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# A research on the innovative performance of clustering enterprises in industrial parks: Evidence from Shenzhen, China

Jiangong BAI
*Singapore Management University*, jiangongbai.2018@ckdba.smu.edu.sg

# A RESEARCH ON THE INNOVATIVE PERFORMANCE OF CLUSTERING ENTERPRISES IN INDUSTRIAL PARKS: EVIDENCE FROM SHENZHEN, CHINA

BAI JIANGONG

SINGAPORE MANAGEMENT UNIVERSITY

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# A Research on the Innovative Performance of Clustering Enterprises in Industrial Parks: Evidence from Shenzhen, China

BAI Jiangong

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**Dissertation Committee:**

GENG Xuesong (Chair)

Associate Professor of Strategic Management

Singapore Management University

WANG Yijiang (Co-Supervisor)

Professor of Human Resource Management and Economics

CKGSB

LI Jing

Assistant Professor of Economics

Singapore Management University

SINGAPORE MANAGEMENT UNIVERSITY

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I hereby declare that this dissertation is my original work and it has been written by me in its entirety.

I have duly acknowledged all the sources of information which have been used in this dissertation.

This dissertation has also not been submitted for any degree in any university previously.

BAI Jiangong

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## Abstract

How about the innovation performance of enterprises clustered in the industrial parks? This is the core question of this study. Based on the thinking and evolution of the question, this study will focus on the impact of industrial agglomeration on enterprise innovation performance with enterprise relations and informal institution as intermediate variables.

In this study, Shenzhen, as a city of innovation, is selected as the research area where sample parks and enterprises can be investigated to obtain data. This study constructs and measures the strength of informal institution and enterprise innovation performance through grounded theory and fuzzy matter-element method, evaluates the enterprise relationship in the parks through social network analysis(SNA), and then takes cluster enterprises, the operation of industrial park, enterprise relations in the parks and enterprise innovation performance as four variable sets, build models, and use the method of regression analysis to judge the impact of various factors on enterprise innovation performance in the industrial parks.

This study found that the industrial agglomeration has no direct and significant positive impact on the network of clustering enterprises, but significant positive impact on enterprise innovation performance. Network and informal institution also have significant positive impact on enterprise innovation performance, and informal institution has an intermediary effect between

industrial cluster and enterprise innovation. Especially in Shenzhen, the informal institutional relationship consisted of blood, geography, industry and learning plays an important role. For industrial parks with a certain scale, due to industrial upgrading and renewal, they pay more attention to the exploration of the potential of innovative enterprises, and even give considerable preferential policies to actively guide them to settle in and promote their innovation performance. After all, this benefits both sides.

**Keywords:** industrial agglomeration, industrial park, innovation performance, enterprise relationship, informal institution

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**Acknowledgment**

How time flies! It has been three years since I started my DBA study and my doctoral study is drawing to a close. At this moment, I stand by the window looking into the lush and green garden outside, which witnesses my research objectives and achievements and carries my dreams and future expectations.

I had a lot of ideas while selecting the research topic. Should it be intelligent manufacturing transformation and upgrading, or HR enterprise management or social responsibility and educational development? Until I talked with my thesis supervisor about my career development in January 2020 in Shenzhen, I suddenly realized that the best topic was the industrial park that I spared no effort to build. Based on accumulated resources and management practice, I collected massive data and drew research conclusions on enterprise innovation to provide new ideas about the construction of industrial clusters of Shenzhen and promote the development of my industrial park.

After the topic was selected, I worked hard and I indeed realized the importance of a rigorous attitude towards study and the hard-won research achievements. Finally, I hold this heavy thesis, for which I went through hardship but without extra effort, since I spent a lot of time and energy and gained guidance and help from my supervisor and friends.

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My doctoral study is drawing to a close, but it is not the destination. Time passes very quickly. My longing for and pursuit of knowledge will accompany me in my career and dream and passion will encourage people of vision to forge ahead!

(Written on July 18, 2021 in Shenzhen Linoya Industrial Park and updated on August 7.)

# Chapter I Research Background and Research Significance

## 1.1 Research Background

The construction of industrial park and its influence on social economy have become a major issue on public policy and state role in the 21st century, e.g.: Suzhou Industrial Park relatively relies more on close cooperation between the government and the market. These super-sized reputable science parks are mostly government-funded. Besides, many privately-owned industrial parks also have profound influence on industrial agglomeration and economic development of surrounding areas.

Although industrial park is a cluster carrier that the state promotes vigorously at present, its development is still restricted. Currently, local industrial parks only focus on the geographical concentration of enterprises while ignoring the cluster effect. Park is not equal to cluster and the concentration of dissociated enterprises may not necessarily create a cluster effect. Besides, cluster is not equal to park, the geographical concentration of enterprises is not the only condition for cluster and relatively scattered enterprises also can form a cluster. An ideal industrial cluster is partly enterprise's self-organizing development process under government guidance and with government support, and the government should act as the environment builder and supporter instead of the intervener and oppressor (Zhao and Zhang 2008). In this case, it is of great importance to study the operating condition of industrial parks and their cluster enterprises. In fact, the development of industrial park is a rather complicated topic, which is not only the content of Management science but also should be verified by multidisciplinary knowledge such as Economics and Sociology. At the micro level, we need to study the practical effect of

industrial park from the angle of enterprise relationship. In this respect, a good entry point is to explore innovation behavior and performance, with the interaction relations among cluster enterprises as the research object.

In addition, I have engaged in the manufacturing industry for a long time in Shenzhen and participated in the construction and operation of several industrial parks, so I have personal experience and understanding of industrial cluster, operating condition of industrial park, cluster enterprise and enterprise innovation. According to my personal experience, the operator needs to adopt some measures to maintain the enterprise relationship in the parks as the opportunities for interaction are quite essential for enterprises to exchange information. But if formal institution is relatively weak, enterprise will use the social network as the institutional support for their own development, since the broad network helps them obtain resources from informal resource owners that partly run out of formal institutional arrangements (Ostrom et al.,1993; Ostrom & Ahn, 2009; Webb et al., 2009). Inter-enterprise interaction could promote knowledge flow and the geographical proximity of a park created an opportunity for knowledge transfer (Aral & Van Alstyne, 2011). Therefore, it is very necessary for the builder and operator of industrial parks to explore informal institution under industrial park mode. As long as they understand these problems thoroughly, they can make wiser decisions while building industrial parks to promote innovation output of cluster enterprise and gain economic benefits.

## 1.2 Presentation of Research Problems

The core research problem is the innovation performance of cluster enterprises under industrial park mode.

In today's economic globalization, it is increasingly common that enterprises gather in a specific place due to industrial relations. In a global context, the industrial cluster of major countries absorbed and collected enormous economic energy and cultivated a multitude of world-class industries and enterprises like "a viscous point in a smooth space" (Markusen, 1996). The cluster districts from Silicon Valley, Boston Route 128, Eindhoven Hi-tech Campus to Zhongguancun Science Park have made great contributions to promoting economic development and even industrial development of surrounding areas.

Cluster was reflected in cluster of enterprises geographically, but research showed that such spatial density could not produce competitive advantages (Schmitz, 1995; Steinle & Schiele, 2002). In other words, some clusters make a greater success than others due to other characteristics. Enterprise relationship is a key factor that is widely accepted. For example, Schmitz (1995) pointed out the disadvantage of middle and small-sized enterprises was not small size but whether they were "lonely". Active cooperation of enterprises in the cluster and external economy formed by agglomeration of enterprises in the same place could produce a "group efficiency" to promote enterprise growth. According to Cooke (1996), the competing and cooperative enterprise relationship in the cluster constituted the core characteristic of industrial cluster mode. Feser and Bergman (2000) also pointed out that the quantity and economic value of the cooperative relations among enterprises in

the cluster showed the strength of the cluster. Generally, scholars almost reached a consensus in their studies: the competitiveness of cluster enterprise, a successful form of industrial organization, was mainly from their cooperative relations (Pyke & Sengenberger, 1992; Schmitz, 1995; Schmitz & Navdi, 1999). Such relations offered a mechanism for knowledge and technology transfer to enhance enterprise competitiveness and efficiency (Porter, 1998; Schmitz & Navdi, 1999) and improved the overall competitiveness of the cluster to promote the sustainable development of the whole area.

Relative to a large cluster, industrial park is a very concrete form of cluster. In recent years, scholars showed interest in studying industrial parks. They tried to narrow the scope of cluster and study industrial parks from a more micro perspective. Tan (2006) mainly focused on science and technology industrial park and he said that science and technology industrial park played an active role in promoting technology transfer and regional development, which did not draw enough attention yet. Zhao and Zhang (2008) also considered industrial park as a special form of industrial cluster. They stressed that government should act as the environment builder and supporter instead of the intervener and the oppressor in terms of support of industrial cluster and enterprise's self-organizing development under government guidance and with government support could better promote the benign development of industrial park.

The dense cluster district of industrial park, as a smaller unit, showed a closer geographical relation among its enterprises and the spatial limitations may promote inter-enterprise knowledge exchange and innovation output. A small

cluster facilitated inter-enterprise knowledge creation and exchange and offered more learning opportunities to enterprises (Arikan, 2009) through offering plenty of knowledge workers (Almeida & Kogut, 1999; Rosenkopf & Almeida, 2003) and knowledge transfer channel of the social network (Owen-Smith & Powell, 2004; Whittington et al., 2009). That is, clustering could have a positive impact on innovation output of cluster enterprise (Beaudry, 2001; Whittington et al.2009; Geng & Huang, 2017).

Despite research findings of industrial clustering and innovation performance, innovation behavior and performance of cluster enterprise have been rarely studied with the operation mode of industrial park as the entry point. Thus, this study will thoroughly analyze economic performance and interaction between cluster enterprises in the industrial park and the innovation effect based on survey of various industrial parks of Shenzhen City, so as to explore the particularities of innovation performance of cluster enterprises under industrial park mode.

## 1.3 Research Significance

### 1.3.1 Theoretical Significance

Geographical proximity brought enterprises support factors that could maintain and intensify innovation, such as cultural identity and mutual trust (Baptista & Swann, 1998). Formal and informal institutions including social network, trust and social norm made up an environment affecting cluster innovation and laid a foundation for mutual exchange, collective learning and joint problem solving. In a specific institutional environment, enterprise survived, transaction cost reduced, knowledge was transferred and collective

action was achieved (Maskell, 1999). At present, many scholars analyze the relationship between innovation environment and cluster innovation, with industrial district or industrial cluster as the research object, and stress the importance of the collective learning process of middle and small-sized high-tech enterprises in the regional cluster for innovation.

This study focuses on industrial park from a big district to a small bounded geographic space. This study will analyze the operating condition of industrial park and explore agglomeration and interaction of park enterprises in such a range. The operation mode of industrial park includes development, planning and operation. Millar et al. (2005) divided science and technology industrial park into three classes according to development mode, i.e. market-driven science and technology industrial park, government-driven science and technology industrial park aimed at attracting foreign multinational companies, and government-driven science and technology industrial park focusing on cultivating domestic companies. Jiang and Wang (2008) explained the park management mechanism through the study of creative industry park. She pointed out that enterprise was attracted by such factors as preferential policy and rented or purchased offices from development entities such as management committee and intermediary to settle in the park. The management committee, financial service center and venture capital institution of the park are responsible for raising bank loans, industry development funds, foreign capital and private capital for enterprise to ensure normal creation, production and marketing of the park. After obtaining output value and benefit, enterprise will return a part of profits to different development entities in the form of taxes and dues, rent, property fee and interest. This fund circulation

process ensures normal operation of the park. Based on previous studies, this study puts forwards two basic questions of industrial park: (1) How is the industrial agglomeration of industrial park? (2) Does industrial park mode affect enterprise relationship and innovation performance of enterprise? With various industrial parks of Shenzhen City as the research object, this study will analyze the practical situation, try to answer these two questions and make theoretical contributions.

