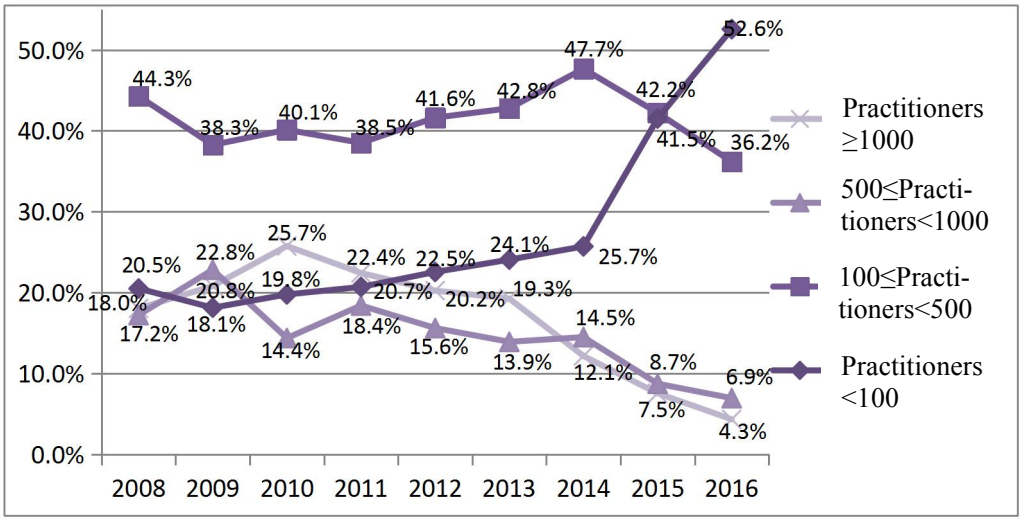

Figure 7-4 Changes to the Percentage of the Year-end Number of Practitioners at High and New Technology Enterprises in Zhongshan at Various Stages

From the summarization of gross sales revenue, total year-end assets and the number of practitioners, the high and new technology enterprises in Zhongshan have developed to be large-scale ones overall. In recent two years, the high and new technology enterprises of relatively small scale have developed at a higher speed, with the number having increased remarkably. In terms of the number and percentage, they have exceeded those with large scale. Those middle-scaled enterprises have undergone steady development, without great fluctuation.

7.1.3 The gross industrial output value of high and new technology enterprises

The gross industrial output value refers to total industrial products made by industrial enterprises within the reporting period and in monetary terms, and represents the most fundamental and most important indicator in industrial statistics. The gross industrial output value of high and new technology enterprises in Zhongshan has increased from Euro 5.102 billion in 2008 to Euro 22.319 billion in 2016, and has remained above Euro 10 billion for three consecutive years from 2011 to 2016. Despite the satisfying achievements, the gross industrial output value has increased unsteadily, without the presence of steady growth trend. The growth rate was only 0.5% and 0.7% in 2012 and 2013 respectively, while it reached 44.8% in 2014, which year witnessed the fastest growth (Figure 7-5).

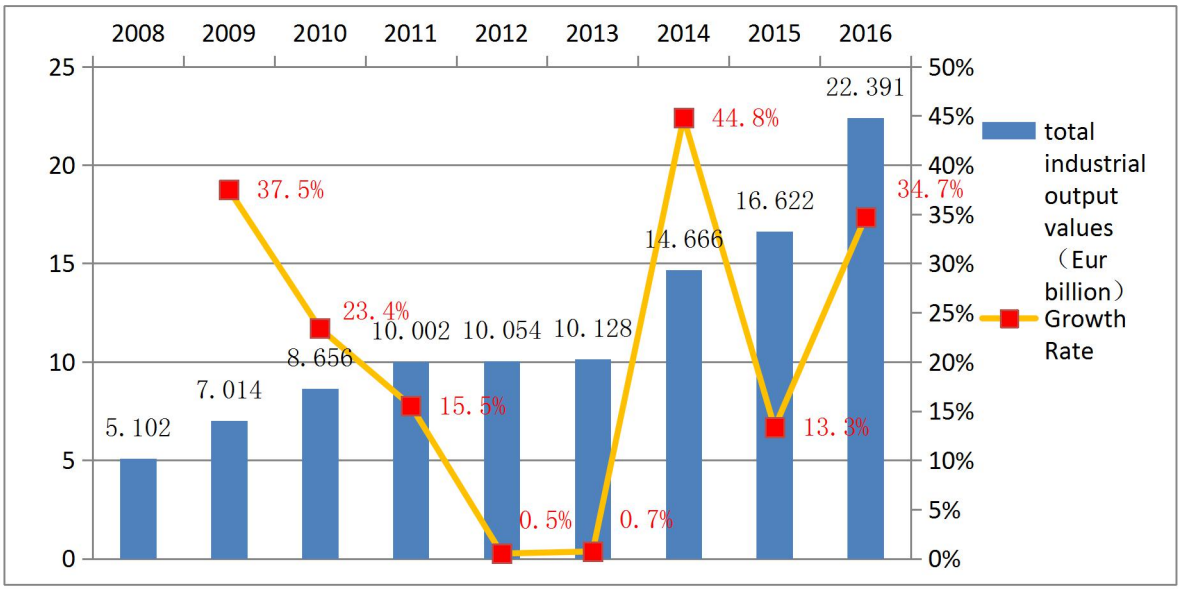

Figure 7-5 The Gross Industrial Output Values of High and New Technology Enterprises in Zhongshan in Various Years

7.1.4 The net profit of high and new technology enterprises showing exponential growth

By 2016, the net profit of high and new technology enterprises in Zhongshan had reached Euro 11.171 billion, 58 times that in 2008 within a short period of 9 years. The net profit exceeded the mark of Euro 10 billion, and achieved further development between 2015 and 2016, with the growth rate reaching 440.3% in 2015. Between 2008 and 2014, about 10 enterprises had net profits of less than zero, at a percentage of less than 10%, while the percentage of such enterprises reached 19.8% and 19.9% in 2015 and 2016 respectively.

7.1.5 Rapid development of private high and new technology enterprises

In Figure 7-6, over the three years from 2014 to 2016, the number of private high and new technology enterprises in Zhongshan had increased from 57 in 2014, to 154 in 2015 and then to 349 in 2016, with their proportion to the total number of high and new technology enterprises having increased from 26.64%, to 36.32%, and then to 39.70%. This indicates a remarkable, steady growing trend presented in private high and new technology enterprises in Zhongshan. Meanwhile, the operating revenues had accounted for 4.93%, 15.10%, and 27.97% of those of all of the high and new technology enterprises in Zhongshan that year respectively. The private high and new technology enterprises have become the backbone force for innovation and development of high and new technology enterprises in Zhongshan.

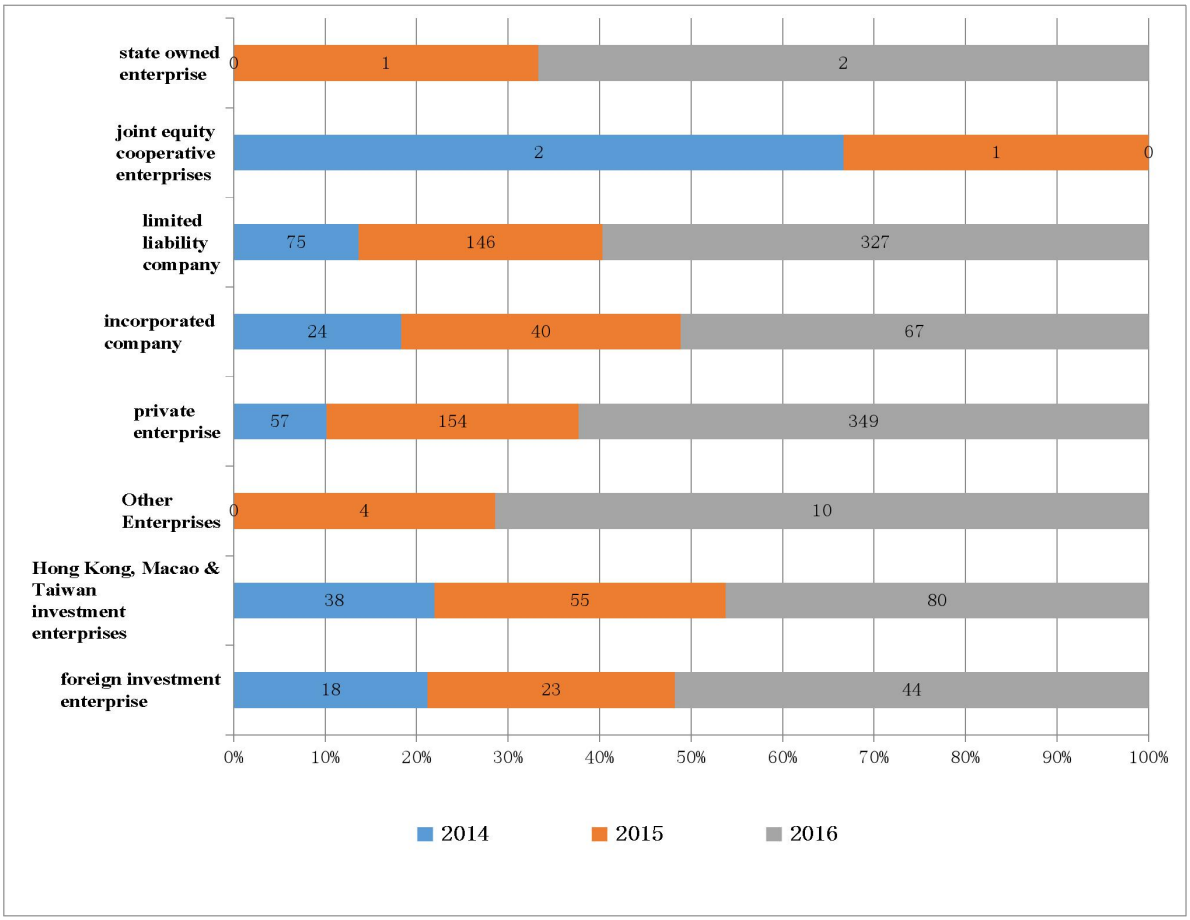

Figure 7-6 Changes to the Percentage of High and New Technology Enterprises of All Economic Types in Zhongshan from 2014 to 2016

7.1.6 The talent structure of high and new technology enterprises to be improved

From 2014 to 2016, the number of talented people of various academic levels for high and new technology enterprises in Zhongshan had increased substantially, and the the number of those with Bachelor degrees had increased at the highest speed, from 16,288 in 2014 to 26,872 in 2016, at an increase rate of 64.98%. The number of those with associate degrees had also risen very rapidly. However, the number of master degree and doctoral degree holders had increased relatively slowly, and in 2016 after the increase, the number of master degree and doctoral degree holders were only 191 and 1,464. Accordingly, Zhongshan should work on introduction and development of talented people with academic degree above master degree, and bring in high-end personnel by various level and in a targeted manner.

7.1.7 Diversified industrial distribution of high and new technology enterprises

Those high and new technology enterprises of Zhongshan in electronic and information, optical, mechanical and electronic integration and new material industries accounted for 62.3% and 62.7% in total in 2015 and 2012 respectively, as the core forces of the high and new technology enterprises; those in biological, medical technology, new energy, efficiency and energy saving, environment protection industries accounted for a lower rate, yet had desirable development prospects; only 5 high and new technology enterprises belonged to nuclear application industry, which was an additional industry in 2016, accounting for 0.57%.

7.2 Performance measure of high and new technology enterprises in Zhongshan

7.2.1 DEA method

To measure the efficiency of high and new technology enterprises, we chose the data envelopment analysis method. Data Envelopment Analysis (DEA) is a new field in the cross-study of operations research, management science and mathematical economics.

7.2.2 Measure analysis

If you want to give an appropriate and reasonable performance measure for high-tech enterprises, then you should first make clear the characteristics of high-tech enterprises. As a strategic leading industry of the national economy of China, high technology industry plays an important role in the adjustment of industrial structure and transformation of economic growth mode. Different from general enterprises, most of high and new technology enterprises are established with available research results, so as to realize technology commercialization. Therefore, many high and new technology enterprises are often pioneers in the development of high and new technology industries. The existence of high and new technology enterprises is based on the innovation of science and technology. Without the invention of science and technology, high and new technology enterprises will lose the basis of its existence. Therefore, high and new technology enterprises mostly come from developed countries and regions. The developed system of science and technology and the system of free choice for scientific and technological personnel are important conditions for the development

of high and new technology enterprises.

However, it is also important to make clear that technical innovation is indeed a prominent feature of high-tech enterprises, a lifeline for their long-term development and a source of motivation. A high technology enterprise itself is also a general enterprise, that is to say, production and operation problems to be considered by general enterprises are also crucial for high-tech enterprises, and similarly financial indicators cannot be ignored in the performance measure of high and new technology enterprises.

The connotations of the aspects of production & operation and scientific & technological innovation of enterprises are overlapped. For example, the sales of new products for technical innovation involve technology transfer and product promotion, and product promotion directly reflects the marketing ability of an enterprise, and is also reflected in the performance measure of the general orientation of production and operation. However, because of differences in the starting point of the two aspects mentioned above, they can't simply be merged into a model, or the result of excessive deviation with the actual situation will be obtained by using a comprehensive indicator system to mix two aspects for measurement.

Therefore, we split the problem to measure two different sets of performance from the perspectives of "production and operation" and "scientific and technological innovation" respectively, and to analyze the cultivation of high and new technology enterprises in Zhongshan on the basis of their efficiency changes in 2014, 2015 and 2016.

7.2.3 Enterprise performance measure in the aspect of production and operation

7.2.3.1 Indicator system in production and operation

Based on mature references and existing research achievements, and at the same time in combination with the characteristics of the DEA method itself as well as the characteristics of database data of high and new technology enterprises in Zhongshan, the indicator system in Table 2-7-1 (Appendix 2) was determined.

By using Cobb-Douglass Function for reference, fixed assets and number of employees were introduced as input indicators, and intangible assets and operating costs were added into the investment project by combining with the actual production. Output indicators comprise sales revenue, total profits & taxes and net assets.

7.2.3.2 Data preprocessing and sample number selection

The calculation principle of DEA method determines that each input or output value can't be negative. However, during the calculation of production and operation efficiency, negative value is likely to occur to output indicators: total profits & taxes and net profit. If either of these two items is negative in the process of comprehensive ranking, it is insignificant for this decision making unit to continue ranking because the high and new technology enterprise cannot reach the normal state of healthy profit-making, and needs to be removed.

After removing the DMU (Decision Making Unit) containing any negative in the indicator, we continued to refuse the ideas of 5% outliers in the statistical population with normal distribution, so as to get rid of some decision making units with excessively small input indicators, i.e. enterprises with fixed assets at less than RMB25,000 and enterprises with current assets at below RMB1.224 million respectively. There are two reasons for it: first, these outliers possibly occurred due to statistical error, so they should be rejected; second, removed enterprises are ones with a relatively small size, in fact have a limited impact on the overall development instruction of high and new technology enterprises, and their removal also does not affect our core development trend, and on the contrary because of reduced interference of abnormal value with DEA method, the trend seems to be clearer.