Then, this study analyzes informal institution in a cluster environment and tries to cover the shortcomings of the rough discussion about "informal institution" in most studies. In the studies of cluster, informal institution that plays an important part in economic activities has a wide range, including tradition, custom, norm and practice in the cluster, as well as the personal relationship network built by relatives, friends, town fellows, colleagues and schoolmates, and so on. Most scholars do not make a clear definition but roughly use such concepts as trust, social embeddedness and cultural environment. However, representation of the effective informal institution is different due to a difference in the nature of these informal institutions. Therefore, it is hard to catch principal contradictions if the effect of "informal institution" is discussed roughly, and consequently confusion of the research thought may be easily caused. This study analyzes important informal institutions in a specific geographic space, i.e. enterprise relationship and interaction in the park, in order to avoid the above problem. For this purpose, this study puts forward a concept of "informal institution intensity" on cluster enterprise in the industrial park according to the practical situation of

industrial park and uses it as an important variable to investigate the operation of industrial park and the innovation performance of enterprise.

Finally, this study is aimed at innovation behavior and performance of cluster enterprise. In this regard, existing theoretical research and empirical analysis show that industrial cluster is conducive to improving enterprise technology innovation capability and carrying out innovation activities. But in real industrial cluster and regional economical development, there are different types of technological innovation modes of various industrial clusters. There are two types of researches on industrial cluster innovation capability. On one hand, innovation capability is endogenous, namely internal innovation through externality and cooperativity and scope economy of technological innovation. Saxenien (1996) gave examples for studying cluster innovative network of IT enterprises represented by Silicon Valley. With traditional industry-oriented enterprise cluster, when most middle and small-sized enterprises lack innovation capability and motive, relying on technical strength and R&D activity of large enterprises in the cluster is deemed as a feasible way to get out of an innovation dilemma. For example, middle and small-sized enterprises provide products according to technical and quality standards of large enterprises, and large enterprises provide middle and small-sized enterprises with certain technical service to ensure product quality. Order placement and subcontract connection between Japanese large enterprises and middle and small-sized enterprises gave an example of such network innovation (Yamawaki, 2002). On the other hand, innovation capability is exogenous, that is, change and introduction of technical norm constitute an exogenous source of innovation capability. As to exogenous innovation

capability, some scholars discussed such technology leaders as cluster and transnational corporation built relatively stable subcontract and contract relations between production chains to create the imitation and learning opportunities for cluster, as a technology newcomer (Birkinshaw & Hood, 1998; Hobday, 1994). Industrial park, as an industrial cluster mode, has various properties [1] and modes, and the investor and the operator input a lot of resources. How well does it work? Does it promote innovation? This study considers it very necessary to thoroughly study the relationship between industrial park and innovation with the aim of exploring the relationship between industrial park and cluster enterprise innovation from a theoretical perspective.

### 1.3.2 Practical Significance

Shenzhen, as the pacemaker of the reform and opening up of Guangdong Province and even China, is different from other cities in political and economic form and business environment. Li and He (2003) analyzed the developmental status of major industrial clusters of Shenzhen and found that 9 industries such as furniture manufacturing industry, transportation equipment manufacturing industry, handicrafts industry, pharmaceutical manufacturing industry and general equipment manufacturing industry were highly concentrated and had favorable conditions for industrial cluster. Thus, studying innovation performance of industrial districts of Shenzhen City is of great significance for not only maintaining the sustainable economic

[1] As to attribute, industrial park can be classified into public industrial park (stated-owned), private industrial park and foreign-funded industrial park according to investor or owner relationship.

development of industrial clusters of Shenzhen, but also providing references for cluster economy of other regions in China.

The author personally founded Lingya Industrial Park and has run it until now. Presently, several enterprises have settled in the park and the park is connected to several other industrial parks and is ready for further development. Thus, this topic offers practical guidance for Lingya Group and it can provide important references for future decision and planning. Since established in 1997, Lingya Group has specialized in R&D, manufacture and sale of high-end precision USB cables and connectors. Through more than 20 years of development, Lingya has become China's largest and technology-leading benchmarking enterprise of the photovoltaic manufacturing industry. The Company acquired 150,000$m^2$ of land and built Lingya Shenzhen Industrial Park in 2003 in Bao'an District of Shenzhen, and acquired land and built the headquarter base of Lingya in 2006 in Songshanhu of Dongguan. As the management changed enterprise development strategy, the manufacturing sector in Shenzhen Industrial Park moved to the headquarter base in Songshanhu of Dongguan in 2016. So Shenzhen Industrial Park introduced a strategic partner-Shenzhen Zhihui Park Service Co., Ltd. to build Lingya Meisheng Wisdom Green Industrial Park. The park has declared to be Shenzhen high-tech business incubator, Shenzhen investment promotion key park and science and technology peach garden of Bao'an District, with a building area of 78,000$m^2$, 40 enterprises and annual output value up to 10 billion Yuan. Linoya Group is currently working on the construction of the park, which will add 350,000 $m^2$ in phase II and 200,000 $m^2$ in phase III. Therefore, the park is expected to cover a total area of more than 600,000 $m^2$

after the completion of construction, accommodating hundreds of corporations, with an output value of over 100 billion Yuan. [2]

In the operation process of the industrial park, operation mechanism and management mechanism should be determined through reference to experience of industrial park samples, which can bring a lot of benefits to the development of Lingya Meisheng Wisdom Green Industrial Park. As to physical environment, we carried out pre-planning, functional layout and hardware facilities construction; as to soft environment, we established functional departments such as Party-masses service center and carried out park activities to enhance enterprise interaction, give play to the positive role of informal institution, enhance enterprise cohesion, provide enterprise with better service and improve enterprise benefit. Analysis and conclusion of industrial park samples offer substantial help for future management measures for the park and the development and construction of phase II.

Furthermore, summary of experience in operation management of industrial park, exploitation of the role of informal institution and park enterprise innovation offers intellectual support for brother parks or enterprises for mutual development and progress.

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All data are provided by Linoya group

# Chapter Ⅱ Concept Definition and Theoretical Review

## 2.1 Industrial Cluster

Since the 20th century, scholars of Economics, Management, Sociology and Economic Geography have taken a strong interest in industrial cluster phenomenon and triggered an interdisciplinary cross-over research upsurge of industrial cluster. In Steiner (1998)'s point of view, cluster has existed for long and it has continuously extended and increased day by day in number since the Industrial Revolution. Marshall (1890) first analyzed the cluster phenomenon of middle and small-sized enterprises in *Principles of Economics* based on the observation of UK Sheffield toolmaking industry in the 19th century. Nowadays, cluster phenomenon has gradually expanded all over the world. There had been 15 highly geographically concentrated enterprise clusters in America by 1990 (Krugman, 1991). There were also several industrial clusters in the middle and northern areas of Italy, which involved such traditional industries as textile, shoemaking, furniture, machinery and food and were collectively referred to as "The Third Italy". In the 1990s, the export value of 350 Indian middle and small-sized enterprises accounted for 60% of total export value (Scott, 1992). At the same time, 537 middle and small-sized enterprise clusters also grew in Japan in textile, food, furniture, building material and machinery industries (Yaniawaki, 2002). On account of multidisciplinary research and complex cluster phenomenon, industrial cluster was defined differently. In the initial stage, industrial cluster was defined as follows:

(1) Industrial district. Marshall first put forward this concept in *Principles of Economics* (1890). He discussed this problem from the angle of "external

economy" and believed industrial district had the following six characteristics: First, industrial district had a homologous value system with local communities and a collaborative and innovative environment; second; vertically connected enterprise clusters existed in the industrial district; third, industrial district had the optimal human resources; fourth, industrial district had an ideal market; fifth, competition and cooperation coexisted in the industrial district; last, industrial district had a characteristic local credit system.

(2) New industrial district. At the end of the 1970s, "The Third Italy" achieved fast industrial growth and Becattin (1990) redescribed the economic development phenomenon of these small enterprise clusters using Mashall's "industrial district" concept. This type of industrial districts was commonly characterized in that: They were a spatially concentrated regional production system, in which there were plenty of enterprises that were in different production stages or produced the same or similar products in different ways, and small enterprises or micro-enterprises accounted for a very large proportion; industrial district often had advanced division of labour; "flexible specialization" production mode was adopted; competition and collaboration coexisted in the industrial district, and competition occurred based on innovation instead of wage reduction; a great many institutions such as enterprises, financial institutions, local chambers of commerce and training institutions played a positive role in the industrial district; the industrial district had common cultural settings and institutional environment. To distinguish from Mashall's industrial district in the 19$^{th}$ century, such industrial district was often called "New Industrial District".

(3) Industrial cluster. Porter put forward the famous “diamond model” in 1990 to explain the international competitive advantages of industrial clustering of a state. He included cluster in the analysis framework of the Theory of Competitive Advantage and founded cluster-based new competitive economic theory. The analysis object of “diamond model” mainly focused on macroscopic national-level industrial cluster. In 1998, Porter further explained cluster in *Cluster and New Competitive Economics*: Cluster was the collection of interconnected and geographically concentrated companies and institutions in a specific area (Porter, 1998), including a group of industries and other organizations that played an important part in competition and were interconnected. Cluster often extended downwards to marketing channels and organizations and expanded laterally to auxiliary product manufacturers and industry companies relating to technical skills or investors. Finally, many clusters also included governments and other organizations that provided specialized training, education, information research and technical support.

The study of industrial cluster entered an effusive period at the end of the 20$^{th}$ century. Dijk (1997) thought that cluster could be defined as a professional network comprised of professional enterprises and organizations and their value chains were connected through exchange of product, service and knowledge. Rosenfeld (1997) defined cluster as a loose geographic agglomeration of identical or related enterprises with a synergistic effect. Enterprise “chose” to enter the cluster based on interdependence to enhance economic activity and promote business transaction. Baptista and Swann (1998) defined cluster as an affiliated enterprise network that was located in a small area (with the science base of a state as the center) and highly

geographically concentrated. Rolelandt and Hertog (1999) defined industrial cluster as a network formed by highly interdependent enterprises (including professional suppliers), knowledge production organizations (universities, research institutions and engineering design companies), intermediaries (brokers and consultants) and organizations through interconnection of value chain in order to acquire new complementary technologies, gain benefits from complementary assets and knowledge links, accelerate the learning process, reduce transaction cost, overcome or build market barriers, obtain collaborative economic benefits and spread innovative risks. Padmore and Gibson (1998) regarded cluster as a flourishing agglomeration formed through enterprise interaction. Such interaction may be realized through competition and cooperation or supplier or customer in the value chain.

In the 21st century, researcher focused more on the performance of enterprises in the cluster than the definition of cluster. Folta et al. (2006) proved the relationship between cluster size and enterprise performance and their research findings not only supported the viewpoint that scale yield of cluster kept increasing, but also indicated that diseconomy of cluster played an increasingly important role with its development. Some said cluster scale affected congestion cost and the latest research showed that a larger cluster may increase the congestion cost of enterprise. For high-tech enterprise, congestion cost may appear by increasing the competition against value input (e.g. scientist) (Zucker et al.,1999), or the risk that their knowledge was seized by geographically close rivals increased (Shaver & Flyer, 2000). Such congestion cost increased the possibility of cluster diseconomy.

Some scholars explored the effect of proximity on information transfer from geographical proximity of cluster enterprise. Research stressed that companies could get a lot of benefits from the proximity of other organizations on the condition that these companies could obtain an exclusive source of knowledge (Bathelt et al., 2004). For instance, the alliance of local partners allowed enterprises to acquire complex or specialized knowledge and prevented them from transferring knowledge among adjoining enterprises in the same cluster (Laursen et al., 2012), and the relationship with remote partner enabled companies to acquire knowledge that they could not acquire locally (Whittington et al., 2009). When local and informally acquired knowledge was used, embeddedness of science community also offered resources to assist enterprise innovation (Funk, 2012). Some researchers have started to investigate how externality weakened with geographic variation. Orlando (2004) pointed out that knowledge spillover barely weakened in 200 miles for enterprises in the same four-figure Standard Industrial Classification (SIC) range. On the contrary, Rosenthal and Strange (2003) found in the studies of six American industries that in most cases, agglomeration externality decreased sharply in the first several miles and then it decreased more slowly.

Based on the above analysis, cluster in this study refers to a specific area formed by geographic clustering of related industries in an urban space. It is a relatively broad concept, which not only includes the industrial areas (from bottom to top) without obvious boundaries formed spontaneously by enterprise's site selection for supply chain and industrial parks or industrial bases (from top to bottom) built under government support and guidance.

Cluster enterprises refers to enterprises that are implanted in the cluster network and geographically located in the industrial cluster.

## 2.2 Industrial Park

Since the World War II, each country in the world have formulated regional industry development policies and established numerous industrial parks such as free zone, export processing zone, free trade area, enterprise zone, industrial park, industrial village, industrial regiment, science park, technology park, research park, technology city, economic and technological development zone, high and new tech development zone, eco-industrial park and creative industry park. Wang and Zhu (2018) divided industrial park into two types: Traditional industrial park focusing on simplex short-term economic growth goal and modern industrial park focusing on diversified long-term comprehensive development goal. Not only is the former earlier than the latter, different countries and regions focused on developing the manufacturing industry and stressed the processing and manufacturing process in the initial stage when they adopted the policy instrument industrial park. Modern industrial park extended or increased new links based on the processing and manufacturing process of traditional industrial park and they were diversified in organization form and functional performance in different links.

The development of modern industrial park is driven by innovation. Since the 1980s, a new regional development theory based on technological innovation has started to prevail with the emergence of Endogenous Growth Theory. According to this theory, regional inherent technical potential and regional technical acceptability are a major factor of regional economic

growth. Regional inherent technical potential includes technological level of labor force, entrepreneurial quality and local innovation environment and atmosphere. Regional technical acceptability is determined by various factors such as society, politics, policy, economy, culture and nature. When a region relies on external technology, an internal ability is needed to absorb external knowledge and technology. The ability to discover, select, adopt, use, study and improve new technology is an important factor for an enterprise and the region where it is located to achieve an economic success. Modern industrial park will come into shape with the increasingly mature cognition of regional development.

In China, various industrial parks play an important part in national and local economic development, foreign investment attraction and foreign investment and relevant researches have been carried out. At present, existing export processing-oriented industrial parks in coastal provinces are developing from depending on foreign capital to laying equal stress on domestic capital and foreign capital or focusing on domestic capital, from relying on outsourcing businesses of transnational corporation to independent innovation, from processing and manufacturing to producer service, and from serious pollution to clean production and green development. Various modern new technologies and new business types emerge endlessly and maker spaces such as accelerator and incubator emerge, which promote the development of the domestic market, innovation and entrepreneurship and even attract foreign innovators and entrepreneurs to the park. Obviously, many parks like the foresaid traditional industrial parks in the initial stages for reform and opening-up have developed into science park, eco-industry park and

innovation zone; existing high and new tech development zones were cultivating innovation clusters quickly and focused on industry-university-research cooperation and institutional innovation for enterprise network construction (Zhang & Liu, 2003).

According to current status of China, the labor process will keep a certain characteristic during regional transfer as the capital flows increasingly freely. Wang (2005) pointed out that industries with a low technical content such as the clothing industry and the shoemaking industry were flowing to zones with a lower labor cost and forming a new generation industrial park. Industrial park transferred with change in spatial division of labor and inland provinces with low wage level and land use fee such as Jiangxi, Anhui and Sichuan were becoming a new high of industrial park. However, the rising land price and labor price posed new challenges and threats to industrial park strategies adopted by inland provinces and municipalities.

Wang (2008) studied Guangdong Nanhai Xiqiao light textile industrial cluster, Jiangmen motorbike industrial cluster and Dongguan Qingxi electronic information industrial cluster from the aspect of specialized town and carried out case analysis of technological innovation mechanism for different industrial clusters. He defined industrial clusters and classified them into endogenous clusters and exogenous clusters. Unlike endogenous cluster that relies relatively purely on “internal connection”, exogenous cluster relies heavily on its strong external connection and exogenous cluster had strong process innovation and product innovation capacity mainly because enterprises can acquire external knowledge more timely, more efficiently and

at a lower cost. External enterprise will actively provide the cluster with technical support to ensure product quality.

Some researches narrow the geographical range for study and focus on an area of a city. Zhang et al. (2009) discussed how community relation affected the growth of community. They found an inverted U relationship between regional community density, community and the geographical distance of the nearest community, and zone overlapping of the nearest community and the growth of community, using unique panel data set of 53 Chinese technological development communities during 1988 to 2000. Research result shows that adjacent communities are reciprocal and competitive. With Zhongguancun Science Park as an example, Tan (2006) studied China's largest semiconductor, computer and telecommunication enterprise cluster, including domestic and foreign-funded enterprises. He is concerned about the origin and growth of industrial clusters in traditional highly-controlled economies and regions, their role in promoting technology transfer and innovation, and challenges to be faced enterprise in the future.

Based on the above analysis, industrial park in this study refers to agglomeration areas which have clear geographic boundaries or whose geographic boundaries are defined through planning, and where enterprises with definite industry orientation and perfect public service facilities and management systems settle.

## 2.3 Cluster Enterprise and Enterprise Relationship Network

The discussion of enterprise relation actually shows the concept of embeddedness of Granovetter (1985). The most basic behavior in the

economic field is exchange. Whether it is the traditional way of exchange of barter or modern way of exchange with universal equivalents as the medium, both sides must trust each other to some extent; otherwise, exchange cannot be made. Embeddedness underlined a specific personal relationship and the effect of the structure of such relationship on building trust (Ahuja, 2000; Lavie, 2007). Enterprises in an industrial cluster had more opportunities to come into contact with each other due to geographic proximity, so they can form a closed network in a small scope, members are directly or indirectly connected, transfer information and have mutual cultural effect based on network trust. The discussion on enterprise network relations showed the influence of social factor and other informal institutions on economic behavior. Relevant researches will be briefly summarized below.

Qiu (1999) analyzed the cause of small enterprise cluster from the angle of relational network. In a broad sense, any economic phenomenon and behavior can be taken as a corresponding cultural deposit result and the existence and development of small enterprise cluster are restricted by the cultural environment. “Humanistic network” relating to geographical relationship and genetic relationship is a parallel system relative to the economic intercourse network of the entire middle and small-sized enterprise cluster and it forms an integrated compound operation structure, so it can greatly improve the operational stability of small enterprise cluster. For individual investors, the humanistic network enables them to acquire from the network various resources necessary for existence and development. Humanistic group can intensify supplier-organization commitment and trust to smoothly close the deal of intermediate products. Stability and non-contractual property of deal,

delayed payment for goods and even inter-bank lending and recommendation of organization are a common phenomenon in the cluster.

In the study of cluster, the importance of informal institutions such as social culture in the local economic development process was realized very early. The “industrial district” proposed by Marshall, “The Third Italy” advanced by Bagnasco and “innovation environment” put forward by European innovation research group (GREMI) all stressed or implied such a basic viewpoint: Local inimitable and historically inherited informal institutions such as custom and culture became an important basis for promoting cluster enterprise cooperation and collective efficiency so that cluster became global “sticky places”. The role of informal institutions such as trust, social capital and overall milieu became a focus of cluster researches. For example, in the opinion of Wang (2001), cluster enterprises had identical or similar social and cultural settings and institutional environments, and enterprise economic behaviors were deeply rooted in common internal languages, background knowledge and transaction rules, so they were reliable, foreseeable and apt to produce an assembly effect and deeply establish systems. According to him, informality of social relations that mainly rely on interpersonal trust does not mean fragility but may imply a potential power. In the case of incompletion of contract, the binding force of informal interpersonal trust often enabled both parties to continue performing a contract in an appropriate way beyond the contract scope and based on good faith. Gai (2002), Fu (2002) and Wei (2003) et al. also held the same viewpoints.

As social interaction intensified, geographic proximity promoted the integration of idiosyncratic beliefs, hypotheses and values, which can jointly

develop into a shared "macroscopic culture" among cluster enterprises. A social and professional network appeared between individual and company in the cluster (Stuart & Sorenson, 2003). Such a relationship between social norm and geographic proximity formed a kind of "geographically local social capital" (Laursen et al., 2012). They were often called "game rules" in the cluster and enhanced "non-marketable interdependence" among juxtaposed companies in order to promote intercompany interaction (e.g. license and alliance) even without formal economic exchange. Such relation of interdependence intensified companies' cognition of proper and effective social relations and provided them with clues on other companies' way of act (Bell et al., 2009). Thus, the knowledge exchange process will be based on social interaction and implanted in a broader social structure to guide enterprise interaction. For example, people believed Silicon Valley succeeded just because it was implanted in a decentralized but cooperative industrial system with a centralized social network and high-level social capital (Saxenian, 1994).

Enterprise relationship, an informal institution that was highlighted in enterprise practice, became a strategic means for enterprise to acquire resources and enhance operational efficiency and effect (Peng & Luo, 2000). Uncertainty of external environment of enterprise affected the process and result of enterprise resource acquisition and transformation, the role of enterprise relationship in enterprise and enterprise performance. Peng and Luo (2000) classified enterprise relationship into political relation and commercial relation. Political relation referred to the relations between enterprises and governments, market management agencies, supervision departments and

government officials; commercial relation mainly referred to the relations between enterprises and other commercial institutions or partners, such as suppliers, customers, rivals, R&D institutions and other intermediaries. Enterprises with political relation can acquire corresponding information and knowledge earlier through such informal consulting channels to reduce the uncertainties arising from policies, quickly adjust enterprise structure and strategic action and bring competitive edges to enterprise's long-term development, but commercial relation provided enterprises with market information. Business partner can provide industry inside information that can hardly be obtained from the external market environment, such as rivals' production plan and market adjustment information (Sheng et al., 2011). Enterprise relationship discussed in this study is commercial relation.

The commercial relations among enterprises in the park differ with geographic closeness. Research showed that the function of social network structure was determined by role (Fleming et al., 2007) and relationship (Tortoriello & Krackhardt, 2010). Funk (2012) defined the importance of inter-organizational network as a series of relations built by enterprise members through participating in enterprise-level innovation projects jointly. In their opinion, such enterprise network relation was conducive to stimulating ideas and creating new knowledge. Interacting with colleagues helped them seek a new combination through allowing them to visit existing knowledge base of the organization and giving them an access to different ways of solving problems. Then, these networks were widely used as a tool of information processing and ideological development. Frequent interaction can help build trust and create a comfortable environment for researchers when they encounter an

obstacle and asked help from others (Obstfeld, 2005). Based on the interaction of these organizational boundaries and task characteristics of enterprise, there were reasons to believe that enterprise relationship built on the basis of geographical location was effective and special (Funk, 2012).

Based on the above analysis, enterprise relationship in this study refers to a stable social network built by cluster enterprises in the industrial cluster based on commercial behavior or trust, which is closed and exterior and in which cluster enterprises can carry out business activities using partial social capital. Informal institution is a wider scope that contains not only inherent social capital such as genetic relationship, geographical relationship, history of a place, cultural tradition and other macroscopic ideologies, but also acquired social capital such as the relations built or grown from relatives (genetic relationship), fellow villagers (geographical relationship), rivals (karmic connection) and schoolmates (scholarship).

As a supplement of formal institution, the network formed by multiple enterprise relations helps coordinate labor division and cooperation of enterprises and enterprise interaction can enhance mutual trust and dependence. Lv and Su (2010) indicated that enterprise relationship network can be an external resource of middle and small-sized enterprises. Research on the development process of middle and small-sized enterprises in Northeast China shows that enterprise relationship network can provide enterprises with social contact opportunities, reputation, competition and cooperation conditions, marketing resources and technical expertise, of which the technical cooperation network formed during the provision of technical expertise can directly promote growth of middle and small-sized enterprises. Das and Teng

(2003) regarded enterprise's cooperation with other enterprises in the network as an opportunity, which can help enterprise build a stable technical R&D alliance while developing and designing products and acquire implicit knowledge resources more easily.

Tsai and Ghoshal (1999) verified the relationship between enterprise relationship network and technological innovation performance using structural equation model and found that enterprise multirelation could go beyond the organizational boundary among enterprises of large groups, gain more resource exchange opportunities and have positive influence on product innovation. They also verified that enterprise connection in the relational network could be divided into formal connection and informal connection, enterprise innovative behavior was a more complex sociological process and effective social relations in the network could actively promote enterprise behavior, since enterprise multirelation endowed enterprise with information acquisition advantages and had positive influence on enterprise innovation.