7.2.3.3 Statistical description of result analysis

On the basis of data preprocessing in the previous section we obtained a feasible production set including historical data (from 2014 to 2016), with considerably comparable inputs and outputs (deflated by corresponding indexes, to partly offset the impact of currency devaluation and appreciation over time), and then calculated DEA, with the following results obtained (Table 7-1):

Table 7-1 Annual Average of Overall Efficiency, Technical Efficiency, Scale Efficiency and Returns to Scale from 2014 to 2016

		δ_{PTE}		δ_{SE}		δ_{OE}	$\sum\lambda$
2014	0.561	0.168	0.953	0.072	0.532	0.156	3.34
2015	0.571	0.175	0.950	0.078	0.540	0.166	2.49
2016	0.583	0.168	0.939	0.097	0.544	0.154	1.97

Wherein: OE（Overall Efficiency）= PTE（Pure Technical Efficiency）× SE（Scale Efficiency）

Corresponding standard deviations are δ_{OE}, δ_{PTE} and δ_{SE} respectively; $\sum\lambda$ refers to the average of weight sum, showing the changes of returns to scale.

7.2.3.3.1 Changes of Pure Technical Efficiency（PTE）

Technical efficiency shows the efficiency of operation and management of the enterprise itself. It is worth mentioning that during the period of 2014-2015 the city of Zhongshan witnessed the growth rate of high and new technology enterprises ranking the first in the entire province, and at the same time the steady growth of pure technical efficiency of high and new technology enterprises, which is indeed rare. In 2016 when the number of high and new technology enterprises developed continuously and rapidly, the mean value of pure technical efficiency was increased considerably, without big ups and downs of standard deviations. In 2016, high and new technology enterprises in Zhongshan saw great improvements in their operating and production efficiency.

7.2.3.3.2 Changes of Scale Efficiency（SE）and returns to scale

From the point of Scale Efficiency (SE), the scale of most of high and new technology enterprises can be adapted to their own development level, and experienced obvious further improvements from 2014 to 2016. A majority of them have been running on the horizontal line near to the optimal scale (average scale efficiency up to 0.939 in 2016).

Weighted summation of DMU reflects the changes of returns to scale of enterprises. As shown by the relatively large annual average sum, the development focus of high and new technology enterprises doesn’t lie in whether to rapidly increase their own scale. The changes of scale have no significant impact on overall efficiency, and also reflect the tendency of diminishing returns to scale on the whole. However, it must be noted that diminishing returns to scale don’t mean discouraging high and new technology enterprises to expand their production scale, and just show that high and new technology enterprises cannot blindly increase the input of all kinds of production factors at the same time, and they should gradually increase their scale emphatically and strategically.

7.2.3.3.3 Changes of Overall Efficiency（OE）

From 2014 to 2016, the overall efficiency increased year by year, and in 2016 reached its lowest standard deviation, which proves that such growth is relatively stable and comprehensive growth, and there is a very low possibility of overall average increase because of data bias. Such efficiency change results show that during the past three years the coordinated development of high and new technology enterprises was remarkable, the overall development situation more comprehensive, and the polarization of development somewhat improved. There are two possible causes for such changes:

(1) In 2015 and 2016, the government attached greater importance to the guidance and support of high technology industry, and helped a lot of high and new technology enterprises that encountered difficulties during development. Moreover, by virtue of their own strategy reconfiguration and numerous environmental factors, some enterprises with less optimistic overall efficiency shortened the gap between themselves and benchmarking enterprises.

(2) The government has attached greater importance to guiding the transformation of traditional manufacturing industry, and meanwhile focused on and incubated high-quality new and high-tech enterprises. These incoming transformational new enterprises have good development ability and potential themselves, driving the coordinated development as an overall, and thus affecting the overall performance gap with benchmarking enterprises.

7.2.3.4 Cultivation effects in the aspect of production and operation of new and high-tech enterprises of different scales

According to annual income, companies are divided into companies above designated size (annual income > = RMB20 million) and those below designated size. A majority of enterprises below designated size are at the start-up phase, at which more external environment support may be needed. However, enterprises above a certain size are relatively mature, and their survival capacity and operating conditions are better. From the point of time dimension, their quantity change is (The annual income classification standard in 2014 is different from the annual income classification standards in 2015 and 2016 due to the issue of classification standards, so it is temporarily not included in the discussion.) Here are pie charts of enterprise classification according to scale in 2014 and 2015:

From the above charts, among numerous new high and new technology enterprises, newly-founded enterprises are in rapid growth at an increasingly bigger proportion, so this

requires that more attention should be given to such enterprises in the process of cultivation of new and high-tech enterprises, so as to guide vigorous development of the new force.

The average overall efficiency in the production and operation of high and new technology enterprises below designated size is significantly lower than the average of enterprises above designated size (Table 7-2). This might be because in the case of economic downturn in recent years, enterprises below designated size are generally small and micro enterprises at a small scale; despite their more flexible operation and management, such enterprises are also faced with the difficulties in their poor ability to resist risks, narrow financing channels and limited credit lines. Moreover, many small and micro businesses among high and new technology enterprises in Zhongshan are start-ups, and their managers' lack of economic management knowledge also affects the reasonable utilization of resources.

Table 7-2 Average Overall Efficiency of New and High-tech Enterprises Classified According to Scale in 2015 and 2016

Company type	Average overall efficiency in 2015	Average overall efficiency in 2016
Companies above designated size	0.547	0.552
Companies below designated size	0.500	0.518

Although the overall efficiency of high and new technology enterprises below designated size remains under the average level, the increase rate of overall efficiency of enterprises below designated size is higher than that of enterprises above designated size during the development of these two years; the increase rate of production efficiency of new and high-tech enterprises above designated size is insignificant. If relevant departments want to further improve the overall efficiency of high-tech enterprises in the city, they should pay more attention to the situation and give more attention and support to small and micro enterprises.

7.2.3.5 Cultivation effects in the aspect of production and operation of new and high-tech enterprises in different technical fields

The national strategic emerging industry planning and central & local supporting policies have determined 7 areas (23 key directions), including: I. Energy conservation and environmental protection: key breakthroughs in high efficiency and energy saving, advancement and environmental protection as well as recycling; II. Emerging information

industry: next-generation communication network, Internet of Things, integration of three networks, new panel display, high-performance integrated circuit and high-end software; III. Biological industry: biological medicine, biological agriculture and biological manufacturing; IV. New energy resources: nuclear energy, solar energy, wind energy and biomass energy; V. New energy vehicles: plug-in hybrid electric vehicles and pure electric vehicles; VI. High-end equipment manufacturing: aerospace, marine engineering equipment and high-end intelligent equipment VII. New materials: special functions and high-performance composite materials.

In 2016, more than 92.5% of new and high-tech enterprises in Zhongshan were strategic emerging industries. Among them, electronic information industry, advanced manufacturing and automation, and new material industry were the core strength of new and high-tech enterprises. And the other broad categories include new energy and energy saving, and biomedical industry. This kind of industries has higher requirements for market access, and at the early stage requires investing a lot of funds in supporting experimentation, production, personnel, and research & development; the research and development cycle is relatively long, and technical progress rate generally is not high, but the biomedical industry is an important industry involving national policy and people's livelihood, with important strategic significance. The changes of the number of all kinds of new and high-tech enterprises in 2015 and 2016 are shown below (Figure 3-7-1 in Appendix 3).

It can be seen that high technology manufacturing industry developed rapidly,almost being doubled, and the high-tech manufacturing industry including electronic information and advanced manufacturing & automation accounted for the largest share each year. High-tech manufacturing industry and the new material industry are the core strength of new and high-tech enterprises. These two kinds of enterprises showed their development trend in quantity, and accounted for more than 50% of the total number of new and high-tech enterprises in 2016.

Among them, the growth rate of new and high-tech enterprises belonging to the industries of high-tech manufacturing, new energy resources, high efficiency and energy conservation, and environmental protection even exceeded 100%. Then, efficiency changes of each industry were analyzed from the perspective of overall operation efficiency. The following chart shows the measure of the efficiency value of each technical field corresponding to high technology and enterprises (Table 7-3).

Table 7-3 Distribution of the Performance Value of Production and Operation of New and High-tech Enterprises in Different Technical Fields in 2015 and 2016

	High-tech manufacturing	New materials	New energy resources and energy saving	Environmental protection	Biological medicine	Others
2015	0.526	0.527	0.553	0.546	0.692	0.540
2016	0.539	0.550	0.530	0.551	0.667	0.544

As the backbone of new and high-tech enterprises, high technology manufacturing industry improved in overall efficiency value, but the average value of overall efficiency within the two years was lower than the average level of new and high-tech enterprises in the city, requiring further enhancement of high technology manufacturing in the future development, so as to guarantee that high technology manufacturing enterprises can maintain steady progress in quality and quantity, which is of critical strategic significance because the high technology manufacturing industry plays a crucial role in promoting the overall performance of new and high-tech enterprises, and meanwhile can provide more jobs.

With regard to the new material industry in which the number of enterprises accounted for the second largest among the total number of new and high-tech enterprises, although its overall efficiency was lower than the average in the first year, but in 2016 the new material industry achieved the operational efficiency beyond the average, with very obvious progress. As the new material industry serves as the core strength of new and high-tech enterprise development, the appropriate authorities in Zhongshan also have paid great attention to the cultivation of new material enterprises. According to the performance of recent years, the cultivation of new material enterprises in terms of production and operation has achieved remarkable success.

The number of enterprises in new energy industry was doubled from 2015 to 2016, but their overall efficiency of production and operation declined to a certain degree. As an important strategic industry involving national policy and people's livelihood, the energy industry has received high attention from the academia, politics, and various interest groups in the society; energy economics has also started to become a hot topic and a new tool creating efficiency. It is very meaningful to realize further development of the new energy industry in the aspect of operational efficiency (if applicable).

The total number of new and high-tech enterprises related to environmental protection industry was increased considerably. It is indeed rare that under such circumstances the operational efficiency of enterprises could be maintained, with small progress. In the next step, relevant departments should focus on guaranteeing the increase in the number of such enterprises while avoiding the occurrence of enterprises with low efficiency in production and operation.

High efficiency of biomedical industry is surprising. This industry maintained a fairly high level of operational performance in 2015 and 2016 consecutively. This proves that good performance of the biomedical industry is not annual abnormal fluctuation but benign growth with high efficiency, which is very rare, because the biomedical industry needs a lot of investment at the initial stage, and its long research and development cycle requires more funds for research, thus limiting its development to a great extent. Behind this gratifying situation manifested in the aspect of current production and operation are a lot of impetus. Here, it is worth mentioning that South China TCM Town located in Nangang Town has developed very rapidly, and the number of new and high-tech technology enterprises in this area is in rapid growth, which is closely linked with tireless efforts of relevant departments.

Summary: The cultivation and development of most high-tech technology enterprise industries in Zhongshan is gratifying, especially for backbone industries —high technology manufacturing industry is at stable development speed, with strong impetus, but it should be noted that efficiency cannot be lost in the process of rapid growth in quantity; new energy, energy-efficient industries and environmental protection industries are also making steady progress. As one of the core strengths of new and high-tech enterprises, the new material industry has come a long way in terms of quantity and production and operational efficiency, and it should be considered how to continue keeping this situation. Not constrained by its own industry characteristics, biomedical industry has solved the difficulties in development previously faced by enterprises of the same type, and made growth and progress in a surprising way. If relevant departments can maintain and promote such progress, it can be expected that biomedical industry will continue to grow and become a characteristic industry in Zhongshan.

7.2.3.6 Summary of cultivation effects in the aspect of production and operation of new and high-tech enterprises

As seen from different scales, new and high-tech enterprises above designated size have obvious improvements in their overall efficiency; relatively smaller new and high-tech enterprises at the start-up phase should strive for a higher rate of progress under the premise of stable and good efficiency. From the perspectives of different industries, most industries are developing well, and high technology manufacturing industry as one of the core strengths of new and high-tech enterprises are in the process of robust development. However, high attention should be paid to the overall efficiency values still falling. Continued guidance and policy encouragement should be given to biomedical industry, so as to further establish advantages.

7.2.4 Enterprise performance measure in the aspect of technical innovation

7.2.4.1 Indicator system

Table 2-7-2 shown indicator system in the aspect of technical innovation, you can see it in Appendix 2.

New and high-tech enterprises have the following characteristics: first, big R&D investment; second, many scientific and technologic talented people; third, products and services provided by enterprises have high technological content, which determines that it is incomprehensive to analyze the overall efficiency of new and high-tech enterprises simply from their productivity and financial indicators. A large amount of scientific and technological research & development spending and technical output for supporting the enterprise’s future long-term development can't be ignored. From this point of view, by reference of the concept of technology innovation and statistical standard specified by OECD, we continue to add the indicators in the following two aspects:

7.2.4.2 Data preprocessing and sample number selection

The thinking of data cleaning here is similar to that in the aspect of production and operation. However, relevant output indicators in the aspect of technical innovation are mostly zero items, including very high specific items, and in order to avoid the loss of too much information during the use of EDA algorithm, some outliers are acceptable , so it is conceivable that in terms of technological innovation, the overall efficiency finally obtained

will certainly be more biased than that in the aspect of production and operation. Nevertheless, it actually is the current status of technological innovation of new and high technology enterprises. As there is a huge difference in technological innovation capabilities between enterprises, enterprises with strong innovation capabilities can fully exert knowledge spillovers, and significantly improve the overall enterprise performance.

To reduce such effects as much as possible, the following enterprises are screened out from the collection of all new and high-tech enterprises from 2014 to 2016: 1. Enterprises with the number of patent applications of current year being greater than or equal to one, 2. Enterprises with at least one output being not zero in addition to patent applications (insufficient remaining samples in case of three items, thus losing representative significance). Upon completion of the above screening, we should continue to truncate any fixed assets at less than 5% of the overall level. The sample obtained finally can give a good picture of the changes of technological innovation capability of new and high-tech enterprises in Zhongshan with time.

7.2.4.3 Statistical description of result analysis

On the basis of data preprocessing in the previous section we obtained a feasible technical innovation set including historical data (from 2014 to 2016), with considerably comparable inputs and outputs (deflated by corresponding indexes, to partly offset the impact of currency devaluation and appreciation over time), and then calculated DEA, with the following results obtained (Table 7-4).

Table 7-4 Annual Average of Overall Efficiency, Technical Efficiency, Scale Efficiency and Returns to Scale

		δ_{PTE}		δ_{OE}	$\sum\lambda$
2014	0.264	0.226	0.052	0.069	33.84
2015	0.278	0.226	0.086	0.122	23.15
2016	0.320	0.2634	0.145	0.204	12.62

Wherein: Standard deviations corresponding to OE（Overall Efficiency）and PTE（Pure Technical Efficiency）are δ_{OE} and δ_{PTE} respectively; $\sum\lambda$ refers to the average of weight sum, showing the changes of returns to scale.

7.2.4.3.1 Changes of Pure Technical Efficiency（PTE）

Technical efficiency shows the efficiency of operation and management of the enterprise itself. It is worth mentioning that during the period of 2014-2015 the city of Zhongshan witnessed the growth rate of high and new technology enterprises ranking the first in the entire province, and at the same time the steady growth of pure technical efficiency of high and new technology enterprises in the aspect of technical innovation. In 2016 when the number of high and new technology enterprises developed continuously and rapidly, the mean value of pure technical efficiency was increased considerably, without big ups and downs of standard deviations, which proves an improvement in these enterprises' ability to carry out technical innovation by use of their existing elements.

7.2.4.3.2 Changes of Overall Efficiency（OE）

From 2014 to 2016, the overall efficiency increased year by year, the results of which indicate that in the past three years the coordinated development of new and high-tech enterprises is remarkable, and the overall development trend is more comprehensive. However, as seen from the standard deviation increasing year by year, polarization occurred to technology innovation abilities. New and high technology enterprises with a technological base and economic power had the ability to generate more scientific and technological achievements and, in turn, further strengthened their technical innovation capacity.