Informal institution that affects cluster enterprise and the development of the entire region was reflected in different ways in different places; while concrete case studies of cluster in different areas showed a vivid and widely different picture to us. We can deepen the understanding of the role of informal institution in the cluster development through reading these cases. Although most cluster cases gave the same description as cluster theoretical model – displaying the active role of informal institution in cluster enterprise cooperation formation and cluster development, some case studies showed that for some clusters or some development stages of clusters, informal

institution had negative influence on cluster development or the role of informal institution changed. These case studies will be reviewed below.

Chari (2000) found in the study of Indian Tirop knitting industry cluster that local social and cultural factors had a significant impact on the industry development. In his viewpoint, the development status of Tirop knitting industry revealed that the promoting effect of agriculture on industry development was not only limited to capital, labor force, land mortgage loan and inflated rural market but also shown in local social network. If local customs were correctly combined with industrial and commercial features like Tirop, these customs would be the key to changing an agricultural district into a competitive small enterprise network district. Most owners of Tirop were the native "Gounder". Early in the 20$^{th}$ century, local farm adopted the production mode of combining enterprise production with manpower domestication. It was just through such close cooperation and exchange with employed farmers that "Gounder" entrepreneurs that were born rural laborer partly transformed the network partnership in agriculture into the capital to promote industrial development. "Gounder" entrepreneurs first applied such network relation to fine labor division and cooperation so that their enterprises interacted with each other very well. Comparative study also showed that "Gounder" in Kaniyalar started to transit from agriculture to industry earlier than "Gounder" in Tirop, but they failed mainly due to absence of these cultural advantages.

In Silicon Valley, social capital network did not mainly concentrate on family ties but the ties among schoolmates and colleagues. Saxenian even regarded the social network built through the relationship among classmates, colleagues and schoolmates as quasi family social relation. Such a special interpersonal

relationship network enabled Silicon Valley entrepreneurs to gain the needed capital in a very short time, get operation partners and build a trustworthy and tacit leading body. According to the author, cooperative Silicon Valley culture is one of the local factors of Silicon Valley's success. It was just based on Silicon Valley's special individual cooperation cultural atmosphere that enterprises there formed "amazing" cooperation (Saxenian, 1994). Saxenian (1998) also pointed out in a subsequent study that there exist transnational Chinese social networks in Taiwan and Silicon Valley, which is owed to the close relations between Taiwanese overseas students and skilled workers. These close individual and professional ties enabled international entrepreneurs to quickly transfer skills, know-how, market and technical information and facilitated transnational capital flow. Information was transmitted between the two regions quickly due to close relation of such social network, common identity and mutual trust.

Bazan and Schmitz (1997) studied the influence of social-culture tie in the shoes industry cluster of Snows Valley in the south of Brazil on cluster development and found that the non-economic tie among enterprises played a major part in cluster development: Every enterprise in the cluster was forced to keep their promises to promote cooperation. Research showed that the importance of such non-economic tie changed with cluster development. Snows Valley had four development stages: First was the pre-industrial stage characterized by very distinctive social-cultural identity. Identical social and cultural characteristics came from common identity of German descendants and common experience in living through the hardship through cooperation and help. The second stage lasted from 1930 to 1940, in which intrinsic

social-cultural tie promoted the rapid development of local cluster. This situation changed with local export growth until 1970. In the third stage, the role of social-cultural tie in enterprise cooperation weakened mainly because external purchaser started to play a critical part in cluster development. The fourth stage started from the 1990s when there was a new foundation for cooperation. The increasingly high quality standard and quick-response requirement urged shoes producers to "reinvest" in building a partnership with suppliers. The trust relationship of the cluster changed from characteristic-based trust to process-based trust. The author stressed that such change did not mean that the characteristic-based trust totally disappeared in the later cluster development stage and the foremost screening mechanism for cooperation was still to have similar characteristics (local and/or special social organizations).

Nadvi (1997) observed the role of social network in coordinating enterprise transaction and promoting cooperation in the Pakistan Sialkot stainless steel surgical instrument industry cluster and found three interlaced social networks in this cluster: Connection of the same race (called "Biradari"), family connection and geographical relationship. This cluster largely originated from handicraft tradition of the race Biradari. The function of this social network was very important for the formation of this cluster, but it gradually vanished with cluster development. Nowadays, whether enterprise belongs to "Biradari" has had no influence on their cooperation. Family connection (including family connection extended from marital relation and close friendship in local places) still played a part, but it played an imbalanced part and family connection promoted horizontal cooperation. Geographical relationship, which

was not a key factor promoting the vertical cooperation between final product manufacturer and subcontractor but was located in the same place (even through it was a weak connection compared with family connection), played a more important part in promoting the occurrence of enterprise cooperation than hierarchical connection and family connection. Even if local enterprise strengthened external connections in the global market, local social network still worked. Local social identities were still very important for the operation of the production network. Therefore, in this cluster, there should be no clear division such as division between business and family, but mixing of business and family.

Industrial agglomeration actually includes production network and social relations. The interaction between enterprises comes from it, based on strong personal relationship, realizing interpersonal trust and informal system interaction. Enterprises in a cluster have the same or similar social and cultural background and institutional environment, and their behaviors are rooted in the voice, background and transaction rules in the common circle, so they are reliable and predictable, easy to produce aggregation effect and interaction mechanism, and also constrain trust relationship and performance responsibility.

Therefore, rules of transaction, close neighbor relations and appropriate informal institutions in a particular aggregate are very important for successful inter-firm cooperative behavior. Trust and commitment in enterprise managers' personal network have great influence on informal system. If properly used, it will produce positive personnel flow and knowledge spillover.

## 2.4 Enterprise Innovation and Innovation Performance

The concept of "innovation" was first systematically proposed by Schumpeter (Joseph Alois Schumpeter). He thought innovation must create new values, enterprise was the main body of innovation and the scope of innovation often included product, business model and process. Innovation was defined very broadly and it was defined in a different way specific to different research focuses. Cummings and Teng (2003) considered innovation a successful application of new product or new technology. Upholding a stricter attitude, Chaharbaghi and Newman (1996) considered creation of new knowledge as innovation. In general, innovation was defined differently in different fields. Although the definition of innovation was gradually widened, innovation roughly had three connotations: First is product innovation, which referred to changes in appearance and function of products or services provided by enterprise (Cooper 1998). Innovation meant to introduce new product ideas, technological processes and scientific and technological achievements consciously and apply them to product design, development or production to create economic benefits (Lukas & Ferrell, 2000). Second is process innovation, which meant to add new production elements into the production or service process of enterprise, such as change in input ratio of material and optimization of production process (Damanpour, 1991). Supporters of process innovation such as Knox (2002) considered innovation as a better and more valuable new idea, new practice or new method. Third is management innovation, which was mainly reflected in reform of organization structure, corporate strategy and procedural rule (Hine & Ryan, 1999) and closely

related to daily work of organization. Such innovation was non-technological innovation (Hine & Ryan, 1999). It was only a change in the organization and a change in management practice and management process, but it did not directly result in reform of product, service or protection process. Nevertheless, the importance of management innovation should not be overlooked. Just as CEO of a cleaning company said: “We work very hard to change innovation into a strategy and a process”. Only an excellent team and efficient operation can help create a good innovation atmosphere and lay a foundation for production innovation and process innovation.

There are two types of innovation models. One is closed innovation driven by endogenous growth theory, namely enterprise independent innovation, and the other is open innovation proposed by Chesbrough (2003). The latter emphasized that enterprise’s exchanging knowledge with external partners and expanded the boundary of innovative network. Scholars had rough the same understanding of innovative behavior: enterprises with bounded rationality would learn to continuously adjust strategies according to changes in their own conditions and environmental factors for the purpose of innovation output, but they have not come to an agreement on describing innovation performance.

Innovation performance is the direct evaluation of innovation activity and innovation efficiency of enterprise and the concentrated expression of enterprise innovation result. As a kind of performance, it is a quantifiable concept. Literally speaking, performance means to fulfill a task or a goal. Innovation performance means to fulfill a task or goal of product or process innovation of enterprise. Generally, innovation performance is the

comprehensive assessment on technological innovation level of an enterprise and it is often hard to be defined clearly. Innovation performance is theoretically defined as the contribution degree of technological innovation activity to overall operational efficiency and effectiveness of enterprise. Of course, different scholars define innovation performance in a different way specific to different research objects. Cordero (1990) stood for explaining innovation performance effect from the perspective of technology, marketing and finance. Some scholars agreed to consider only result factors instead of process-related factors and measure innovation performance from the aspect of process and product innovation, such as Fritsch and Lukas (2001), Belderbos et al. (2004) and Jantunen (2005).

Some researchers advocated defining innovation performance from the perspective of innovation degree. Rochford and Rudelius (1997) divided product innovation of enterprise into brand new product innovation and existing product transformation from the angle of product innovation and defined innovation performance of product in these two aspects. Domestic researchers defined innovation performance also in different ways. Zhai (2008) proposed to measure enterprise innovation performance broadly through empirical study. To be specific, enterprise innovation performance should include technological innovation, knowledge innovation and management innovation. According to overseas definition, enterprise innovation performance was a broad concept and a measurement of the overall effect of enterprise innovation activity. Generally, technological innovation activity of enterprise had the most direct and obvious effect on enterprise operational efficiency and it is the most commonly-used and objective method to measure

enterprise innovation performance in existing empirical studies. In this study, enterprise innovation performance also will be defined as technological innovation activity to improve the operation efficiency.

Some researches stressed inter-organizational relationship promoted enterprise cooperation and produced innovative return on relationship (Hervas-Oliver & Albors-Garrigos, 2008). These strategic assets were implanted in surrounding social environments and affected innovation through promoting knowledge sharing and interactive learning. A main knowledge dissemination mechanism in the cluster supplemented the proved linkage effect, including informal and formal cooperation and relation, and built relations among institutions, suppliers, other related industries and different agencies nearby (Becattini &Sengenberger, 1990; Porter, 1990; Keeble & Wilkinson, 1999). All these relations could be represented by the framework proposed by Johannisson et al.(2002), of which various relations in the cluster were classified into first-order embeddedness (inter-enterprise relation), second-order embeddedness (relation with social and economic organization) and third-order embeddedness (enterprises indirectly connected through social and economic organization) based on the degree of economic (systematic) and social (substantial) embeddedness. Johannisson et al. (2002) find that enterprise gained new ideas, information and opportunities from network diversity, connection quantity and involvement in regional institution in order to get power. The acquisition of such knowledge directly affected enterprise innovation performance.

Inter-enterprise connection constituted an innovative network, which played a critical role in the study of technological innovation. The great impact of the

innovative network among middle and small-sized enterprises, enterprises and organizations in the technology innovation activity of cluster enterprises has become a research focus of cluster researchers (Porter, 1990). Middle and small-sized enterprises in the cluster and the main body of economic behavior could not only act in simple cooperation, but also carry out full information exchange through innovative network. Middle and small-sized enterprises involved in the innovative network could benefit from study and accelerate innovation activity (Storper & scott, 1992): Lechner and Dowling (2003) studied how middle and small-sized enterprises promoted technological advance using external innovative network in different development stages. In his mind, innovative network was of great significance for the development of middle and small-sized enterprises, every enterprise had different network ties, these networks kept developing with enterprise development, and enterprise development and technological advance depends not only on the establishment of enterprise innovative networks but also on the extension and development of these networks.

Based on the above analysis, enterprise innovation behavior in this study refers to different commercial actions taken by enterprise based on self-cognition and surroundings for the purpose of innovation output. Innovation performance measures the innovation output level of enterprise in technology, mode and system.

Whereas research contents of various research fields contain enterprise innovation and different fields have a different viewpoint, relevant antecedent variables of enterprise innovation are different. According to Frank (2007), enterprise innovation was mainly driven by individual, enterprise and network.

From the perspective of individual, the influence of personal characteristics of entrepreneur, manager and related technical staffs on enterprise innovation performance was highlighted. For example, Eggers and Kaplan (2009) introduced individual factors such as traits of character, vocational skills and learning efficiency into the studies of innovation. Xie and Ge (2007) and Wang and Jiang (2007) explored and analyzed the influence of enterprise culture and incentive mechanism on technological innovation performance. From the perspective of network, business connection or interaction between enterprise and external organizations or individuals (including upstream suppliers, target organizations, real and potential rivals, governmental agencies and financial institutions) was highlighted. It was mainly reflected in technological competition and cooperation, knowledge spillover and transfer, social capital or relational capital, financing and policy support. Domestic researcher Zhang, et al. (2012) discussed the influence of enterprise relationship capital on the research and development of innovation performance of alliance networks. Wang (2013) analyzed the relationship between external social capital and innovation performance of cluster enterprise from the perspective of knowledge spillover and learning effect. Apart from the aforesaid factors, scholars thought environmental factors such as market environment and macropolicy environment of enterprise, including monopoly degree, marketization degree and rule of industry and government policy, also influenced enterprise innovation. For instance, Ma and Guan (2000) pointed out that industry policy would affect the number of patents. Nie Ming et al. (2003) pointed out that national macroeconomic system had a significant impact on enterprise innovation performance.

This study focuses on the influence of enterprise relationship on innovation performance, so relevant studies are reviewed briefly. Sukoco and Lee (2007) measured internal social capital of enterprise using trust, commitment and interaction, chose knowledge management ability as an intermediate variable and carried out empirical research on social capital and innovation using structural equation model. Empirical research result showed that entrepreneurial orientation had positive influence on knowledge management ability of organization, product or process innovation and organization effectiveness; knowledge management ability had significant influence on innovation and organization effectiveness; social capital of enterprise had a positive regulating effect on the relations among entrepreneurial orientation, knowledge management ability and innovation and organization effectiveness. With contractual governance and relational governance as an antecedent variable, Xue et al. (2010) carried out exploratory research on the relationship among relational capital, organizational learning and R&D alliance performance using survey data of 142 enterprises. Result showed that relational capital and organizational learning were key factors to enhance R&D alliance performance: The construction of relational capital was related to contractual governance and relational governance. Meanwhile, organizational learning of enterprise was affected by organization's learning intention and relational capital. Carey et al. (2011) put forward a comprehensive model framework to study the relations among the relation, structure and cognition of social capital as well as the relations between these dimensions and enterprise performance. The analysis of data of the relations between 163 enterprises and suppliers and organizations indicated the indirect

influence of the relational dimensions of social capital on the cognitive dimension and the indirect influence on the relation between the structural dimension and enterprise performance. Wang (2013) verified whether external capital of enterprise could affect innovation performance of cluster enterprise based on the survey data of ICT cluster in Pudong District of Shanghai. Empirical study showed that three dimensions (structure, relation and cognition) of external social capital of enterprise had no direct influence on the innovation performance of cluster enterprise and they needed to play an indirect role through knowledge spillover and learning effect. External structural capital could indirectly influence innovation performance of cluster enterprise through knowledge spillover and learning effect; while external relational capital and external cognitive capital could play an indirect role in innovation performance only through knowledge spillover.

Plenty of empirical researches also stressed that intrinsic technology and knowledge spillover advantages of industrial cluster facilitate the formation of innovative network. Morgan (1997) held two most basic viewpoints about innovation and cluster: First, the interaction between different industry bodies was very important for successful innovation; second, the innovation process was rooted in the institutional environment of production network or cluster. According to new industrial space theory of Storper and Scott (1992), technological innovation was often limited to specified areas, namely the geographic space of innovation process. Knowledge of high-tech department was based on professional technological advance, which was mainly reflected in high spatial agglomeration. Simultaneously, the agglomeration of economic activities helped participants enhance economic and technical benefits.

Feldman (1994) found that innovation activity and innovation output occurred in industrial clusters or production activities with geographical contraction characteristic in American industrial circle.

The book *Regional Innovation System: Regional Government Management Function in the Context of Globalization* chiefly edited by Cooke (1996) gave a detailed description of the concept of regional innovation system. They considered regional innovation system as a regional organization system consisting of geographically divided and connected manufacturing enterprises, research institutions and higher educational institutions, which supported and produced innovation. In Wei Ge's point of view, regional innovation system included manufacturing enterprise clusters for production and supply of innovative products, educational institutions for cultivation of innovative talents, research institutions for innovative knowledge and technical production, governmental agencies with financial and policy restrictions and support for innovation activities and service innovation institutions such as financial and commercial institutions. German Baden- Wurttemberg Technology Evaluation Center invited relevant experts to participate in an academic conference in 1995 and published *Regional Innovation System: The Role in Governance of Globalization World* in 1998, which pointed out that different regional innovation systems had various main innovative characteristics, e.g.: labor force, education, research institution, knowledge externality or spillover, and industry organizations were different among different regional innovation systems, but regional innovation environment and technological innovation relied more on mutual learning and knowledge spillover between regional enterprises and institutions. Besides, local

government policies played an increasingly important role in the development of regional innovation system and they offered help and specification for regional technological innovation through specific systems and institutions. Asheim et al. (1997) described the concept of regional innovation system as well. Afterwards, EU scholars carried out thorough studies of European regional innovation system, such as EU Targeted Socio-Economic Research (TSER), Northern Europe Baltic Sea Rim Regional Innovation System Research, Research by Asheim and Dunford (1997) on Future Regional Development in Europe of German Aachen, Research by Maastricht University Innovation and Technical Economy Research Institute (MERIT, 1998) on European Regional Innovation Strategy, and Empirical Research by Lawson and Lorenz (1999) on Minneapolis of Minnesota and Cambridge Region. Caniels et al. (2003) had studied and evaluated regional innovation difference and diffusion since the 1970s and presented a new innovation diffusion model. Maurseth and Verspagen (1998) also studied European knowledge innovation difference and diffusion and their influence on regional innovation system.

The rising industrial cluster plays an increasingly important role in the development of world economy and cluster technological innovation becomes a research focus in the wake of regional innovation system. In a sense, cluster technological innovation is the extension and specific application of regional innovation system. In the studies of cluster technological innovation of high-tech industrial fields, Saxenian (1994)'s comparative study of innovation cluster of Silicon Valley and Boston Route 128 was a classic case. These two regions had totally different industry organizations and innovation

environments. Knowledge flow and collaborative innovation of Boston Route 128 existed in an independent enterprise system. An enterprise mostly cooperated and exchanged with other enterprises in the same group about production technology, but Silicon Valley was different. Located between San Francisco in the middle of California and San Jose, Silicon Valley gathers thousands of high-tech enterprises, including about 3,000 electronic technology enterprises with annual sales of electronic products up to USD 400 billion in recent years. Silicon Valley succeeded due to its adventurous initiative spirit and fierce market competition. In addition, the development of the regional innovative network formed by enterprises, universities, scientific research institutions and business associations there promoted the technological innovation of numerous regional high-tech enterprises and boosted the sustainable development of high-tech industrial clusters in Silicon Valley (Saxenian 1994). According to Saxenian, the high benefit produced by enterprise technological innovation was very important for high-tech industrial clusters such as Silicon Valley and innovation advantage was a major source of benefit of industrial cluster. Enterprises in Silicon Valley enhanced core competitiveness through continuous professionalization in order to adapt to fierce competition. Frequent formal or informal exchange of talent, knowledge, technology and information among enterprises was also a very important factor. Meanwhile, flow and complementation of knowledge technology invisibly facilitated mutual cooperation between enterprises. Perfect innovative network and enterprise interaction continuously enhanced the innovation capacity of cluster enterprises and maintained the world-leading position of Silicon Valley enterprises in competition.

At a micro level, geographical location and innovation environment affected innovative behavior and output of cluster enterprises. As an important form of enterprise innovation input, enterprise innovation performance can reflect the output ratio of innovation input and indicate whether innovation input was correct and had guiding significance for enterprise development. From the angle of industry, Patrick (2013) collected relevant samples, investigated technological innovation input of the American manufacturing industry from 2007 to 2015 and drew research conclusions. He thought that technological innovation had positive influence on and positive correlation with enterprise performance. More technological input not only caused no economic burden to enterprises and improved enterprise performance, but also had a considerable impact on stock value to some extent. From the angle of conclusion, Cruz-Cazares et al. (2013) found from research that technological innovation input could enhance economic benefits of enterprise and had certain positive influence on enterprise performance. Domestic researchers also drew similar conclusions. Guo et al. (2017) carried out empirical test on data of 252 enterprises with big data characteristics through questionnaire survey, and the result showed a positive correlation between innovation capacity and enterprise performance as well as between previous performance and enterprise performance. Yang et al. (2017) carried out empirical study on 115 questionnaires of science and technology industrial cluster based on enterprise behavior theory, and the result showed a different innovative manner arising from performance-oriented culture in different market environments. Exploratory innovation was displayed in enterprise with

performance-oriented culture only in the fierce market environment, and most enterprises with performance-oriented culture adopted exploitative innovation.

Presently, enterprise performance is measured mainly using financial index, operating index and market index of enterprise. For example, Lumpkin and Dess (2001) developed a scale to measure enterprise performance using empirical approach in the aspect of sales, sales growth rate and profit rate. In most researches, performance was measured using financial indexes as financial indexes were visualized and accessible. However, measurement with financial indexes had obvious advantages. This method was so one-sided that it reflected only the financial effect of business operation instead of all conditions and it may mislead researchers into making incorrect evaluation of enterprise performance. Thus, relevant researches gradually included such indexes as innovation, operation and technical improvement in the enterprise performance measurement framework (Heeley, 2008).

In existing academic empirical researches, innovation performance was measured in different ways and there were four measurement methods: First, innovation content was evaluated subjectively or objectively. Subject evaluation indexes mainly included improvement of new product quality, optimization of technological process, improvement of market share and increase of enterprise development opportunity. For instance, Mohamed and Richard (1996) designed a scale to measure enterprise innovation performance from 15 aspects such as product and service, product quality, production technology, marketing strategy, enterprise-government relation and enterprise-agency relation. Objective evaluation indexes mainly included production schedule, number of patents (Hagedoorn & Cloodt, 2003), number

of relevant reports or works (Foss & Laursen, 2003) and research input. Subramanian and Nilakanta (1996) measured enterprise innovation performance using objective and concrete average innovation quantity, average innovation time and time for leading competitors to launch innovative products or services. Yi- Renko, et al (2001) measured enterprise innovation performance using the quantity of new products or services developed in the past three years. Second, innovation performance was evaluated by successful innovation. Gemunden, et al (1996) described the innovation result and measured innovation performance using successful product innovation and successful process innovation. Ritter and Gemunden (2003) held the same viewpoint. Third, innovation performance was measured using input and output of resources necessary for innovation. There will be no output without input; the same was true of innovation. Innovation performance (namely innovation output) will inevitably be affected by innovation resource input. How to improve output under the condition of certain innovation resource input and how much input enterprise can reduce under the condition of certain output were two indexes to measure innovation performance (Cordero, 1990), which can be further divided into technology, marketing and finance. The advantage of this method was that the responsibility for improving innovation performance can be assigned to related departments. e.g.: The Development Department was responsible for technical performance and the Marketing Department was responsible for marketing performance. Fourth, innovation performance was measured using management tools. Cooper (1990) and Krawiec (1984) measured the innovation time in different stages using PERT

and CPM respectively and used them as measurement indexes of enterprise innovation performance.

As shown in Table 1, most domestic researchers measured innovation performance in consideration of the effect of technological innovation on enterprise. For instance, technological innovation performance of enterprise can be measured using number of new products, number of new patents, sales contribution ratio of new products, development time of new products and development success rate of new products, but researches have been carried out on measuring innovation performance from the angle of product innovation and process innovation, so an innovation performance measurement system was made up of product innovation and process innovation.