7.2.4.3.3 Cultivation effects in the aspect of technical innovation of new and high-tech enterprises of different scales

Similar to production and operation performance analysis, we still need to analyze the changes in the performance of new and high technology enterprises above designated size and below designated size in Zhongshan. Among numerous new high and new technology enterprises, newly-founded enterprises are in rapid growth at an increasingly bigger proportion, so this requires that more attention should be given to such enterprises in the process of cultivation of new and high-tech enterprises, so as to guide vigorous development of the new force.

Table 7-5 Average Overall Efficiency of New and High-tech Enterprises Classified According to Scale in 2016

Company type	Companies below designated size	Companies above designated size
Overall efficiency in 2016	0.101	0.165

The average overall efficiency in the technological innovation of high and new technology enterprises below designated size is significantly lower than the average of enterprises above designated size, which is also in line with the past theory (Table 7-5). In general, enterprises above designated size can provide better conditions for scientific research, organize better scientific research teams, and at the same time has a more perfect and wider information feedback system with more comprehensive information, all of which are conducive to the practice of technical innovation.

7.2.4.4 Cultivation effects in the aspect of technical innovation of new and high-tech enterprises in different technical fields

The distribution of technical fields of new and high-tech enterprises in Zhongshan has been given in the previous performance analysis of production and operation, so it is not repeated here. Below is the distribution of average efficiency of representative enterprises in various industries from 2015 to 2016 (Table 7-6).

Table 7-6 Distribution of Overall Efficiency Values of New and High-tech Enterprises in Different Technical Fields in 2015 and 2016

2015	0.100	0.074	0.040	0.181	0.050	0.086
2016	0.147	0.124	0.139	0.140	0.102	0.145

As the backbone of new and high-tech enterprises, the high technology manufacturing industry obviously improved in its technical innovation capacity, and is also in a technical field where the two-year overall efficiency in technical innovation is higher than the city's average level of new and high-tech enterprises This is related to higher upgrade requirements of the high technology manufacturing industry and the characteristics of obvious productivity brought by technical improvement. As the support strength of new and high-tech enterprises in Zhongshan, substantial progress in the technical innovation capacity of the high technology manufacturing industry is of great significance.

The new material industry in which the number of enterprises accounted for the second largest among the total number of new and high-tech enterprises also had noticeable improvements in technical efficiency. As the new material industry serves as the core strength of new and high-tech enterprise development, the appropriate authorities in Zhongshan also have paid great attention to the cultivation of new material enterprises. According to the performance of recent years, the cultivation of new material enterprises in terms of technical innovation has achieved remarkable success.

New energy industry not only realized the doubling of the number of enterprises from 2015 to 2016, but also had an obvious increase in the average performance of technical innovation. As an important strategic industry involving the national policy and people's livelihood, new energy is an important industry layout that can not be ignored during national

Zhongshan is very conducive to the coordinated development of an area as a whole (Figure 3-7-2 in Appendix 3).

The performance of technical innovation of new and high-tech enterprises related to environmental protection industry is relatively high, which is, on the one hand, due to the attention to the topic of environmental protection from all walks of life, and, on the other hand, due to the fact that product patents relating to environmental protection can be applied for conveniently, with predictable economic profits. Basically as long as the intended function can be achieved, a reliable consumer market will be available. However, the technical innovation capability of high-tech enterprises related to environmental protection industry had a significant reduction from 2015 to 2016, which should be paid high attention to by relevant departments. The possible reason is the entry of new and high-tech enterprises. At the stage of lacking a completely solid foundation, the innovation efficiency of these new and high-tech enterprises was limited, and the total number of enterprises related to environmental protection was small, thus resulting in the bias of the average value of technology innovation.

In the biomedical industry, its high efficiency in production and operation is gratifying, but its low efficiency in technical innovation is also worrying. Technical progress of this industry often needs a lot of investment, such as clinical trials of western medicine and drug variety breeding of TCM (although there are short-term response techniques of capsule improvement, but the vast majority of Class I intellectual property rights of biological medicine are quite time-consuming), long research and development cycle, and more R & D expenditure, which also limits its development to a great extent. The weak innovation ability

of high-tech enterprises in the domestic biomedical field is a common problem and it will take a long time to solve this problem. In the process of promoting the modernization of the biomedical industry, relevant departments should encourage enterprises to innovate more basically and technically, in order to adapt themselves to the fast-changing modern society.

7.3 Ranking of new and high-tech enterprises in Zhongshan by erformance measure

7.3.1 Technical research and development capabilities

In the city of Zhongshan, new and high-tech enterprises are numerous, and their technical research and development capabilities are uneven, so the capabilities of new and high-tech enterprises cannot be ranked only according to their technical research and development scoring. Different enterprise scales, and specific research & development personnel and funds will have an impact on research and development capabilities. According to the number of researchers, the scales of new and high-tech enterprises in Zhongshan are divided, as shown in Table 2-7-3 (Appendix 2), in which enterprises where the number of scientific researchers is greater than or equal to of 100 people account for 21.24% among 838 enterprises. Technical research and development capabilities of new and high-tech enterprises are distinguished by number of patent applications. New and high-tech enterprises in Zhongshan are divided into four levels, namely, respectively the number of patent applications < 10, 10≤patent applications of current year < 50, 50≤patent applications of current year < 100, and 100≤patent applications of current year, with their respective proportion as shown in the figure below. Among new and high-tech enterprises where the number of patent applications is greater than or equal to 50, enterprises with strong research and development ability are further screened out according to their scores.

7.3.2 Scientific and technological development capabilities - Analysis by different industries

High-tech manufacturing industry（Photoelectric integration and information electronics）:

Table 7-7 Ranking of Scientific and Technological Innovation Capabilities of High-tech Manufacturing Industry in 2016

Ranking	Company name	Total number of researchers	Patent applications of current year	Score
1	Union Optech Co., Ltd.	146	122	0.102745
2	Majesty Packaging Systems Limited	336	160	0.064922
3	Zhongshan Broad-Ocean Motor Co., Ltd.	346	129	0.058593
4	Tongyu Communication Inc.	417	38	0.04317
5	Guangdong Midea Environmental Electric Manufacturing Co. Ltd.	840	243	0.033125

New materials:

Table 7-8 Ranking of Scientific and Technological Innovation Capabilities of New Material High-tech Enterprises in 2016

Ranking	Company name	Total number of researchers	Patent applications of current year	Score
1	Vatti Corporation Limited	296	166	0.062863
2	Nox Bellcow Cosmetics Co., Ltd.	113	19	0.024303
3	MLS CO LIMITED	568	103	0.020479
4	China Ming Yang Wind Power Industry Group Limited	485	41	0.019588

New energy (new energy, energy conservation and environmental protection + nuclear energy and its application):

Table 7-9 Ranking of Scientific and Technological Innovation Capabilities of New Energy High-tech Enterprises in 2016

Ranking	Company name	Total number of researchers	Patent applications of current year	Score
1	Guangdong Enaiter Electric Appliance Co. Ltd.	131	37	0.041189
2	Baroque Wood (Zhongshan) Co. Ltd.	232	14	0.037875
3	Guangdong Nenglong Education Co. Ltd.	203	13	0.024578

Environmental protection:

Table 7-10 Ranking of Scientific and Technological Innovation Capabilities in the Industry of Environmental Protection in 2016

Ranking	Company name	Total number of researchers	Patent applications of current year	Score
1	Zhongshan Jixin Core Lock Co. Ltd.	84	4	0.063813
2	CTS (Zhongshan) Technology Co. Ltd.	33	7	0.060974
3	Zhongshan Geelong Manufacturing Co. Ltd.	283	9	0.043651

7.3.3 Ranking of new and high-tech enterprises in the aspect of production and operation efficiency

As a win-win working method, high-efficiency production and operation is not to increase employees' workload but to seek a highly efficient, comfortable and labor-saving work method, thus increasing enterprise revenue, reducing production costs, saving production time, and reducing the labor intensity of workers, allowing employees to rest adequately, and improving employee satisfaction. According to the comprehensive profits and taxes, the operational efficiency of new and high-tech enterprises in Zhongshan was divided. Among 1178 new and high-tech enterprises, enterprises with the comprehensive profits and taxes being greater than or equal to 5000 accounted for 46%, and new and high-tech

enterprises in Zhongshan were divided into four levels according to the comprehensive profits and taxes, respectively total profits and taxes <1000, 1000≤total profits and taxes <10000, 10000≤total profits and taxes <20000, and total profits and taxes≥20000. Among enterprises with total profits and taxes≥50000 the efficiency was screened out for ranking according to overall efficiency score (Table 2-7-4 in Appendix 2).

7.3.4 Ranking of new and high-tech enterprises in the aspect of production and operation efficiency - Analysis according to different industries

High-technology manufacturing industry (photoelectric integration and information electronics):

Table 7-11 Ranking of Production and Operation Performance in High-technology Manufacturing Industry in 2016

Ranking	Company name	Total profits and taxes	Score in overall efficiency
1	Zhongshan Taiguang Electronic Materials Co., Ltd.	276281.5	0.999538
2	CTS (Zhongshan) Technology Co. Ltd.	133622.6	0.820966
3	Zhongshan Shiyu Animation Technology Co. Ltd.	50138.4	0.663469
4	Zhongshan Broad-Ocean Motor Co., Ltd.	387635.6	0.647874
5	Guangdong Daya Smart Kitchen Appliances Co., Ltd.	93051.8	0.633157

Biomedicine:

Table 7-12 Ranking of Production and Operation Performance in Biomedical Industry in 2016

Ranking	Company name	Total profits and taxes	Score in overall efficiency
1	Zhongshan Zhongzhi Chinese Herbal Medicine Co., Ltd.	93457.71532	1
2	Zhongshan Southern New Well Food Biology Engineering Co., Ltd.	409087.0392	1
3	A&Z Pharmaceutical (Zhongshan) Inc.	176241.4374	0.89739
4	Guangdong MWX Flavoring Food Co., Ltd.	529805.3005	0.740213
5	Guangdong Long-fu Pharmaceutical Co., Ltd.	50047.22026	0.707353

New materials:

Table 7-13 Ranking of Production and Operation Performance in New Material Industry in 2016

Ranking	Company name	Total profits and taxes	Score in overall efficiency
1	Guangdong Juhe Silicone Material Co., Ltd.	59065.1	0.653148
2	Guangdong Hoshion Industrial Aluminium Co., Ltd.	85863.62	0.634248
3	Aestar (Zhongshan) Co., Ltd.	94051.25	0.612063
4	Zhongshan Yongfa Paper Industry Co., Ltd	92361.82	0.603899
5	Bauhinia Variegata Ink & Chemicals (Zhongshan) Co., Ltd.	64216.67	0.531764

New energy:

Table 7-14 Ranking of Production and Operation Performance in New Energy Industry in 2016

Ranking	Company name	Total profits and taxes	Score in overall efficiency
1	Vatti Corporation Limited	462855.9105	0.74542
2	TCL Air Conditioner (Zhongshan) Co. Ltd.	147453.6556	0.609566
3	Guangdong Chungchak Heavy Industry Co. Ltd.	75864.69494	0.531026
4	Zhongshan Changhong Electric Co. Ltd.	150022.4277	0.52782
5	Zhongshan Mingyang Electric Co. Ltd.	55759.01214	0.502627

Environmental protection:

Table 7-15 Ranking of Production and Operation Performance in New Energy Industry in 2016

Ranking	Company name	Total profits and taxes	Score in overall efficiency
1	Zhongshan Environmental Protection Industry Co. Ltd.	56149.15	0.934789
2	Palm Eco-town Development Co., Ltd.	50597.8	0.547291

7.4 Contributions of new and high-tech enterprises to regional economic development

7.4.1 Contributions of new and high-tech enterprises to gross industrial output value

In 2016, with the added value of RMB 26.528 billion and at an increase rate of 14.7%, the high-tech manufacturing industry accounted for 19.1% of the industrial added value above designated size, but the number of enterprises in the high technology manufacturing industry accounted for below 10% of the total enterprises above designated size, apparently reflecting contributions of the high technology manufacturing industry to the promotion of regional industrial production. As the backbone of the development of new and high-tech enterprises in Zhongshan city, the high-tech manufacturing industry will play a more and more important role in regional economic development in the future. Under the impetus of high-tech enterprises, other kinds of high-tech industries are developing in a coordinated manner, with their ability of regional economic contribution to be steadily enhanced.

As seen from the distribution of townships (Figure 7-7), there are 2 townships with the

gross industrial output value of RMB10 billion respectively (Torch Development Zone and Nantou Town), 5 townships with the gross industrial output value of RMB5 billion (included) —RMB10 billion (included) respectively (Xiaolan Town, West District, Tanzhou Town, Huangpu Town, Dongfeng Town), 11 townships with the gross industrial output value of RMB1 billion (included) —RMB5 billion respectively (Shenwan Town, Sanjiao Town, South District, Nanlang Town, Minzhong Town, Henglan Town, Gangkou Town, Fusha Town, Dongsheng town, East District, Banfu Town), and 7 townships with the gross industrial output value of below RMB1 billion respectively (Wuguishan, Shiqi District, Shaxi town, Guzhen Town, Dachong Town and Cuiheng New District). Townships including Torch Development Zone, Nantou Town, Xiaolan Town and West District ranking the first ten in the gross industrial output value accounted for 81.83% of the gross industrial output value in Zhongshan city.