Table 1.Measurement indexes of enterprise innovation performance

| Measurement index | Researcher |
|---|---|
| Number of brand new products | Yli-Renko et al. (2001); Cooke& Clifton (2002); Hall et al. (2002) |
| Number of redesigned products | Hall et al. (1999); Balkin et al. (2000); Yii-renko et al. (2001); Danncels (2002) |
| New product development time | Yli-renko et al. (2001); Cooke &Clifton (2002); Laursen (2003); Jantunen (2005) |
| Qualification rate of innovative product | Spencer (2003) |
| Market share of innovative product | Hall et al.(1999); Laursen (2003); Jantunen (2005) |
| Sales contribution rate of innovative product | Hall et al.(1999); Hagedoorn&Cloodt (2003) |
| Ratio of input and output of innovation resources | Cordero (1990) |
| Ratio of R&D expenses in turnover | Hall et al.(1999) |
| Actual number of finished innovation works | Hagedoorn& Cloodt (2003) |
| Number of published reports and works | Hagedoorn&Cloodt (2003) |
| KEYS scale | Amabile (1996) |

| | |
|---|---|
| PERT and CPM scale | Cooper&Schendel (1976); Cordero (1990) |

# Chapter Ⅲ Research Content, Technical Route Map and Innovation Point

## 3.1 Research Content

This study is mainly intended to survey various industrial parks of Shenzhen City and analyze their innovative behaviors and performance with cluster enterprise under industrial park mode as the object. Since cluster enterprises gather in the industrial park, enterprise relationship especially informal institution is an important analysis variable. To be specific, this study has four objectives:

First, explore how industrial park runs. Although industrial park is a very common industrial cluster mode or phenomenon, there are about 3,777 industrial parks in Shenzhen City, [3] but operation of industrial park has been rarely studied from enterprise's perspective according to existing data analysis. Previous researches mainly focused on industrial clusters, such as Silicon Valley and Boston Route 128 (Saxenian, 1994), Taiwan Software Area (Saxenian, 1998) and Beijing Zhongguancun (Tan, 2006). Due to relevance of industry chain, enterprises can gather actively in a relatively open environment according to resource allocation and form industrial clusters naturally. To achieve certain policy goals, the government can also build industrial cluster by administrative power. However, industrial park had various owners and operators, which had no full spontaneity or government constraint and must face the market and consider their survival and development. Therefore, they must consider how to run and optimize industrial park. It was just the problem that the author encountered while building and operating industrial park and

[3]Data source: Official website of Prospective Industry Research Institute, https://f.qianzhan.com/yuanqu/diqu/4403, May 15, 2020.

the author hoped to gain certain cognition or answer from this study and provide references for future development.

Second, explore enterprise relationship and informal institution arrangement in industrial park. In fact, enterprise relationship is a complex concept, which not only contains Granoetter (1985)'s embeddedness thought but also refers to Putnam (1993)'s social capital concept. Peng and Luo (2000) classified enterprise relationship into political relation and commercial relation. Political relation referred to the relations between enterprises and governments, market management agencies, supervision departments and government officials; commercial relation mainly referred to the relations between enterprises and other commercial institutions or partners, such as suppliers, customers, rivals, R&D institutions and other intermediaries. A close relation with business partners helped enterprise with improvement of their learning ability and knowledge exchange and technical integration with partners (Luk et al., 2008). Commercial relation provided enterprises with market information. Business partner can provide industry inside information that can hardly be obtained from the external market environment, such as rivals' production plan and market adjustment information (Sheng et al., 2011), as well as gain credit record of potential partners (Poppo & Zenger, 2002). Enterprise relationship in the industry park is more commercial relation and a great many enterprises gather in the industrial park instead of being isolated from each other. They exchange with each other to acquire new knowledge to cover the shortcomings of formal institution partly. As a matter of fact, industrial park is an industrial cluster and even more an important "relation" integration, in which numerous informal institutions work, surely affecting enterprise innovation. Thus, based

on reflection upon and evolution of core problems, this study will focus on investigating the influence of industrial cluster on enterprise innovation performance, with enterprise relationship and informal institution as an intermediate variable.

Third, explore innovative behavior and performance of enterprises in the industrial park. Existing researches on cluster enterprise innovation focus on knowledge spillover and personnel flow, but few researches limit enterprise relationship to industrial park and, with this as an intermediate variable, investigate innovation performance of cluster enterprises. Generally, interaction and communication among enterprises in the park will certainly affect their innovative behaviors. Core enterprises in the park can even act as the manager and defender that offer support such as intellectual property to satellite enterprises and provide support for innovation of cluster enterprises. The influence of the interaction among these enterprises on their innovation has been rarely valued, so this study will thoroughly analyze and explore innovative behaviors and performance of enterprises based on enterprise relationship in the industrial park.

Finally, this study studied the spacial scale of Shenzhen City. The manufacturing industrial cluster of Shenzhen City is a typical case of innovation in China. Benefiting from active involvement of market entities and benign interaction between the business circles and government, numerous industrial clusters of Shenzhen develop through actively getting involved in the global value chain according to export-oriented industry strategy. Some industrial clusters form spontaneously and some develop out of industrial park, with transboundary innovations made in UAV, LED, robot,

VR/AR and new wearable equipment. Advanced industry associations and developed transboundary cooperative social relation networks play an important part in this process. Through the research of industrial park, this study is aimed at exploring the unique performance of cluster enterprises in innovation performance and based on this providing references for the further improved innovation environment of Shenzhen City, enabling decision makers to understand the general significance of cluster enterprise innovation in industrial park mode, and highlighting uniqueness of Shenzhen combined with regional features and industrial strengths, in order to adopt measures to improve innovation performance and further exploit the demonstration effect of special economic zone of Shenzhen.

### 3.2 Technical Route Map

According to the logic of problem presentation, theoretical analysis, empirical research, result verification, conclusion and presentation of suggestions and based on relevant theories, this study built enterprise cluster network of industrial park mode, proposed research hypotheses, empirically analyzed the influence of enterprise cluster network on innovation performance using social network analysis method and structural equation model, verified the empirical result using case analysis method with Shenzhen City as an example, drew conclusions and put forward countermeasures and suggestions for the development of enterprise clusters of Shenzhen City. The technical route map of this study is shown in Fig. 1.

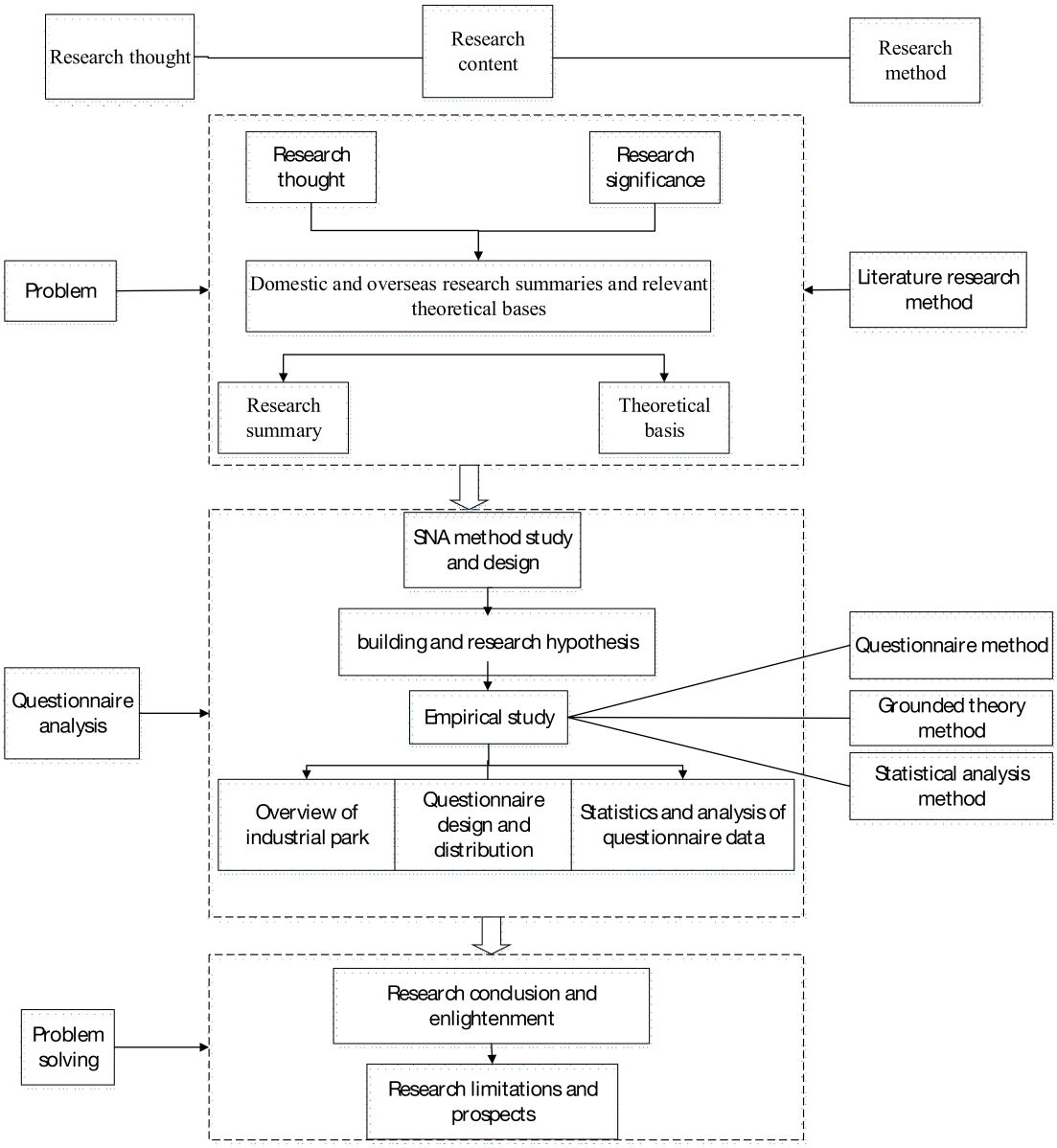


Fig 1. Technical route map

### 3.3 Innovation Point

First, in terms of topic selection, few researches have been carried out on innovation performance of cluster enterprises in the industrial park, based on the study and analysis of existing documents, which is the entry point and the purpose of this study. Then, this study fully investigates the influence of informal institution on park cluster and enterprise innovation, with Shenzhen as an example and with informal institution as an intermediate variable. The

aforesaid two points are of certain innovative significance for topic selection of this study.

Second, in terms of research method, few researches have been carried out on enterprise cluster network in the industrial park, but this study quantifies the attributes of enterprise cluster network from the perspective of structural feature and relational feature to better reveal the role of cluster enterprises under industrial park mode in the social relation network, in order to more easily explore the inherent law of the effect of social relation network on cluster enterprise innovation.

Domestic theoretical researches have been carried out on social network analysis and few empirical researches have been carried out. This study analyzed social relation network of enterprise cluster and the influence of social relation network on innovation performance of cluster enterprises, by combining social network analysis and econometric modeling. Moreover, this study focuses on the relations among genetic relationship, geographical relationship, karmic connection and scholarship, with informal institution as a major intermediate variable and according to practical situation of Shenzhen, and explored the problem of innovation performance of industrial park cluster and enterprises in the park, which is conducive to not only clearing the relations between the doers and between the doer and the environment in the social relation network but also revealing the internal mechanism of cluster innovation.

Third, qualitative researches have been carried out using grounded theory in this study. This study builds theories in the database and summarizes and forms a special theoretical basis based on plenty of interviews with experts,

entrepreneurs and park workers and through collation, sorting and analysis. Meanwhile, index system is built and intensity of informal institution is estimated using quantitative research method to provide support for subsequent empirical studies.

# Chapter Ⅳ Construction and Measurement of Informal Institution Intensity and Innovation Performance Indicator System

## 4.1 Overview of Grounded Theory

Intensity of informal institution can be explained differently from different perspectives, especially because industrial parks of Shenzhen lack official data analysis, and grounded theory of qualitative research method can be adopted for research. At present, a mature theory system has gradually formed for grounded theory. Grounded theory falls into the category of qualitative analysis and is a bottom-up analysis method. Grounded theory has typical characteristics of qualitative analysis and these characteristics are suitable for real data research in real life. That is, extract corresponding theories from statistical survey questionnaire data so that the studies of informal institutions in the industrial parks of Shenzhen are carried out based on massive survey data.