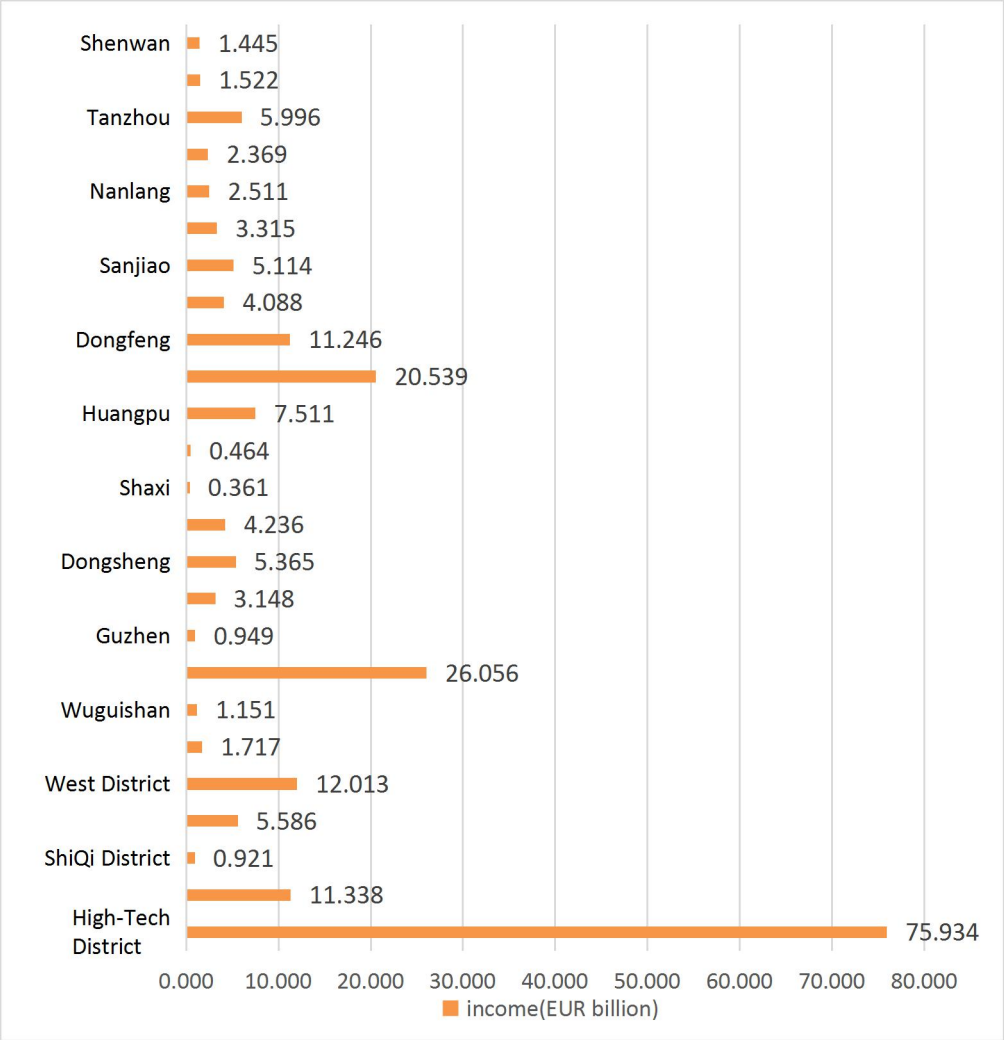

Figure 7-7 The gross INCOME of New and High-tech Enterprises in All Townships in Zhongshan in 2016 (EUR Billion)

7.4.2 Contributions of new and high-tech enterprises to operating profits

Operating profits refer to the surplus of all kinds of revenues generated during the production and operation of enterprises after deducting all costs, and reflect the total profit and loss of enterprises during the reporting period. At the same time, the stronger the profitability, the more cash flow, the stronger the solvency of enterprises is. Profits are a central issue that internal and external parties to enterprises are concerned about, a source of funds from which investors obtain investment income and creditors collect principal and interest, the concentrated expression of business performance and management efficiency of operators, and also an important guarantee for gradually perfecting the workers' collective welfare facilities.

In 2016, operating profits of new and high-tech enterprises in Zhongshan reached RMB12.013 billion (Data source: Zhongshan Office of Science and Technology, preliminary statistics), accounted for 37.94% of the corporate profits of the entire city. Considering that the number of personnel in new and high-tech enterprises accounted for about 13% of the city's total working population (preliminary statistics), its contribution to the corporate profits in the city cannot be ignored.

7.4.3 Tax contributions of new and high-tech enterprises

In recent years, by closely following the strategic plan of innovation-driven development of Guangdong Province, and focusing on the preferential policy of income tax, Guangdong Provincial Office, SAT has been actively supporting the development and expansion of new and high-tech enterprises in Guangdong Province. The tax data shows that tax preferential policies have significantly boosted new and high-tech enterprises, and new and high-tech enterprises in the province have manifested good development momentum, strong profitability and great tax contribution.

Due to the relatively small proportion of new and high-tech ones in tax payment enterprises, the tax contribution of high-tech enterprises enjoying preferential policies is also less, and the total amount of taxes paid in 2016 is RMB 7.24 billion. However, relatively speaking, its tax contribution ability is stronger and the growth rate is higher. From 2008 to 2016, the average annual growth rate was 42.4%, which was not only higher than the average annual growth rate of over 10% in the whole province at the same stage, but also faster than the average household growth rate of above 13.8% in the province. In 2016, the household

average enterprise income tax payment was RMB 7.58 million, which was well above the city average. In 2016, the actual payable amount of income tax accounted for 7.8% in the whole city, with strong tax contribution ability compared with the proportion of 5.3% households.

7.5 Recessive contribution of new and high-tech enterprises to the economy of Zhongshan

7.5.1 Technology spillovers between new and high-tech industries

New and high technology industries can play a role in optimizing industrial structure mainly through the use of technology spillover and technological innovation promoted by new and high technology industries to make decisive factors that affect the industrial structure change, so as to achieve the goal of optimizing industrial restructuring. Such decisive factor change is the change of supply and demand factors, and constant innovation of high and new technology industries, to infiltrate into traditional industries through technology spillovers again, further promote the innovation, upgrading and improvement of production process of traditional industry, then make changes in supply and demand factors, leading to widespread industry spread effect to optimize the industrial structure, and finally, promote the sustained growth of economy by the optimization and upgrading of industrial structure.

Technological innovation is a complicated process, in which a vast amount of knowledge frequently flows. The difference of knowledge from ordinary commodities lies in its own nature of non-exclusive public goods. The so-called non-exclusiveness means that it is very difficult for the producer to monopolize knowledge for a long time. This nature easily makes knowledge casually spill over to another production organization from a production organization. Due to the difference of each enterprise in the ability to share and absorb technology, if the enterprise of technology spillovers and the enterprise receiving such spillovers are highly similar in the capacities of technology absorption, technology transformation and technical processing, the speed of technology spillover will be accelerated. The capacities of enterprises for technology absorption and transformation often rely on scientific research personnel. A man is the creator of technology. There are often many kinds of interpersonal contacts between enterprises and enterprises, and all kinds of interpersonal communication and contact will facilitate the diffusion and flow of knowledge. In Zhongshan, R&D personnel still belong to high-end scarce resources, with quite high value mobility.

Some companies eager for technological progress will attract people talented in research and development in various ways. Along with the intentional or unintentional flow of R&D personnel, knowledge is also constantly flooding into another production organization. In recent years, the development of high and new technology industries in Zhongshan has indeed been continuously improved, and most enterprises in such industries have strong scientific research capabilities, so the flow of new technical knowledge will be more rapid. Once knowledge flows out to another new and high-tech enterprise, new knowledge and technology will be generated through fast transformation and absorption,thus causing a new round of spillovers. On the other hand, high and new technology enterprises are more competitive. According to the Porter's competitiveness model, more resources and factors are required to be sent to high and new technology enterprises in order to keep their competitiveness,including access to knowledge resources. In Henan province, high and new technology industries are still continuously growing stronger, and their competitions for new knowledge and new technology are particularly intense. Current knowledge resources are indispensable advanced factors of production for any high and new technology enterprise in Zhongshan; due to the scarcity of knowledge, any knowledge spillover will stimulate other enterprises to compete for obtaining it, so as to accelerate the absorption and digestion of technology knowledge, and further generate new technology spillovers.

7.5.2 Technology spillovers of new and high-tech industries to traditional industries

Due to the competitiveness of market, each production organization in the market economy will reject other competitors in order to maintain their own material interests. By virtue of their own rich technology, new and high-tech industries can produce more advanced products at lower costs; in order to be able to survive in the market, traditional industries will have a strong desire for obtaining the advanced manufacturing technology. Once high and new technology enterprises in this area have mastered key technologies necessary for traditional industries, these traditional industries, for saving time and costs, will adopt a variety of possible ways to cooperate with high and new technology enterprises in the same province, thus leading to the flow of advanced technology into these traditional enterprises, and accelerating the outflow of technical knowledge to traditional industries.

The effects of technology spillover and technical innovation can make an industry change, and this change can easily affect industries correlated with it in this area. If correlated

industries are industries with strong forward and backward spread effects, such industries can drive the significant development of upstream and downstream industries, so as to affect the composition of the three industries in Zhongshan.

Chapter 8: Conclusion

Ronald Harry Coase described in his book "How China Became Capitalist:" The long-term impact of the introduction of modern science and technology and management experience on China's economy goes far beyond the areas highlighted by comparative advantages." The Chinese economy has gone through three stages of rapid development of scissors, namely, the first scissors between the marginal revolution of private and mixed-owned property rights and the demand for commodity economy after the reform and opening up in 1978; the second scissors between the trade demand in the international market and low-cost production factors (land resources, demographic dividend) and the industrialized scale economies effect with China's accession to the WTO in 2001; the third scissors between China's expansion of domestic demand with RMB 4 trillion investments (real estate, high-speed rail and other infrastructure investment) and gradual development and growth of private economy and the national enterprises (private brands and market channels) and rapid development of the capital market after the 2008 financial crisis. The new normal economic period, i.e. the transition period of knowledge-based economy and the industrialization has gradually come. Innovation-driven development is undoubtedly the only and sustained proposition for the country and the market during this period.

8.1 Research conclusions

With regard to the four aspects of the research questions presented in 1.4, after systematic research and analysis, the thesis draws the following conclusions:

"1. What is the theoretical basis for the formation of local industrial clusters in Zhongshan City? What kind of development path was adopted for industrial clusters in the past?"

(1) The theoretical basis for the formation of local industrial clusters in Zhongshan City.Through literature analysis, the focus of attention of industry clustering lies in the cluster formation of characteristic industries, and the industry clustering process of specialized downs relies on the industry clustering within the administrative division scope oriented to local

governments. Therefore, we can define local industrial clusters as a development form of clustering economy with the basic units of administrative towns (districts), relatively centralized leading industries, a large economic scale, wide market coverage and a high degree of specialized supporting coordination. What needs to be emphatically explained here is the concept of the administrative areas of specialized towns. As the most grass-roots administrative organization in the Chinese administrative system setup, the town directly governs the specific affairs of local residents, enterprises and other practitioners, and undertakes the most grass-roots management in terms of the specific industrial organization and the implementation of policies. That is to say, the town undertakes complicated, specific and multiple management affairs. It is also the most grass-roots organization to be assessed. It is an administrative unit which gets in touch with economic entities the most often. Therefore, studying the industry clustering of grass-roots administrative areas is not only a realistic urgent need for analyzing the process of Chinese economic growth and the future transformation and upgrade of Chinese economy, but also has a very high value for theoretic research.

(2) Through historical literature analysis, we can think that the characteristic industrial clusters of specialized towns in Zhongshan City have observed the three-stage development path. The first germination stage is characterized by “three-processing and one compensation” of coastal economic belt since the reform and opening up and “one town one product” with the township as the administrative division. The second growth stage is characterized by the rapid growth of industrialization, e.g. the government-led “characteristic industrial public service platform”. The third transformation and upgrading stage, i.e. the current stage is characterized by “innovation-driven development”. The development at each stage can not be separated from the keyword “innovation”.

“2. In the face of the new normal of economic growth and the constraints of the factor-driven development model, what kind of development path has been adopted by Zhongshan for industrial transformation and upgrading? Why was such a development path adopted? And what is its theoretical basis?”

From the relevant literature, we can understand that specialized towns are in the form of traditional industrial clusters in a sense, while the transformation and upgrading of traditional industrial clusters must be carried out by relying on and focusing on the main line of innovation-driven development. Innovation means the new combination of resources,

management process and value network. To this end, the national, provincial and municipal governments have pointed out the direction and tasks of innovation-driven development from three aspects and given new challenges and new missions to Zhongshan City directly under the jurisdiction of the administrative system, characterized by the unique political, economic and cultural systems. Zhongshan is expected to identify its own advantages and priorities, focus on innovation-driven development by grasping hi-tech enterprises, technology business incubators, new R&D institutions and intellectual property, make up for weaknesses, bring into play the traditional business advantages of Zhongshan specialized towns and accelerate the gathering of innovative elements to create new specialized towns and speed up the integration into the construction of Guangdong-Hong Kong-Macao Greater Bay Area.

Both the above two points must rely on the main line of innovation-driving, to vigorously advocate entrepreneurship. Just as advocated by Edmund S.Phelp in his book *Flourishing*, "The flourishing of a nation depends on the breadth and depth of innovative activities, while the flourishing of a country comes from the innovation universally participated in by its people."

"3. How to build a research model to systematically analyze the economic transformation and upgrading model for specialized towns in Zhongshan?"

With the general idea of layer-by-layer focus, the thesis adopts the analysis framework based on the positioning of Zhongshan in Guangdong-Hong Kong-Macao Greater Bay Area - formation mechanism and cluster analysis of specialized towns in Zhongshan City - case study on IPR transformation and upgrading of specialized towns in Decorative Lighting Industry of Guzhen Town - DEA performance analysis on hi-tech enterprises in Zhongshan, i.e. the innovation subjects, to conduct systematic research and analysis on the transformation and upgrading model for specialized towns in Zhongshan City (See Figure 1-2: Research Framework of Industrial Transformation and Upgrading Model for Specialized Towns in Zhongshan City for details).

"(1) Is there a macro-level strategic opportunity period for the economic transformation and upgrading of specialized towns in Zhongshan City? What is it? What are the strengths and weaknesses?"

Through the analysis in the third chapter,"The four positionings" proposed at the Thirteenth CPC Congress of Guangdong Province for Zhongshan are a world-class modern equipment manufacturing base, a regional comprehensive traffic hub on the western bank of

the Pearl River, a regional R & D center of scientific and technological innovation and a high-quality livable city in the Pearl River Delta, which have become the programmatic objective for the development of Zhongshan City in the forthcoming five years. Just as shown in Figure 3-2, in order to further promote the cooperative development of Hong Kong-Zhuhai-Macao Greater Bay Area, Hong Kong-Zhuhai-Macao Bridge, Shenzhen-Zhongshan Channel, Humen No. 2 Bridge and other major cross-river channel projects have been planned for construction. The all-round matchmaking of the traffic between the eastern and western bank of the Bay Area will not only tremendously reinforce the sufficient flow of the core economic factors of the Bay Area, but also bring more opportunities for the development of Zhongshan. In particular, as the direct channel between the two economic circles including "Shenzhen-Dongguan-Huizhou" and "Zhuhai-Zhongshan-Jiangmen", and the traffic link of the three free trade zones including Qianhai, Nansha and Hengqin, Shenzhen-Zhongshan Channel will turn the layout of the Pearl River Delta from the shape of "∧" to "A", incorporate Zhongshan City into the 1-hour life circle of core cities in the Bay Area, and set up more convenient organic relationship between Zhongshan and Shenzhen/Hong Kong. the development concept of the "Guangdong-Hong Kong-Macao Greater Bay Area" world-class urban agglomeration has been elaborated. As a "bridgehead" for the innovative resource matchmaking of Zhongshan-Zhuhai West Bank of Guangdong-Hong Kong-Macao Greater Bay Area, Zhongshan should not only exert its geological advantage, but also play its pivot and transformation role in innovative resources so as to seize this opportunity for strategic development. Through the analysis in the Fifth chapter,has been elaborated "3 major advantages and 3 major disadvantages" of Zhongshan City, advantages: 1. good industrial base and strong industrial advantage; 2. good population and labor force structure and technical education personnel base; 3. low wage costs of personnel, with certain competitiveness in the Pearl River Delta. Disadvantages: 1. The shortage of land for construction use has become a core factor restricting the industrial development of Zhongshan; 2. Insufficient growth of fixed asset investment and relatively small investment and financing scale; 3. big gap in advanced manufacturing, producer services and other core industries compared with benchmark cities.

"(2) What is the economic structure of the specialized towns in Zhongshan City? Is it possible to study it through analytical method in a systematic and theoretical manner?"

This thesis chooses the statistical data of 15 specialized towns in Zhongshan City during the 6-year period from 2010 to 2015, and selects 23 indicators that can reflect the development of the specialized towns according to the research topic.The four categories of specialized towns are denoted by four colors in cluster analysis. We can clearly see that the industrial feature of the nine specialized towns in Category 1 is basically traditional industries (namely, agricultural products, casual wear, game and entertainment, textiles, fine chemicals, tourism, classical furniture, American style traditional furniture, mahogany furniture); the four specialized towns in Category 2 are more concentrated on traditional industries and have a higher degree of industrialization (namely, food industry, small household appliances, office furniture, lighting); Nantou in Category 3 and Xiaolan in Category 4 are focused on household appliances and hardware products respectively, with a the higher industrialization requirement.