Informal institution has a wide scope and the binding effect of abstract documents, as a reference, on man originates from the choices made by organization members in life, including customs and ethics, morality, life style, inheritance of traditional culture and value. There are three types of cognition of informal institution. John Rogers Commons (1983), a representative of the school of old economic institution, was of the opinion that collective action controlled individual action using institution and institution was a rule of conduct; while informal institution was the customs, convention, ideology, cultural tradition and morality and ethics contained in the entire institution. Thorstein B Veblen (1899) was of the opinion that informal institution was

comprised of general thinking habit and present popular mental attitude. John Stuart Mill (1926) was of the opinion that product distribution was affected by customs and competition, of which the former had a much greater effect on the latter. Except large business districts with retail trades whose decisive factor was competition, for most other places, customs and conventions were the decisive factors. The institutional economic school mainly advocated that economic value problems must be studied through reference to moral issues. Particularly, the good or the bad could be judged through technical value evaluation; while faith and behavior evaluation had a deeper impact on man. Douglass C. North (1993) developed the school of new economic institution after inheriting the school of old economic institution. He mentioned that institution had formal requirements and constraints on man and they specially targeted at people's daily interaction. These institutions were compulsory, but informal institutions had no formal binding force. He also pointed out that only a few behaviors were restricted by formal institution and informal institution was not a supplement of formal institution in people's daily activity. On the contrary, formal institution was a small part. William (1996), a new economic institutionalist of another school, held that governance did not exist alone and it changed with institutional change. He classified institutions into not explicitly specified informal institutions, formal institutions such as law and politics and comprehensive governance mechanisms including corporate governance mechanism, government governance mechanism and transaction governance mechanism, among which informal institutions included religion, ideology, social concept, custom and culture, and so on.

Generally speaking, in contrast to formal institutions, informal institutions are not consciously created and designed by people, nor are they enforced by the state. Informal system is formed unconsciously by people in a certain geographical area (such as Shenzhen city) during long-term communication. With the change of time, the form of existence, scope of application, size of influence and group of action of informal system will change to some extent. Once formed, informal system has strong vitality and lasting influence, and can realize self-expansion and inheritance. It can be maintained consciously through the internal behavior and perception of each person, forming a kind of cultural constraint.

In the process of restraint, everyone has a strong tendency to follow the rules, otherwise he will not know the positive incentives of informal institutions, difficult to follow, and even be rejected. As time goes by, this interaction and constraint relationship permeates into all aspects of the society, thus forming a social norm and social resources. For example, the clan relationship based on blood emphasizes respect for the elderly and love for the young, and has an obvious differential pattern. In Shenzhen, the chaoshan businessmen who pay special attention to clan relations have obvious family bonding effect, and strive for a career, and can return home in glory and honor their ancestors. Thus, coupled with the language barrier, it is difficult for people without blood ties to enter their business circle, or get the core business, or enter the core management. Similarly, such incentives and constraints also exist in informal institutions such as geography, industrial relationship and academic relationship, constructing behavioral boundaries.

The study of enterprise innovation performance is a complex problem comprising various elements and it is determined by the combined action of various interconnected factors. According to existing literature review, a lot of studies have been carried out on innovation performance of cluster enterprises from different perspectives. From the perspective of enterprise evaluation, factors of the study of cluster enterprise innovation performance mainly include customer evaluation, shareholder evaluation and effect on competitive context and adaptability. From the perspective of enterprise relationship, the determinants of the study of innovation performance of cluster enterprise include various “relations” and environments faced by enterprises, various owned resources, unique ability of enterprises and cultural concept. From the perspective of enterprise development, influence factors of the study of cluster enterprise innovation performance mainly include reform factor, reform process, environment, enterprise self-confidence and industrial order structure. From the perspective of enterprise innovation, influence factors of the study of cluster enterprise innovation performance are summarized into quick reaction capability, output acceleration capability and resource effectiveness. From the perspective of corporate governance, the combined action of viability, adaptive capacity and development ability determines the study of cluster enterprise innovation performance. The research framework of cluster enterprise innovation performance refers to the interconnected structure comprising research elements of cluster enterprise innovation performance. Different scholars drew different conclusions on the research framework of cluster enterprise innovation performance.

Therefore, intensity of informal institution and enterprise innovation performance should be studied on a basis of reality and the problems of different conditions of different industrial parks cannot be solved using a certain theory or model but should be analyzed in consideration of various composite factors. Intensity of informal institution and enterprise innovation performance can be studied based on grounded theory, with no need for the initially preset theories and exclusive of the verified theories. In this study, the collected data was summarized into concepts and these concepts further evolved and were summarized combined with grounded theory in the data analysis process so that data, theoretical analysis and final conclusion support each other. The research process of grounded theory combined with corporate survey can show the intensity of the bottom-up real informal institution and a suitable enterprise innovation performance index system for the industrial park.

## 4.2 Data Collection

The selected case parks or enterprises should be typical and in line with the research theme, so as to draw objective and true conclusions from the research. Because this study involves the industrial park and the enterprises in the park, and therefore the typicality of shenzhen industrial park cluster and the performance management of typicality, respectively, for they set up two sets of the interview outline and questionnaire (as shown in attachment 1, 2, 3), fully to take about the strength of informal institution and the situation of the enterprise innovation performance.

Shenzhen Industrial Park is diverse and involves many industries or fields. In

the years of operation, it has set up its own enterprise cluster and constantly revised it to conform to the characteristics of enterprise development stage. Each zone with banquet, conference, university of industry park, park autonomous organization, internal journals, relationship between standardized management model of enterprise cluster, promote enterprises to or communication, to permeate the park enterprises to employees of enterprise culture at the same time, understand the inner thoughts and ideas, formed a set of widely accepted within the enterprise culture system, And the informal system that grew out of it.

In terms of data collection, this study will mainly be obtained through existing text analysis, data collection, questionnaire survey, interview and other methods. The data collected in this study are mainly composed of three parts. First, relevant data of enterprises in Shenzhen Industrial Park and corresponding data of enterprises in Shenzhen Industrial Park are obtained. Secondly, this study interviewed a number of entrepreneurs and executives of enterprises in Shenzhen Industrial park, and obtained their views on the research of innovation performance of enterprise clusters in Shenzhen Industrial Park, and sorted out the data. In the third. In this study, enterprises in industrial parks were investigated by questionnaire, and information about the relationship factors of blood relationship, academic relationship, business relationship and geographical relationship in enterprise development, research on innovation performance of cluster enterprises, enterprise culture and enterprise development environment was obtained, and sorted into relevant materials.

In this study, 42 industrial parks were selected as samples, of which 41 were

actually valid samples. As for the selection of industrial park samples, according to the research needs, based on the situation of Shenzhen, first of all, in terms of region, covering the main areas of Shenzhen, such as Nanshan, Futian, Bao 'an, Luohu, Dapeng New Area, etc. Second, in terms of ownership attribute, state-owned, collectively owned, private and other types of industrial parks are selected. Thirdly, in terms of scale, industrial parks of various types are selected. Fourthly, professional and comprehensive industrial parks are selected from the aspect of industrial diversity. This ensures the typicality, representativeness and applicability of industrial park samples.

As for the samples of enterprises in industrial parks, this study selected them from the sample industrial parks. Each sample industrial park selects about 10 sample enterprises, and the actual effective samples are 400. As for the sample selection of enterprises in the industrial park, according to the research needs and the situation of the industrial park, firstly, in terms of the nature of enterprises, the research selects state-owned, private, joint venture, foreign capital and other types; Secondly, in terms of enterprise scale, this paper selects enterprises with different number of employees; Thirdly, as for the establishment time, this study also tries to select enterprise samples with a certain time span; Fourthly, in terms of enterprise asset scale, according to the data of shenzhen market authorities, this paper selects enterprise samples with different asset sizes. This ensures the typicality, representativeness and applicability of industrial park enterprise sample selection.

## 4.3 Grounded Theory Mechanism Analysis

### 4.3.1 Grounded Theory Process

The research approach of grounded theory is a new case study method, a

research method jointly developed by Strauss and Glaser and a qualitative research method of discussing based on the collected data and developing theories. Grounded theory is different from other research methods in that common research methods need to verify related data collected based on known theoretical basis and framework model and they are a kind of top-bottom logic. However, grounded theory is used to explore the research fields whose logic has not been verified by existing theoretical models. This study mainly studies the influence of industrial park mode on performance management of industrial parks of Shenzhen. Even though empirical studies have been carried out, relevant studies have been rarely carried out and professional theories or relevant theories have not been presented. Although the foregoing informal institution theory and enterprise performance theory involve enterprise culture, there are no concrete models for the relevance between performance management and industrial park mode and they are just described indirectly. Thus, grounded theory is coded after the time frame of the collected data is collated.

The uppermost research characteristics of grounded theory are “continuous comparison” and “theoretical sampling”. Continuous comparison means to continuously add the data quantity and change the data category in the grounded routinization process of the collected data. Data is collected and compared simultaneously, increase and decrease of data quantity cannot be ignored during comparative analysis, and a research framework is gradually formed in the exploration process to closely connect the two. The two steps cannot be executed separately. Instead, data analysis should be an end to data collection, data should be summarized briefly and data size should not be

modified. This process cannot finish until adequate theoretical data is collected, that is, the concept of main category is identified during specific operation. If theoretical data is not adequate, this process will proceed. "Theoretical sampling" means that the data collected in the initial stage of grounded theory will play a guiding role in subsequent data analysis and collection. Such data still has reference value in the category formed in the subsequent studies, and the conclusions so reached are real and effective. Routinized grounded theory is often divided into three stages and processes. First, carry out openness coding of data, figure out relevant concepts and carry out categorized management of the concepts. After data is categorized, carry out principal coding, analyze data using paradigm model and screen out main category and auxiliary category. Finally, carry out selective coding and describe the whole story chain. The routinization flow chart of grounded theory is shown below:

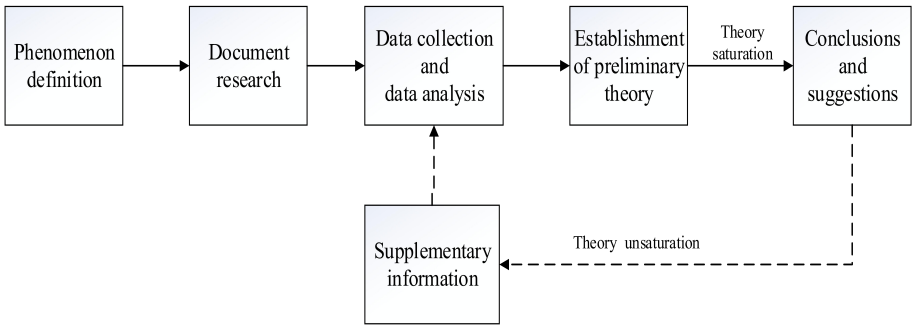


Fig 2. Grounded theory flow chart

Routinized grounded theory starts from openness coding. Nvivo and other data processing software are used for auxiliary studies, since they can effectively identify highly repetitive effective keywords in data and provoke researcher's thought. Data of grounded theory can be regarded as a large database and

effective keywords are file index tags of the database. The tag collation process can be deemed as the data extraction process. The collated tags are placed in a saving bag for content index. The catalogue is the concept of core contents, called conceptualization. The conceptualized contents are further processed and combed and a large scope will be formed, called category. Bai (2014) explained openness coding as acquiring phenomena from data, conceptualizing the phenomena and grouping them in a category.

Principal coding is the process of including the previous categories in a fixed model, which is called paradigm model. The paradigm model connects all categories in series and further processes them, so it is an essential tool for routinized grounded theory. Main category can be selected from numerous categories using paradigm model and other categories are named auxiliary category. The paradigm model is shown in Fig. 3:


Fig 3. Paradigm model example

Causality condition is the cause of main category, phenomenon is a superficial event caused by causality condition, vein is a special condition for connecting the main bodies of the main categories in series, intermediary condition is the initiator or the depressor, behavior/ action strategy is the action taken, and result is the outcome of action.