"(3) Where are breakthroughs in the economic transformation of specialized towns in Zhongshan City and whether there are feasible real-life cases?"

In the sixth chapter, the thesis emphatically analyzes the World Intellectual Property Organization's sole case of intellectual property protection in China, which provides a realistic and feasible development path for the transformation and upgrading of traditional industries. Once again, it verifies the central role of innovation-driven development in the transformation and upgrading as the main line. The core point of intellectual property protection is to promote the occurrence of innovative behavior while maintaining market equity and stability, accelerate effective spillover of industrial technology and encourage the entrepreneurial spirit through regular effective protection of knowledge, to reach an overall improved level of industrial competitiveness. The level of industrial competitiveness is related to corporate competitiveness in the industry, for improved corporate competitiveness plays an important role in strengthening the overall competitiveness of the industry to which an enterprise belongs. The patent protection of exterior design may rely on improving the level of competitiveness of enterprises in the lighting industry, to promote the improvement of overall competitiveness in the industry, and achieve Pareto optimality. The enterprises in the lighting industry of the ancient town have undergone a process in which they have become

strong from weak in competitiveness. At the origin and infant stage of clustering in the lighting industry, the lighting enterprises of the ancient town were weak in competitiveness; they mainly took the form of small workshop. At the stage of initial development of industrial clustering in the lighting industry, the lighting enterprises of the ancient town started to have competitiveness improved to some extent, with their number increasing sharply, contributing to the view of street lighting along a distance of ten li; then, industrial clustering of lighting enterprises entered the stage of rapid development, deriving small and median-sized lighting enterprises one after another, which started to operate their own brands and have their innovative awareness improved, contributing to substantially improved corporate competitiveness. Since 2009, the industrial clustering of lighting enterprises has remained at a mature and stable stage, with the overall competitiveness substantially enhanced. The enterprises above designated size occupy a large part of enterprises in the lighting industry, while they think highly of brand building and have strong sense of innovation. By innovating design and improve product quality, these enterprises also enhance their own management. The constantly strengthened protection of exterior design patents is conductive to improving the sense of innovation of the enterprises and increasing corporate input to research and development, thus expanding their brand influence, promoting their overall competitiveness, and motivating their innovative vitality and entrepreneurial spirit.

The representation of knowledge-based economy is that knowledge, as a kind of capital, will be integrated into the market in the form of property rights and become a new economy-driven development mode. In China, the intellectual property market is transitioning from its infancy to rapid growth phase, and will lead to a new round of intellectual property rights revolution and a new wealth story will continuously update people's perception of capital. This round of intellectual property revolution will be accompanied by a new business model driven by disruptive technology under the background of the government-sponsored innovation drive, resulting in a brand-new supply and demand scissors that has never been attained in the history of human civilization. From the perspective of the development cycle of global enterprises worth tens of billions of dollars, knowledge-based economy has gradually replaced the scale economy to shorten the production time of such an industry giant. The disruptive innovation model of knowledge-based economies represented by Apple, Microsoft, Google, Facebook, Ali, Tencent and Jingdong has gradually replaced the scale-effect business model featured by industrial technology innovation. However, such innovative business models are often led by an immature technology or concept. Subversive

changes in the supply side lead the fundamental changes in end-customer consumption patterns of demand-side customers and rapid replication at near zero costs, replacing the original business ecology in a short time. It is essentially different from the hard-drive, excavators and other disruptive innovations at the level of industrial technology mentioned by Mr. Christensen. It's no longer the disruptive innovation of the performance, convenience, reliability and price, but of the business model and consumer behavior. However, the competition between old and new business models still follows the RPV model proposed by Mr. Christensen. Resources, management processes and value networks are still the keys to change.

"4. What are strengths of the economic innovation subject for the specialized towns in Zhongshan City? How can they be systematically analyzed and utilized?"

Through the analysis in the seventh chapter, we have learned that after 10 years of high-speed growth, especially in the past three years, hi-tech enterprises in Zhongshan City have become the main force and innovation subject of industrial transformation and upgrading, and innovation-driven development. The hi-tech industry gains benefits by improving the existing products or launching new products through technology research and development, and technology landing. Under the impact of hi-tech industries, traditional industries have desired for advanced manufacturing technologies to achieve considerable development. Traditional industries are constrained by their weak technological foundation. For the sake of saving time and cost, it is more likely for them to establish a cooperative relationship with hi-tech industries in the region or the province, and to introduce advanced technologies from the hi-tech industry, thus accelerating the technological spillover from hi-tech industries to traditional industries.

The progress of an industry is closely related to the role of technological spillovers and technological innovations, while the progress of an industry has a certain leading role in other interconnected industries in the region. Zhongshan's industrial facilities in the upper, middle, and lower reaches are relatively complete. Technology spillovers in industries with strong industrial forward and backward ripple effects can simultaneously drive upstream and downstream technological advancements, and become the core kinetic energy for the conversion of new and old kinetic energy, thus guaranteeing the high-quality growth.

8.2 Prospects for transformation and upgrading of specialized towns in Zhongshan City

To sum up, in order to promote the economic development and integrate into the construction of regional economic agglomeration in Guangdong-Hong Kong-Macao Greater Bay Area, Zhongshan City should shoulder the historical mission of building a new type of specialized towns with the focus on the integration of innovative elements, giving full play to the role of the innovation subject, forging hi-tech enterprises into the backbone of innovation-driven development of new and old kinetic energy conversions, putting into practice more efficient and strict IPR systems, and opening the door to the era of knowledge-driven economy.

Such a change depends on the core elements, i.e. the speed and magnitude of information transfer. With the maturity of China's 4G network and high-speed rail technology, the concept of space-time for China in the past has been completely broken. As the chief architect of reform and opening up, Comrade Deng Xiaoping guided and defined the past revolutionary reforms of intellectual property rights and the preemptive reform model. He achieved brilliant achievements of 30 years of development through the blooming experimental field of reform in county-level competition among local governments, and basically completed the mission of entering the era of industrialization. Now China has become the experimental ground for new technologies, new ideas and new models all over the world. Through such infrastructures as information networks, high-speed railways, expressways and civil aviation, China has greatly narrowed its space-time concept as a large-scale, populous country with multiple cultural sources and complex landscape.

In future, China will be the world's largest and best experimental field for artificial intelligence, big data, virtual reality, blockchain, unmanned driving, genetic engineering and other new technologies and new ideas, so innovation-driven will be the main theme of our generation and even for decades to come. With the changes of the times, the roles and tasks of Chinese local governments in the past should also change. In the past, governments simply gained from land supply and industrial one-off property rights transactions, and now they have gradually evolved into industrial organizations. They choose to gain periodic income from fiscal and tax revenue and adopt more forward-looking, higher-risk-return industry-funding model with market-oriented investment in capital to invest in innovative

business model experiments led by knowledge-based economy, so as to obtain the long-term return on Trust business model.

This article, based on this exploratory research and analysis framework, brings forward the research reference model for the specialized town. According to Xi Jinping's report at Nineteenth CPC National Congress, it has been clearly stated that China will strive to achieve the Two Centenary Goals, that is, to build a comprehensive well-off society by 2020, and by 2050 to achieve the overall goal of a socialist modernized country. Until now China is still in the primary stage of socialism. At present, the meaning of socialist modernization must be consistent with the overall law of economic development worldwide, and China is now at an important juncture in accelerating industrial modernization and opening up an era of knowledge-based economy. The content of the transformation and upgrading should include the task of accelerating the upgrading of industrial modernization and opening the knowledge-based economy transition. Thus new propositions have been put forward for our local government and specialized town managers. As an important part of Guangdong-Hong Kong-Macao Greater Bay Area, Zhongshan should be pinpointed as a bridgehead and an intelligent manufacturing industry base for joining innovative resources in the east and west coast, to vigorously develop new types of industrial incubation carriers and industrial capital markets, establish and perfect a knowledge-based economy innovation system, and accelerate the integration into the innovation-driven development and construction of Guangdong-Hong Kong-Macao Greater Bay Area.

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Appendix 1

1、Introduction to high and new technology enterprises of Zhongshan

A high and new technology enterprise is defined in Administrative Measures for the Determination of High and New Technology Enterprises issued by Chinese authority in 2008. In China, the high and new technology enterprise generally refers to a resident enterprise which continues to conduct research and development and transformation of technological results to develop its core, independent intellectual property within the scope of High and New Technology Fields under the Key Support from the Government, based on which it conducts operating activities. Such resident enterprise is a knowledge-intensive and technology-intensive economic entity. The high and new technology enterprise serves as the nose of an ox (the key) to implement innovation-driven development strategy, and the principal part of promoting technology innovation and industrial upgrade. It is of great importance for accelerating regional economic development to energetically develop and strengthen the high and new technology enterprises.

The concept of high and new technology enterprise is derived from the western countries. However, the high and new technology enterprise has been identified and emphasized from a different perspective by scholars from different countries. In defining the high and new technology enterprise, scholars from Britain and France lay stress on the knowledge intensity of the high and new technology enterprise, i.e. high input in research and development, high proportion of scientific and technological personnel and high technical content of products; scholars from Japan not only look at the enterprise's existing technology of high technical content, but also focus on current technology that can lay a solid foundation for upgrade and renewal of technologies of the next generation; based on the proportion of research and development expenses to selling expenses and the proportion of the number of research and development personnel to that of total staff, and by combing the high technical content of product-led technology, the U.S. Department of Commerce divides the high and new technology industry into such three fields as information technology, biological technology and new material technology. The Organization for Economic Cooperation and Development (OECD) includes such three indicators as the proportion of total expenses to total output, the

proportion of direct expenses to output, and the proportion of direct expenses to industry added value, into the important statistical category which is used to measure whether a sector belongs to the high and new technology industry. This has gained support from most of the countries in the world, and in this way, aviation and aerospace manufacturing, computer and office equipment manufacturing, electronic and communication equipment manufacturing, and pharmaceutical manufacturing among other sectors have been identified to belong to the category of high and new technology industry.

2、The characteristics of high and new technology enterprises in China

Compared with traditional technology and industry, high and new technology enterprises have many remarkable characteristics, which are mainly embodied in the following aspects:

(1) They are both brain-intensive and knowledge-intensive enterprises. The proportion of the number of science and technology personnel engaging in research, development and relevant technological innovation activities to the number of all staff of the year is not lower than 10%; the high and new technology enterprises which are knowledge-intensive, technology-intensive and capital-intensive serve as the benchmark reflecting corporate innovation level comprehensively;

(2) High investment on research and development, with details provided in Administrative Measures for the Determination of High and New Technology Enterprises;

(3) Attaching importance to research and development of high value-added products. The high and new technology enterprises think highly of research and development of strategic high value-added products, which have strong radiation and driving effects and a prosperous future of industrialization, to preempt the zenith of technology. Such products have a short refresh cycle and belong to the industry which generally presents a high-speed growth trend;

(4) Collecting and transforming high-end results both at home and abroad. Through industry-university- research cooperation, the high and new technology enterprises establish research and development organizations or branches overseas, and overseas purchase of technology-based enterprises or research and development organizations owning core technologies, the high and new technology enterprises consolidate domestic and foreign innovative resources, gather and transform high-level technological results;

(5) High technology. Through industry-university-research collaborative innovation, the high and new technology enterprises establish strategic alliance with institutions of higher

learning, scientific research institutions, and industry associations, etc., promote research on industrial key generic technology together, and advance the overall technological level of the industry; they energetically introduce advanced applicable technologies, and acquire technological results in urgent need by purchase on the market, and promote production technology level and technical content of products;

(6) High risks. The high and new technology enterprises are exposed to high risks which mainly come from technological uncertainty. A new technology is developed by periodic law, featured by a process of generation, development, application and elimination; it is in periodic variation at all times. Meanwhile, the high and new technology enterprises are faced by brain drain risks since they are highly dependent on scientific and technological talents;

3、Industrial classification of high and new technology enterprises in China

The high and new technology enterprises in China are divided into eight fields by High and New Technology Fields under the Key Support from the Government (see the following table).

Table A-1 The Classification of High and New Technology Enterprises in China

I. Electronic information		
Software	Microelectric technology	Computer products and the network application technology
Communication technology	Radio, film and television technology	New electronic components
Information security technology	Intelligent transport and rail transport technology	
II. Biology and new medicine and pharmacology		
Medicinal biotechnology	Traditional Chinese medicine, natural medicine	Research and development technology for chemical medicine
Pharmaceutical nanotechnology and preparation creation and production technology	Medical instrument, equipment and special software for medicine	Light industry and biochemical engineering
Agricultural biotechnology		

III. Aerospace		
Aviation technology	Space technology	
IV. New material		
Metal material	Inorganic nonmetallic materials	Macromolecular materials
Biomedical materials	Fine and special chemicals	New material related to arts culture industry
V. High technology service		
R & D and design service	Inspection and detection certification and standard service	Information technology service
High-technology professional service	Intellectual property and result transformation service	E-commerce and modern logistics technology
Urban management and social service	Supporting technology for cultural creative industry	
VI. New energy and energy-saving		
Renewable clean energy	Nuclear energy and hydrogen energy	New-type high-efficiency energy conversion and storage technology
High-efficiency energy-saving technology		
VII. Resources and environment		
Water pollution control and water resource utilization technology	Air pollution control technology	Disposal and comprehensive utilization technology for solid wastes
Physical pollution prevention technology	Environmental monitoring and emergency treatment technology for environmental accidents	Construction and protection technology for ecological environment
Cleaner production technology	Resource prospection,	

	high-efficient exploitation and comprehensive utilization technology	
VIII.Advanced manufacturing and automation		
Control system for industrial production process	Work safety technology	High-performance intelligentized instrumentation
Advanced manufacturing process and device	New machinery	Electric system and equipment
Automobile and railway vehicle related technology	High-technology ship and marine engineering device design and manufacturing technology	Transformation technology for traditional cultural industry

4、 Procedures for determination of high and new technology enterprises in China

(1) Submitting application materials. The enterprise shall provide the determination authority (a provincial authority in charge of science and technology) with a determination application.

(2) Compliance review. The determination authority shall establish an expert pool for determination and review of high and new technology enterprises; it shall extract experts from the pool based on the application materials submitted by the enterprise, to conduct review of the declaring enterprise and propose determination opinions.

(3) Determination, publicity and filing on record.

The determination authority shall determinate the enterprises, and publicize those identified ones on the work web of determination and management of high and new technology enterprises for 15 workdays. Those without any objection shall be declared and submitted to National Torch Center for record, and the certificate of high and new technology enterprise will be printed and issued jointly by State Administration of Taxation, Ministry of Finance, and Ministry of Science and Technology, and will be valid for 3 years.

From the determination procedures, we can see that the high and new technology enterprise shall be identified by national, provincial and municipal authorities using

expert-review system. According to Administrative Measures for the Determination of High and New Technology Enterprises issued by the government in 2016, the determination of the high and new technology enterprise is valid for three years, and such high and new technology enterprise shall be re-identified after such three years. The identified high and new technology enterprise may enjoy 15% of taxable income to pay corporate income tax. Therefore, the number of high and new technology enterprises in a region serves as an important indicator reflecting enterprise innovation ability in that region. However, the government shall include this job as a main indicator for innovation-driven assessment and as "the nose of an ox" (the key) for innovation-driven development.

Appendix 2

Additional Reference-Tables

Table 2-1-1 The Indicator System of the Development Phases of Zhongshan City in 2016

Phase of industrialization level	The early period of industrialization	The middle period of industrialization	The late period of industrialization	The period of post-industrialization	Zhongshan City
Per-capita GDP (euro) (Economic development level)	979-1958	1958-3917	3917-7344	7344-17626	12770
The percentages of the three big industries (industrial structure)	A>20%，and A<I	A<20%，I>S	A<10%，I>S	A<10%，I<S	2.2: 52.3: 45.5
The percentage of light industry output value in the total output value of the secondary industry (the structure of the secondary industry)	The light industry is in a dominant position	The heavy industry is in a dominant position	The ratio of the light and the heavy industry is relatively stable	The ratio of the light and the heavy industry is relatively stable	56.94: 43.06
Urbanization level	30%－50%	50%－60%	60%－75%	More than 75%	88.20%

Table 2-1-2 The 15 Provincial Local Industrial Clusters of Zhongshan City in 2011

Serial number	Town	Name of provincial local industrial cluster of Guangdong	Serial number	Town	Name of provincial local industrial cluster of Guangdong
1	Xiaolan	Hardware products	9	Sanjiao	Textiles
2	Huangpu	Food industry	10	Nantou	Home appliances
3	Minzhong	Agricultural products	11	Fusha	Fine chemicals
4	Dongfeng	Small home appliances	12	Nanlang	Tourism
5	Dongsheng	Office furniture	13	Sanxiang	Classical furniture
6	Guzhen	Decorative lighting	14	Banfu	American traditional furniture
7	Shaxi	Casual wear	15	Dayong	Redwood furniture
8	Gangkou	Game and recreation			

Table 2-3-1 Statistics Data Sheet of Innovative Capacity of Seven Cities in Pearl River Delta from 2013 to 2015

	Year	Guangzhou	Shenzhen	Foshan	Dongguan	Zhongshan	Zhuhai	Huizhou
GDP（100 million EUR）	2013	1937.15	1821.58	876.34	689.68	331.49	209.88	338.14
	2014	2088.36	2000.23	930.2	735.17	352.88	233.4	375.05
	2015	2262.55	2187.86	1000.49	784.38	376.25	253.18	392.5
R&D % in GDP	2013	1.9	4.03	2.33	2	2.35	2.53	2.08
	2014	2	4	2.48	2.16	2.39	2.53	1.98
	2015	2.1	4.18	2.45	2.36	2.36	2.64	2.03
Effective invention patents	2013	15554	62293	4537	4228	1559	1919	1100
	2014	18993	70870	5297	5426	1971	2445	1608
	2015	24143	83903	7067	7890	2931	3667	2500
Education budget outlays（100 million EUR ）	2013	28.63	35.97	12.81	14.2	8.26	6.39	9.1
	2014	31.74	41.35	13.22	14.87	8.99	6.14	10.63
	2015	35.88	36.07	16	16.37	8.06	6.61	11.87
Municipal electric power consumption（100 million KWH）	2013	710.69	721.48	527.06	622.51	217.1	121.73	248.44
	2014	765.85	779.93	564.13	660.99	237.64	134.32	276.41
	2015	779.32	806.68	587.84	666.84	245.51	145.37	290.62
Total export（100 million EUR ）	2013	533.86	2598.47	361.45	772.32	225.04	225.94	283.22
	2014	618.01	2417.08	397.09	825.07	236.96	246.63	308.81
	2015	689.95	2244.34	409.74	880.69	238.06	244.89	295.59
Year-end permanent population（10 thousand people）	2013	1292.68	1062.89	729.57	831.66	317.39	159.03	470
	2014	1308.05	1077.89	735.06	834.31	319.27	161.42	472.66
	2015	1350.11	1137.87	743.06	825.41	320.96	163.41	475.55
Land area	sq. km	7434.4	1997.27	3797.72	2460	1783.67	1732.33	11343

Table 2-3-2 2013-2015 Standardized Data Sheet of Six Innovative Capacity Indicators for Nine Cities in Pearl River Delta

City	Per-sq. km GDP	R&D /GDP	Invention patent holding per 10,000 people	Total export	Per-capita education budget outlays	Annual per-capita electric power consumption (KWH)
Shenzhen	4.01	4.07	3.3	4.75	2.77	3.52
Guangzhou	1.13	2	0.74	1.2	1.95	2.85
Foshan	1.97	2.42	1.53	2.29	1.52	3.8
Dongguan	2.39	2.17	1.41	4.86	1.46	3.91
Zhongshan	1.59	2.37	1.35	1.37	2.11	3.66
Zhuhai	1.07	2.57	3.31	1.41	3.16	4.15
Huizhou	0.26	2.03	0.73	1.74	1.78	2.87

Table 2-4-1 Correlation Analysis

	regional total output value		total industrial output value		including: total output value of enterprises above designated size		industrial added value	
	Pearson Correlation	Sig.(2-tailed)	Pearson Correlation	Sig.(2-tailed)	Pearson Correlation	Sig.(2-tailed)	Pearson Correlation	Sig.(2-tailed)
regional total output value	1		.904**	0	.812**	0	.923**	0
total industrial output value	.904**	0	1		.967**	0	.961**	0
including: total output value of enterprises above designated size	.812**	0	.967**	0	1		.909**	0
industrial added value	.923**	0	.961**	0	.909**	0	1	
total agricultural output value	-0.302	0.105	-0.202	0.285	-0.145	0.444	-0.237	0.207
total amount of industrial profits	.495**	0.005	.646**	0	.666**	0	.617**	0
total number of staff and workers	.867**	0	.650**	0	.538**	0.002	.702**	0
industrial electricity consumption	.746**	0	.645**	0	.545**	0.002	.695**	0
number of characteristic economic enterprises	.533**	0.002	0.355	0.054	.166**	0.382	.412*	0.024
total output value of characteristic industries	.542**	0.002	.525**	0.003	.452*	0.012	.486**	0
total number of staff and workers of characteristic industries	.619**	0	.504**	0.004	.404*	0.027	.530**	0.003
number of scientific and technical personnel of characteristic industries	.644**	0	.535**	0.002	.465*	0.01	.559**	0.001
research and development (R&D) personnel	.704**	0	.621**	0	.516**	0.004	.644**	0
total social input in science and technology of the town	.763**	0	.752**	0	.681**	0	.734**	0
governmental input in science and technology	.762**	0	.628**	0	.531**	0.003	.638**	0

number of patent applications of the town	.723**	0	.567**	0.001	.404*	0.027	.572**	0.001
number of patent authorizations of the town	.759**	0	.589**	0.001	.426*	0.019	.599**	0
number of enterprises above designated size established with R & D institutions (no.)	.513**	0.004	.576**	0.001	.516**	0.004	.604**	0
number of provincial and above brand products	.784**	0	.699**	0	.645**	0	.684**	0
number of provincial and above famous trademarks	.854**	0	.720**	0	.627**	0	.727**	0
number of innovative service agencies in the town (no.)	.615**	0	.550**	0.002	.485**	0.007	.596**	0.001
annual number of training personnel of innovative platform	.700**	0	.578**	0.001	.461*	0.01	.576**	0.001
number of foreign service enterprises of innovation platform	.733**	0	.638**	0	.549**	0.002	.631**	0

**Correlation is significant at the 0.01 lecel(2-tailed)

*Correlation is significant at the 0.05 lecel(2-tailed)

Table 2-4-2 Commonalities of Variables

Communalities		
	Initial	Extraction
Zscore (regional total output value)	1.000	.926
Zscore (total industrial output value)	1.000	.958
Zscore (including: total output value of enterprises above designated size)	1.000	.928
Zscore (industrial added value)	1.000	.929
Zscore (total agricultural output value)	1.000	.537
Zscore (total amount of industrial profits)	1.000	.783
Zscore (total number of staff and workers)	1.000	.859
Zscore (industrial electricity consumption)	1.000	.709
Zscore (number of characteristic economic enterprises)	1.000	.856
Zscore: total output value of characteristic industries (RMB ten thousand)	1.000	.891
Zscore (total number of staff and workers of characteristic industries)	1.000	.864
Zscore (number of scientific and technical personnel of characteristic industries)	1.000	.896
Zscore: research and development (R&D) personnel (person)	1.000	.713
Zscore: total social input in science and technology of the town (RMB ten thousand)	1.000	.862
Zscore (governmental input in science and technology)	1.000	.793
Zscore: number of patent applications of the town (piece)	1.000	.925
Zscore (number of patent authorizations of the town)	1.000	.942
Zscore: number of enterprises above designated size established with R & D institutions (no.)	1.000	.547
Zscore (number of provincial and above brand products)	1.000	.760
Zscore (number of provincial and above famous trademarks)	1.000	.891
Zscore: number of innovative service agencies in the town (no.)	1.000	.764
Zscore (annual number of training personnel of innovative platform)	1.000	.831
Zscore (number of foreign service enterprises of innovation platform)	1.000	.838

Table 2-4-3 Table of Variance Explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.99	60.827	60.827	13.99	60.827	60.827	5.467	23.770	23.770
2	2.372	10.315	71.143	2.372	10.315	71.143	5.234	22.758	46.528
3	1.623	7.054	78.197	1.623	7.054	78.197	4.345	18.892	65.420
4	1.017	4.422	82.619	1.017	4.422	82.619	3.956	17.199	82.619
5	.816	3.547	86.166						
6	.697	3.029	89.195						
7	.607	2.641	91.836						
8	.457	1.988	93.824						
9	.408	1.776	95.600						
10	.272	1.183	96.783						
11	.181	.789	97.572						
12	.152	.661	98.233						
13	.111	.485	98.717						
14	.107	.466	99.183						
15	.068	.296	99.480						
16	.044	.192	99.672						
17	.027	.118	99.791						
18	.016	.071	99.862						
19	.012	.053	99.915						
20	.010	.042	99.956						
21	.006	.027	99.984						
22	.002	.010	99.994						
23	.001	.006	100.000						

Table 2-4-4 Principal Component Analysis of Factor Loading Matrix

Component Matrix[a]

	Component		
	1	2	3
Zscore (regional total output value)	.923		
Zscore (number of foreign service enterprises of innovation platform)	.893		
Zscore （number of provincial and above famous trademarks）	.872		
Zscore number of patent authorizations of the town	.859		
Zscore: number of patent applications of the town (piece)	.851		
Zscore (annual number of training personnel of innovative platform)	.846		
Zscore (industrial added value)	.845		
Zscore (total industrial output value)	.833		
Zscore (governmental input in science and technology)	.830		
Zscore (number of scientific and technical personnel of characteristic industries)	.829		
Zscore (total number of staff and workers)	.829		
Zscore (industrial electricity consumption)	.795		
Zscore (total number of staff and workers of characteristic industries)	.794		
Zscore (number of provincial and above brand products)	.791		
Zscore: research and development (R&D) personnel (person)	.776		
Zscore: total social input in science and technology of the town (RMB ten thousand)	.766		
Zscore: number of innovative service agencies in the town (no.)	.737		
Zscore (including: total output value of enterprises above designated size)	.724	.576	
Zscore (number of characteristic economic enterprises)	.698		
Zscore: total output value of characteristic industries (RMB ten thousand)	.685		
Zscore: number of enterprises above designated size established with R & D institutions (no.)	.578		
Zscore (total agricultural output value)	-.506	.529	
Zscore (total amount of industrial profits)			.613

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table 2-4-5 Principal Component Analysis of Rotated Factor Loading Matrix

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Zscore: total social input in science and technology of the town (RMB ten thousand)	.818			
Zscore (number of patent authorizations of the town)	.751			
Zscore (number of provincial and above famous trademarks)	.730			
Zscore (number of provincial and above brand products)	.716			
Zscore: number of patent applications of the town (piece)	.692			
Zscore: number of enterprises above designated size established with R & D institutions (no.)	.624			
Zscore (regional total output value)	.576			
Zscore: total output value of characteristic industries (RMB ten thousand)		.847		
Zscore(total number of staff and workers of characteristic industries)		.792		
Zscore (number of characteristic economic enterprises)		.771		
Zscore (number of scientific and technical personnel of characteristic industries)		.685		
Zscore (total agricultural output value)		-.661		
Zscore: number of innovative service agencies in the town (no.)		.584		
Zscore: research and development (R&D) personnel (person)		.576		
Zscore (number of foreign service enterprises of innovation platform)		.572		
Zscore (total number of staff and workers)			.772	
Zscore (annual number of training personnel of innovative platform)			.680	
Zscore (industrial electricity consumption)			.623	
Zscore (governmental input in science and technology)			.613	
Zscore (total amount of industrial profits)				.857
Zscore (including: total output value of enterprises above designated size)				.827
Zscore (total industrial output value)				.760
Zscore (industrial added value)				.717

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 30 iterations.

Table 2-4-6 Component Score Coefficient Matrix

Component Score Coefficient Matrix

	Component			
	1	2	3	4
Zscore (regional total output value)	.051	-.073	.086	.078
Zscore (total industrial output value)	.038	-.066	-.043	.230
Zscore (including: total output value of enterprises above designated size)	-.005	-.097	-.021	.282
Zscore (industrial added value)	.027	-.071	-.002	.203
Zscore (total agricultural output value)	.062	-.189	-.032	.104
Zscore (total amount of industrial profits)	-.137	.070	-.164	.386
Zscore (total number of staff and workers)	-.071	-.122	.376	-.069
Zscore (industrial electricity consumption)	-.008	-.085	.245	-.048
Zscore (number of characteristic economic enterprises)	.173	.262	-.277	-.100
Zscore: total output value of characteristic industries (RMB ten thousand)	-.031	.331	-.324	.147
Zscore (total number of staff and workers of characteristic industries)	-.117	.214	-.008	.039
Zscore (number of scientific and technical personnel of characteristic industries)	-.174	.118	.186	.003
Zscore: research and development (R&D) personnel (person)	-.127	.112	.054	.101
Zscore: total social input in science and technology of the town (RMB ten thousand)	.274	-.080	-.134	.025
Zscore (governmental input in science and technology)	.066	-.093	.217	-.097
Zscore: number of patent applications of the town (piece)	.213	.140	-.166	-.113
Zscore (number of patent authorizations of the town)	.238	.092	-.125	-.136
Zscore: number of enterprises above designated size established with R & D institutions (no.)	.227	-.014	-.223	.084
Zscore (number of provincial and above brand products)	.191	-.081	.034	-.062
Zscore (number of provincial and above famous trademarks)	.169	-.083	.097	-.094
Zscore: number of innovative service agencies in the town (no.)	-.218	.092	.200	.063
Zscore (annual number of training personnel of innovative platform)	-.081	-.003	.272	-.074
Zscore (number of foreign service enterprises of innovation platform)	.011	.069	.081	-.046

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Component Scores.

Table 2-4-7 2010-2011 Overall Score of Specialized Towns

Serial number	Specialized town	2010	2011	Serial number	Specialized town	2010	2011
1	Xiaolan	1.09	1.42	9	Sanjiao	-0.22	-0.15
2	Huangpu	0.08	0.1	10	Nantou	0.18	0.36
3	Minzhong	-0.3	-0.29	11	Fusha	-0.38	-0.37
4	Dongfeng	0.14	0.24	12	Nanlang	-0.33	-0.27
5	Dongsheng	-0.17	-0.06	13	Sanxiang	-0.2	-0.22
6	Guzhen	0.38	0.36	14	Banfu	-0.36	-0.36
7	Shaxi	0.03	0.16	15	Dayong	-0.24	-0.24
8	Gangkou	-0.23	-0.18				

Table 2-5-1 Innovation Service Platforms of Specialized Towns in Zhongshan City

Serial number	Platform name	Construction unit	Serial number	Platform name	Construction unit
1	Guzhen Town Productivity Promotion Center	Guzhen	9	Processing Technology Research and Development Center for Traditional Meat Products in Zhongshan City	Huangpu
	Lighting Industry Transformation and Upgrading Service Platform		10	Construction of Public Service Platform for Household Appliance Innovation	
2	Xiaolan Town Productivity Promotion Center	Xiaolan	11	Office Furniture Innovation Service Platform	Dongsheng
3	Public Technical Service Platform for Apparel Industry in Shaxi Town, Zhongshan City	Shaxi	12	American Style Antique Furniture Innovation and Service Center	Banfu
4	Zhongshan Mahogany Furniture Research and Development Center	Dayong	13	Cultural Tourism Innovation Service Platform	Nanlang
	Zhongshan Mahogany Furniture Engineering Technology Research and Development Center		14	Fine Chemical Technology Innovation Center	Fusha
5	Public Technological Innovation Service Platform for Jean Industry in Dayong		15	Public Service Platform for Environmental Technology	Sanjiao
6	Zhongshan Household Appliance Innovation Center	Nantou		Digital Sanjiao Innovation Service Platform	
7	Engineering Technology Research and Development Center for Green Food in Zhongshan City	Minzhong	16	Classical Furniture Technology and Service Center	Sanxiang
8	Embedded Software Development Platform of Small Appliances	Dongfeng	17	Game and Entertainment Technology Innovation Service Platform	Gangkou

Table 2-5-2 Proportion of the Added Value of Industrial Enterprises above Designated Size in the Seven Major Cities of Pearl River Delta in 2015

	Zhongshan	Guangzhou	Shenzhen	Zhuhai	Foshan	Huizhou	Dongguan
Added value （Euro 100 million）	160.13	566.91	803.30	114.62	545.54	202.17	326.50
Extraction of Petroleum and Natural Gas			3.26%	4.38%			
Mining and Dressing of Ferrous Metal Ores						0.09%	
Mining and Dressing of Nonferrous Metal Ores						0.02%	
Mining and Processing of Nonmetal Ores	0.04%	0.01%			0.02%	0.99%	36.22%
Auxiliary Mining Operations			0.19%				
Processing of Farm and Sideline Food	0.43%	0.68%	0.42%	0.53%	1.03%	0.84%	0.88%
Manufacture of Food	6.53%	3.45%	0.21%	1.79%	2.48%	0.36%	1.39%
Manufacture of Wine, Beverage and Refined Tea	1.67%	2.18%	0.54%	0.55%	1.33%	0.73%	0.84%
Tobacco Products		3.63%	0.85%				
Textile Industry	2.69%	1.09%	0.28%	0.47%	3.63%	0.99%	1.77%
Manufacture of Textile Garments, Footwear and Headgear	5.62%	3.12%	1.33%	1.34%	2.39%	2.08%	5.18%
Leather, Fur, Feathers and Their Products and Footwear	2.54%	1.89%	0.75%	0.63%	1.56%	3.87%	4.83%
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	0.45%	0.17%	0.05%	0.15%	0.69%	1.03%	0.16%
Manufacture of Furniture	2.21%	1.25%	0.52%	0.44%	2.53%	2.39%	2.49%
Papermaking and Paper Products	1.99%	0.43%	0.54%	0.88%	1.36%	0.32%	4.30%
Printing and Record Medium Reproduction	0.69%	0.63%	1.09%	0.42%	0.98%	0.59%	1.92%
Manufacture of Culture, Education, Handicraft, Fine Arts, Sports and Entertainment Articles	3.32%	2.24%	1.62%	0.41%	2.73%	1.45%	4.27%
Petroleum Processing,	0.09%	4.38%	0.36%	1.44%	0.68%	8.23%	0.09%

Coking and Nuclear Fuel Processing							
Manufacture of Raw Chemical Materials and Chemical Products	5.30%	11.81%	0.85%	2.29%	4.20%	7.80%	2.02%
Manufacture of Medicines	3.71%	1.75%	1.31%	4.85%	0.65%	0.37%	0.38%
Manufacture of Chemical Fibers	0.02%	0.04%	0.03%	1.17%	0.15%	0.04%	0.07%
Manufacture of Rubber and Plastic Products	5.32%	1.99%	2.85%	1.71%	5.07%	3.82%	5.96%
Nonmetal Mineral Product Industry	1.81%	0.82%	1.20%	0.74%	7.85%	3.11%	1.77%
Smelting and Pressing of Ferrous Metals	0.31%	0.34%	0.06%	1.30%	2.07%	1.52%	0.37%
Smelting and Pressing of Nonferrous Metals	0.41%	0.85%	0.13%	1.39%	4.57%	0.25%	0.77%
Manufacture of Metal Products	4.73%	1.76%	2.15%	2.16%	7.45%	3.18%	4.46%
Manufacture of General Purpose Machinery	6.88%	3.77%	2.23%	4.55%	3.73%	1.49%	3.30%
Manufacture of Special Purpose Machinery	2.13%	1.19%	3.74%	3.03%	3.45%	0.97%	3.17%
Automobile Industry	2.75%	22%	1.06%	1.77%	3.84%	3.19%	1.49%
Railway, Ships, Aerospace & other Transport Equipment	1.21%	1.78%	0.71%	0.42%	0.52%	0.29%	0.61%
Manufacture of Electrical Machinery and Equipment	16.58%	4.24%	6.75%	28.40%	22.62%	6.06%	8.64%
Manufacture of Computers, Communicati on Equipment and Other Electronic Equipment	12.43%	9.38%	57.86%	20.27%	5.74%	37.57%	29.32%
Manufacture of Instruments and Meters	1.47%	0.50%	1.51%	1.47%	0.67%	0.38%	1.82%
Other Manufacturing	0.96%	0.09%	0.31%	0.04%	0.08%	0.17%	0.37%
Comprehensive Utilization of Waste	0.05%	0.17%	0.04%	0.03%	1.98%	0.18%	0.01%
Manufacture of Metal Products, Machinery and Equipment Maintenance		0.55%	0.07%	0.80%			0.01%
Production and Supply of Electric Power and Heat Power	4.35%	8.52%	4.10%	9.17%	3.06%	5.34%	6.63%

Production and Supply of Gas	0.79%	2.21%	0.36%	0.32%	0.51%	0.07%	0.28%
Production and Supply of Water	0.54%	1.09%	0.69%	0.69%	0.37%	0.23%	0.44%

Table 2-5-3 Average Annual Wage of Employees by Industries in the Major Cities of the Pearl River Delta in 2015

Unit (Euro)

Main industries	Zhongshan	Guangzhou	Shenzhen	Huizhou	Dongguan	Foshan	Zhuhai
Manufacturing	6577	8499	8731	6475	6112	7381	7371
Construction Industry	6144	8876	7581	6134	5970	5534	7822
Wholesale and Retail Trade	6397	8710	9328	6513	6332	6494	8439
Transport, Warehousing and Postal Services	7063	11574	11215	6886	7714	7579	9404
Accommodation and Catering Industry	4659	6486	5954	4924	4370	4636	6974
Information Transmission, Software and Information Technology Services	12299	15414	20182	10804	15576	13289	12375
Financial Industry	18074	23066	29110	14606	22072	12349	15167
Real Estate	7499	8918	8466	8797	9283	10387	7988
Leasing and Business Services	7197	9382	8794	7636	7316	7198	8733
Scientific Research and Technical Services	9611	12411	16229	11217	10596	9714	10280
Health and Social Work	12939	11740	15841	13341	10761	10327	11051
Public Administration, Social Security and Social Organizations	10427	12064	14450	13655	9909	10234	12933

Table 2-5-4 Comparison of Population Structure in the Nine Cities of the Pearl River Delta in 2015

	Total population	Sex structure	Cultural quality structure		Age structure		Urbanization
	Resident population (ten thousand persons)	Sex ratio	Proportion of people with senior high school education（%）	Proportion of people with junior college education and above %）	Proportion of people aged 15-64（%）	Proportion of people aged 65 and above（%）	Urbanization rate（%）
Guangzhou	1350.11	105.08	25.71	23.66	79.12	7.89	85.53
Shenzhen	1137.89	115.56	25.59	22.67	83.22	3.37	100
Zhuhai	163.41	108.32	24.33	21.52	78.5	6.65	38.07
Foshan	743.06	117.25	20.06	14.14	80.44	6.79	94.94
Huizhou	475.55	111.48	17.61	9.15	74.39	6.55	68.15
Dongguan	825.41	102.5	23.5	11.13	83.78	6.03	88.82
Zhongshan	320.96	116.37	22.73	11.32	80.27	5.73	88.12

Table 2-5-5 Completion of Investment in Fixed Assets in Seven Major Cities of the Pearl River Delta in 2015

Unit (Euro)

	Zhongshan	Guangzhou	Shenzhen	Huizhou	Dongguan	Foshan	Zhuhai
Farming, Forestry, Animal Husbandry and Fishery	3158	42719	772	30423	--	15118	2146
Manufacturing	343159	805260	641298	827102	541141	1442509	274507
Construction Industry	1948	22040	306	--	973	--	--
Wholesale and Retail Trade	40720	289872	38117	34643	24141	113607	17001
Transport, Warehousing and Postal Services	74899	581360	496920	228408	182373	174149	257087
Accommodation and Catering Industry	6863	108294	19123	49614	8020	36815	23366
Information Transmission, Software and Information Technology Services	17199	221611	56342	12817	24016	45607	8692
Real Estate	656930	1797161	2078339	860476	82585	1387745	703811
Leasing and Business Services	14193	15001	104441	3160	4610	43036	12787
Scientific Research and Technical Services	909	93581	70603	2598	28206	9898	7630

Table 2-6-1 Comparison of Industrial Designs Protection Modes in Major Countries

Protection Mode	Country	Legislation	Protection Conditions	Examination Method	Term of Protection	Features
Patent Law Protection Mode	China	Patent Law	Novelty Obvious difference	Preliminary examination	10 years	mainly adopts the protection of patent law, supplemented by copyright law, trademark law and anti-unfair competition law
	USA	Patent Law	Novelty Non-obviousness	Substantive examination	15 years	mainly adopts the protection of patent law, supplemented by copyright law, trademark law and anti-unfair competition law
Dual protection mode based on separate legislation and copyright law	EU	EC Design Act	Novelty Uniqueness	Formal examination	Registered designs will be protected in 25 years; unregistered designs will be automatically entitled to a 3-year protection period	Both registered and non-registered system
	Japan	Japan Design Act	Novelty Creativeness	Substantive examination	15 years	Industrial designs protection system are comprehensive and more mature
Dual protection mode based on separate legislation and copyright law	France	Special Design Legislation Copyright Law	Novelty Originality	Registration system	5 years from the date of application for registration up to 25 years	Dual protection through Special Design Legislation and Copyright Law

Table 2-6-2 Design Comparison of Lighting Products under Different IPR Protection Modes

	Authorization conditions	Object of protection	Procedures and time of examination	Term of protection	Scope of rights	Infringement identified
Design Patent Protection	Different or substantially different, applicable to industrial applications, obvious difference	The appearance design of most lighting products conforms to the authorization conditions of design patent.	Upon submission of the application, the design patent can be authorized generally 3-6 months later after passing the preliminary examination.	10 years	Manufacture right, offering for sale, the right of sale, import right	General consumers can judge whether the design is same or similar based on their knowledge and capability. The identification is relatively easy.
Copyright Law Protection	Originality (some of the works have higher artistic demand)	Only a few lighting designs of higher artistic characteristics can be protected as works of art or practical works of art.	The works created will be automatically entitled to the rights.	In case of individual works, the life of the author plus at least 50 years after their death; in case of a legal person or organization's work, 50 years after the first publication	Publishing rights, right of authorship and other personal rights, right of reproduction, right of distribution and other property rights	The infringement will be identified when both the access and substantial similarity are established, and the identification is relatively difficult
Trademark Law Protection	Distinctiveness, non-functionality, legality	Three-dimensional trademarks can be applied only when the designs are distinctive. Due to the fast upgrading of lightings, the trademarks are of little significance.	Upon submission of the application, the trademark can be granted generally in a year to one and half year after passing the preliminary examination and substantial examination.	10 years which can be renewed indefinitely	The same or similar trademarks cannot be used on the same or similar products.	The infringement will be identified when the confusion is caused by application of the same or similar trademarks to the same or similar products.

Table 2-6-3 Situation of Cases of Dispute on Patent Infringement in the Ancient Town from 2011 to 2015

(Unit: Case)

Type of cases of dispute on patent infringement	Invention	Utility model	Exterior design	Total
2011	0	23	58	81
2012	21	45	248	314
2013	3	31	272	306
2014	8	10	199	217
2015	8	16	399	423

Table 2-6-4 Immediate Maintenance Data of Patent Dispute Cases from 2011 to 2016

(Unit: Case)

Year	Filed	Mediated successfully	Compensation amount (Ten thousand Euro)	Unshelved	Closed by mediation	Closed	Success rate	Confirmed judicially	Transferred to court
2011	81	34	/	30	16	79	81.01	/	12
2012	309	75	/	164	77	316	75.63	/	11
2013	306	53	7.59	209	32	300	87.33	17	34
2014	217	65	5.79	89	50	204	75.49	48	31
2015	423	132	10.43	169	137	438	68.72	119	32
2016	470	122	8.27	188	154	464	66.8	92	94
Total	1806	481	32.08	849	466	1801	455	276	214

Table 2-6-5 Exhibition-based Immediate Maintenance Data of Patent Dispute Cases from 2012 to 2016

(Unit: Case)

Year	Filed	Cancelled	Unshelved	Closed
2012	17	0	17	17
2013	18	4	14	18
2014	4	1	3	4
2015	5	3	2	5
2016	33	15	18	33

Table 2-7-1 Indicator System in Production and Operation

Perspectives for analysis	Indicator attribute	Indicator description	Data structure
Production and operation	Input	Fixed assets	（Deflated by GDP index， base year 2014） Total fixed assets
		Current assets	（ Deflated by GDP index ， base year 2014） Total current assets
		Operating costs	（ Deflated by GDP index ， base year 2014） Total operating costs
		Number of employees	Average number of employees within the year
	Output	Sales revenue	（ Deflated by CPI index, base year 2014） Sales revenue
		Total profits and taxes	（ Deflated by GDP index, base year 2014） Total profits + turnover tax Industrial-commercial tax + VAT payable + taxes in administrative expenses
		Net assets	（ Deflated by GDP index, base year 2014 ） Creditors' equity at year-end

Table 2-7-2 Indicator System in the Aspect of Technical Innovation

Analysis level	Indicator attribute	Indicator description	Data structure
Technical innovation	Input	Total scientific research funds of current year	All corporate spending on science and technology activities as well as government subsidies (Deflated by GDP index, base year 2014)
		Total number of researchers	Number of researchers
		Fixed assets	(Deflated by GDP index, base year 2014)
		Number of patent applications of current year	Number of patent applications of current year
	Output	Class-I intellectual property adjustment scores	The scores comprise Class-I intellectual property assessment scores of current year and industrial standard-making scores.
		Technical market turnover	Technical revenue and technical contract transaction amount (Deflated by GDP index, base year 2014)
		Sales revenue of new products	Sales revenue of new products of current year

Table 2-7-3 Ranking of Scientific and Technological Innovation Capabilities in the Aspect of Patent Limitation in 2016

Ranking	Company name	Total number of researchers	Patent applications of current year	Score
1	TCL Air Conditioner (Zhongshan)Co. Ltd.	195	256	0.192721
2	Union Optech Co., Ltd.	146	122	0.102745
3	Guangdong Changhong Electronics Co., Ltd.	217	111	0.097193
4	China Ming Yang Wind Power Industry Group Limited	475	64	0.086352
5	Zhongshan Broad-Ocean Motor Co., Ltd.	338	201	0.085746

Table 2-7-4 Ranking of Scientific and Technological Innovation Capabilities of New and High-tech Enterprises in Zhongshan in the Aspect of Profit and Tax Limitation in 2016

Ranking	Survey unit	Total profits and taxes	Score in overall efficiency
1	Hawley & Hazel Chemical Co. (Zhongshan) Ltd.	1652833.011	1
2	Zhongshan Zhongzhi Chinese Herbal Medicine Co., Ltd.	93457.71532	1
3	Southern New Well Food Biology Engineering Co., Ltd.	409087.0392	1
4	Zhongshan Taiguang Electronic Materials Co., Ltd.	276281.5216	0.999538
5	Zhongshan Environmental Protection Industrial Co., Ltd.	56149.14989	0.934789
6	A&Z Pharmaceutical (Zhongshan) Inc.	176241.4374	0.89739
7	CTS (Zhongshan) Technology Co. Ltd.	133622.6151	0.820966
8	Vatti Corporation Limited	462855.9105	0.74542

Appendix 3

Additional Reference-Figures

Figure 3-3-1 “NASA” 2016 Satellite Contrast Night Pictures of New York Greater Bay Area and Chinese Southeastern Coast

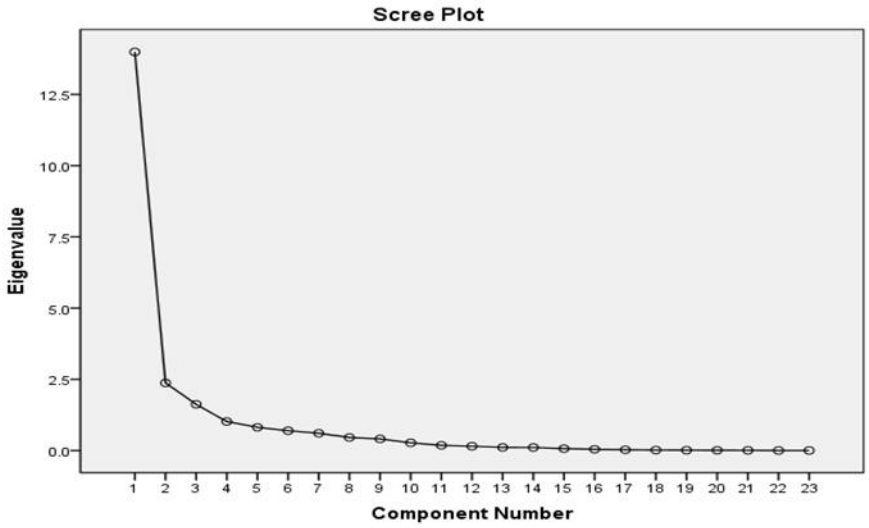

Figure 3-4-1 Eigenvalue Scree Plot

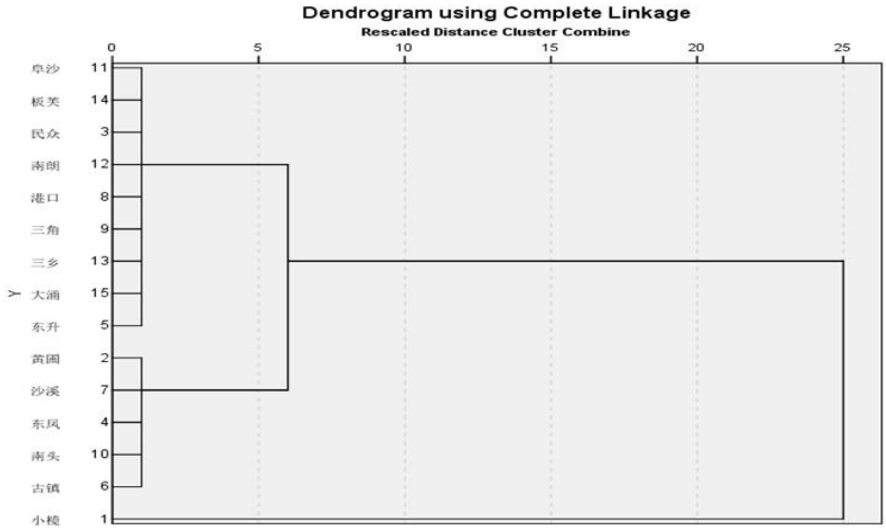

Figure 3-4-2 Clustering Result of Specialized Towns in 2010-2011

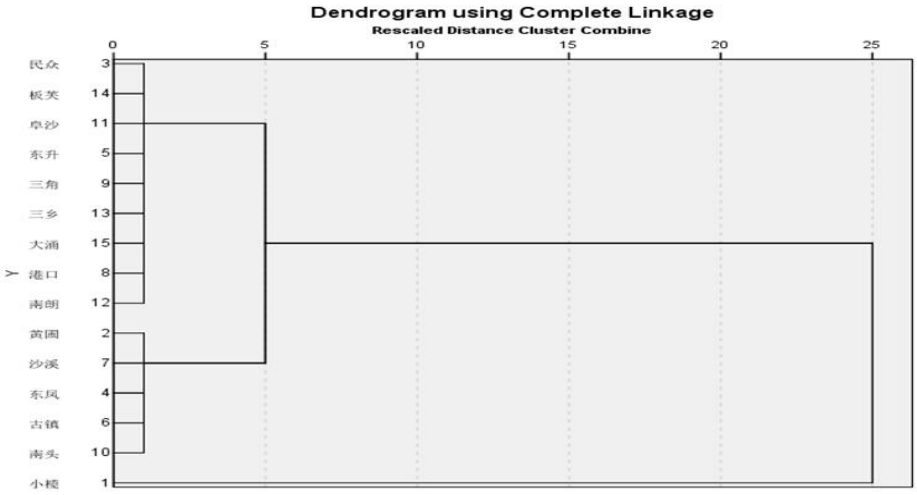

Figure 3-4-3 Clustering Result of Specialized Towns in 2012-2013

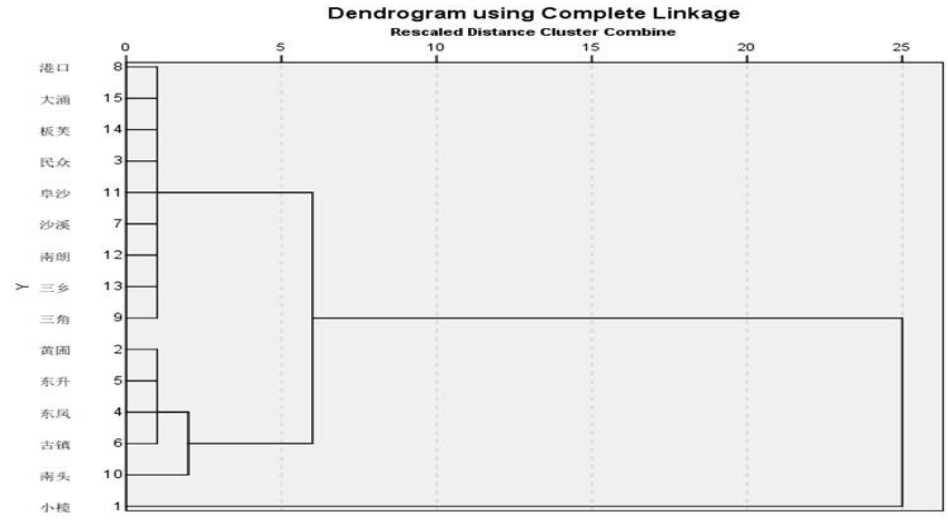

Figure 3-4-4 Clustering Result of Specialized Towns in 2014-2015

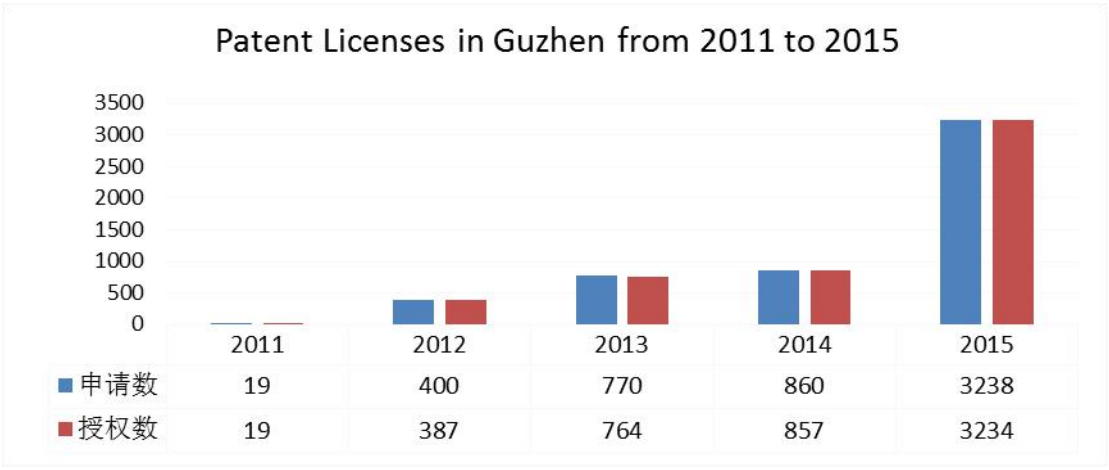

Figure 3-6-1 Patent Licenses in Guzhen from 2011 to 2015

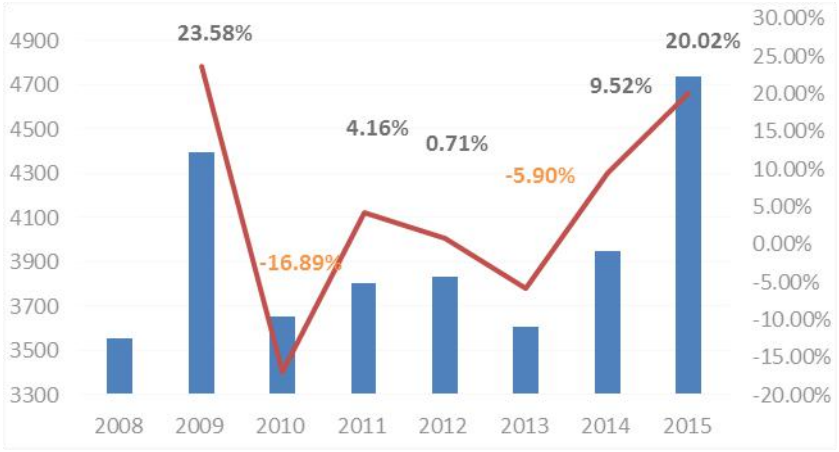

Figure 3-6-2 Trend Chart of Concentration of Specialized Town Enterprises in the Lighting Industry from 2008 to 2015

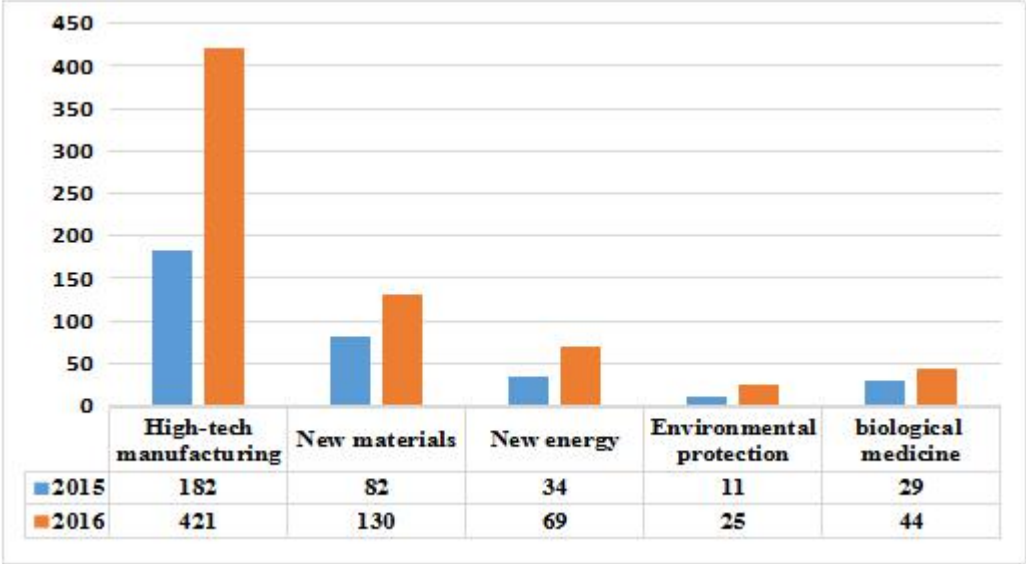

Figure 3-7-1 Changes of the Number of New and High-tech Enterprises in Various Industries in 2015 and 2016

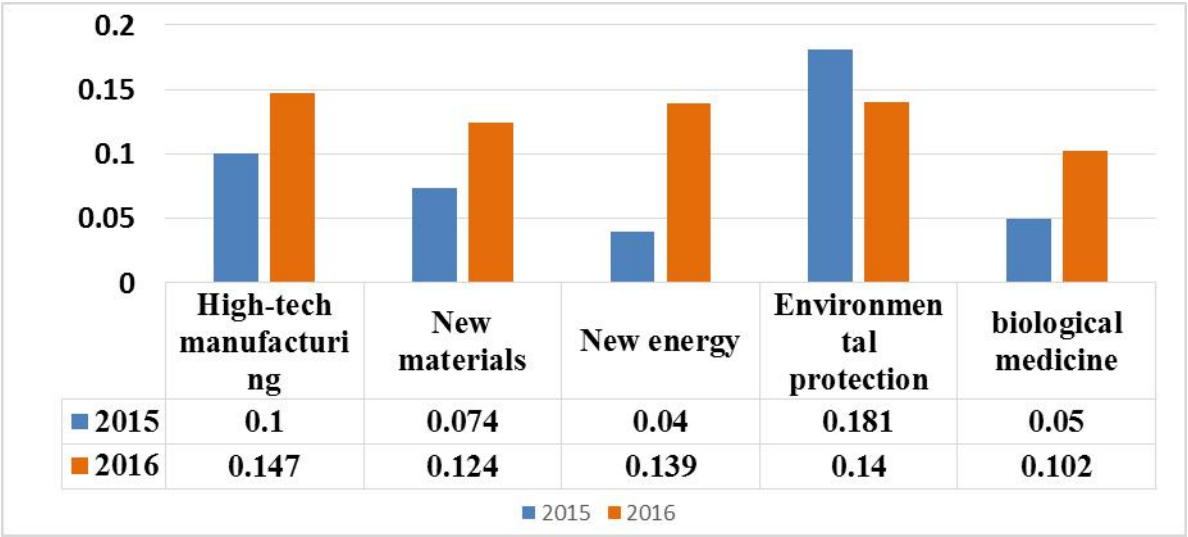

Figure 3-7-2 Changes of Overall Efficiency Values in Different Industries in 2015 and 2016