Selective coding refers to summarizing and analyzing a core category out of the obtained categories as the research subject, managing it with other categories, forming a story chain and endowing it with bone and blood. Zhong

(2011) mentioned that the above two processes should be improved in the selective coding process. It is not only a summary process but also a process of verifying the core category using story chain.

4.3.2 Data Coding

This study acquires data based on the interviews with industrial parks of Shenzhen and park enterprises and carries out routinized grounded theory coding.

1. Openness Coding

The collected data is collated and 20 (al-a20) concepts are formed: a1 blood culture, a2 hard struggle, a3 town fellow culture, a4 collective thinking, a5 horizontal competition culture, a6 innovation technology application, a7 publicity and reasoning, a8 lofty ideal, a9 technology orientation, a10 core competitiveness, a11 crisis awareness, a12 awareness of war, a13 profit target, a14 collectivism, a15 consciousness of risk, a16 efficiency, a17 sense of responsibility, a18 founder's sense of responsibility, a19 determination, a20 founder's pressure. 20 concepts are further collated to 11 (A1-A11) categories: A1 blood culture, A2 basic condition, A3 system effectiveness, A4 technological innovation, A5 enterprise culture, A6 town fellow culture, A7 learning organization, A8 internal coordination, A9 technology transfer, A10 pressure culture, A11 profitability. Relevant examples are shown in Table 2 and Table 3:

Table 2.Openness coding analysis table of industrial park and enterprise culture

| Data piece ( labeling) | **Conceptualization (**a1-a**20)** | **Categorization (A1-A11)** |
|---|---|---|
| In the morning, received a towel blanket and a mattress from the General Affairs Office. During noon break and overtime, many people were reluctant to go back to the dormitory. My sister, brother-in-law and I slept in a bed when we were tired and continued working after we woke up. | **a1** blood culture | **A**1 blood culture ( **al**, **a**2) |
| All employees, including company leader, worked all night long, lied on the table, or slept on foam board or paperboard on the floor when they were tired, and continued working after they woke up. My nephew, who is an engineer, was so tired that his cornea fell off, and consequently he had to go through an operation to protect eyesight. At the end of December, we ultimately succeeded in product innovation. | **a**2 family business characteristics | |
| Respecting knowledge, respecting personality, working hard together and not always meeting the unreasonable demand meritorious employees are the internal requirements for our sustainable development…..The Company embraces individualism on the condition of collectivism. | **a1**4 enterprise cohesion | **A** enterprise culture (**a1**4, **a1**5) |
| Enterprise should cultivate a group of wolfs characterized by acute sense of smell, perseverance and aggressiveness and teamwork. For business expansion, we should create a relaxing environment and encourage everyone to work hard. In that case, a group of leaders will stand out and seize market opportunities. | **a1**5 enterprise aggressiveness | |

Then, “performance management” is coded and 21 (b1-b21) concepts are formed in this stage: b1 replacement of employee with machine, b2 more pay for more work, b3 harsh market environment, b4 national policy restrictions, b5 R&D institution setting, b6 award, b7 single process assessment, b8 employee’s education degree, b9 large R&D input, b10 talent introduction with high salary, b11 talent introduction from colleges and universities, b12 domestic market share, b13 large growth of sales volume, b14 innovation performance, b15 performance evaluation. 10 (B1-B10) categories are

obtained: B1 benefit sharing, B2 harsh macro-environment, B3 internal coordination, B4 performance assessment, B5 scientific research basis, B6 R&D focus, B7 emphasis on talent introduction, B8 business model, B9 high profit, B10 innovation performance. Enterprise performance management coding is shown below:

Table 3.Openness coding analysis table of enterprise performance management

| Data piece ( labeling) | Conceptualization (b1-b20) | Categorization (B1-B10) |
|---|---|---|
| Our company proposed employees to hold shares as per 10 Yuan/share and distribute dividends as per 15% of profit (after-tax). Dividends are distributed according to title and quarterly performance 1 year after employees enter the company and employees can acquire shares by annual bonus. | B1 Enterprise system construction degree | B1 system effectiveness (b1, b2) |
| The company has adhered to the principle that people who work harder and contribute more will "earn more money" since its establishment. The phenomena of internal conflict, negative emotion and team disharmony arising from "unfair distribution" have rarely occurred to our company. | b2 system action effect | |
| In the early period, the company faced not only the problem of personnel and capital shortage, but also intense market competition, but we took advantage of distribution channels such as Alcatel-Lucent, Alcatel and Ericsson to solve the problems. | b3 product channel | B2 business model (b3, b4) |
| Considering different policies in different places, we built distribution channels in East China and South China using policy advantages and developed the local markets by virtue of robust capital of local partners and local government support. | b4 terminal layout | |

4.3.3 Grounded Coding Analysis

Based on the above analysis, case of grounded theory should be selected mainly according to the principle of accessibility and typicality. After plenty of case studies, industrial parks of Shenzhen and their cluster enterprises are

studied as they have these two characteristics. Therefore, this study mainly adopts the coding mode of grounded theory while building an index system for analyzing the intensity of informal institution of industrial parks of Shenzhen and mainly adopts openness coding mode in the first stage of the coding process and obtains standardized concepts, which become first-level code of this topic. Then, first-level code of references is subdivided using principal coding mode based on openness coding, and standardized concepts in first-level code are divided into different main categories. Finally, the core category of several selective codes is summarized according to the category relation of principal code.

(1) Openness coding

In the openness coding process for informal institution problem of industrial parks of Shenzhen, researcher complies with the principle of believing in everything and not believing in everything. Openness coding is the first stage of the coding process and it is aimed at deeply thinking about the concepts and categories abstracted from the data in accordance with relevant references and preliminarily collating the data collected. According to the research and analysis of cluster enterprise innovation performance under grounded theory, after determining the topic of study and interview of cluster enterprise innovation performance of industrial parks of Shenzhen, documents on research and evaluation indexes of cluster enterprise innovation performance of industrial parks of Shenzhen are sorted, and hundreds of initial concepts are obtained in combination with expert analysis. Since the frequency of occurrence of these hundreds of concepts is superimposed, initial concepts are reclassified and openness coding is eventually identified mainly from

questionnaire according to practical situation. Relevant topics are quantified in the questionnaire and the category of concepts is identified. Finally, corresponding categories are identified through repeated comparative analysis, and categories are continuously attributed and dimensionalized. Based on the above principles, this paper keeps records on questionnaire and carries out data analysis.

(2) Principal coding

Principal coding, also called second-level coding, is mainly aimed at identifying the concrete relations among the concepts, and the organic relations among the data should be fully identified in the principal coding process. The concepts obtained from openness coding are dispersed. Principal coding is to reanalyze and integrate the categorized concepts of openness coding, connect different types of attributes and rearrange the divided data in the initial code so that the analysis result is consistent. For this purpose, correlation analysis should be carried out for plenty of investigation materials so that different events and different concepts can be interconnected in some veins. This paper carries out analysis according to the categorized concepts in openness coding and classifies them into different main categories from the perspective of business management, industrial economics and regional economics. According to the above analysis, cluster enterprise innovation performance of industrial parks of Shenzhen can be studied and analyzed from different perspectives, even though a complete theory cannot be built.

(3) Selective coding

Selective coding, also called third-level coding, refers to analyzing the built concept system based on completing principal coding and selecting the core

category from the concept system. When the core category is connected to other resources, it should have the ability to build connections quickly. Meanwhile, the built connections should be rich in content. Selecting a "core category" from all the identified concept categories through systematic analysis means to continuously analyze a core category. According to the abovementioned category relation of principal coding, the core category of selective coding is summarized and based on this an evaluation index system is built.

Generally, informal institution has broad connotation and extension and scholars do not define it clearly but use such concepts as cultural and historical tradition, value, social relation, capital relation, trust, embeddedness and cultural environment in a general way. The research context of cluster enterprise of industrial park contains not only informal environment of cluster such as cultural tradition, ideology, custom and convention in the cluster, but also social relations in the cluster and personal relationship network comprised of relatives, friends, town fellows, colleagues and classmates. Therefore, it is hard to grasp principal contradictions if informal institution is discussed broadly and consequently the research thought may be confused easily. For this reason, it is very necessary to define the connotation and extension of informal institution in the industrial park. Since this study is carried out based on Shenzhen, data is collected from industrial parks of Shenzhen and their cluster enterprises and Shenzhen is an emerging and very young city, of which the historical and cultural features are less prominent than those of other cities in China, this study will ignore regional congenital informal institutional factors such as historic culture and custom and focus on informal institution

formed by the rebuilt social relations such as town fellows and classmates. In fact, Shenzhen mainly consists of migrants, and interactions through building social relations such as relatives, town fellows, colleagues and classmates are very common in business practice. Such informal institutional relation formed by genetic relationship, geographical relationship, karmic connection and scholarship provides a certain mutual trust mechanism or exchange platform for enterprises to gather in the industrial park and interact. For this purpose, in order to better measure the informal institution of industrial park, a variable "informal institution intensity" is proposed through grounded analysis, which is to value genetic relationship, geographical relationship, karmic connection and scholarship. The closer the relationships are, the more they are intersected and the higher the values are. A set is formed and placed in the park enterprise relationship variable dimension.

## 4.4 Indicator System Construction

### 4.4.1 Construction of Informal Institution Intensity Index System

Based on the previous studies and grounded analyses, "informal institution intensity" index system is built in this study, as shown below.

Table 4.Informal institution intensity index system

| **First-level coding/openness coding (third-level index)** | **Second-level coding/principal coding (second-level index)** | **Third-level coding/selective coding (first-level index)** |
|---|---|---|
| Father and son/daughter $X_1$ | $A_1$ direct relatives | A genetic relationship |
| Couple $X_2$ | | |
| Brothers/sisters $X_3$ | | |
| Nephew and uncle $X_1$ | $A_2$ collateral relatives | |
| Brother-in-law/ cousin $X_2$ | | |
| Relatives on the side of mother or wife $X_3$ | | |

| | | |
|---|---|---|
| Paternalism $X_1$ | $A_3$ family firm characteristics | |
| Family decision X2 | | |
| Control of men and money $X_5$ | | |
| The same village $X_1$ | $B_1$ village level | B geographical relationship |
| The same township $X_2$ | | |
| The same county $X_1$ | $B_2$ county/district level | |
| The same district $X_2$ | | |
| The same (county-level) city $X_3$ | | |
| The same prefecture-level city $X_1$ | $B_3$ prefecture level | |
| The same province $X_1$ | $B_4$ provincial level | |
| Primary school classmates $X_1$ | $C_1$ primary and middle school classmates | C scholarship |
| Middle school classmates $X_2$ | | |
| High school classmates $X_3$ | | |
| Junior college classmates $X_1$ | $C_2$ university classmates | |
| University classmates $X_2$ | | |
| Postgraduate classmates $X_1$ | $C_3$ postgraduate classmates | |
| Doctor classmates $X_2$ | | |
| Enterprise/industry training class $X_1$ | $C_4$ training classmates | |
| Self-paid training class $X_2$ | | |
| The same post $X_1$ | $D_1$ the same department/branch | D karmic connection |
| The same department $X_2$ | | |
| The same branch $X_3$ | | |
| The same enterprise $X_1$ | $D_2$ the same enterprise | |
| The same social organization $X_2$ | | |
| The same industry in local place $X_1$ | $D_3$ the same industry | |
| The same industry in other places $X_2$ | | |
| The same industry in the park $X_3$ | | |

4.4.2 Construction of Enterprise Innovation Performance Index System

As stated above, enterprise innovation behavior in this study refers to the different commercial actions enterprise adopts based on self-cognition and surroundings for the purpose of innovation output. Innovation performance measures the innovation output level of enterprise in technology, mode and system. Table 1 shows the previous research methods and measurement indexes of enterprise innovation performance. There are different innovation

performance measurement methods in the empirical studies of current academic circles. Considering special situation of cluster enterprises in the industrial parks of Shenzhen, innovation performance measurement system should be rebuilt.

Based on the previous researches and grounded analyses, an enterprise innovation performance index system is built in this study, as shown below:

Table 5.Innovation performance index system

| **First-level coding/openness coding (third-level index)** | **Second-level coding/principal coding (second-level index)** | **Third-level coding/selective coding (first-level index)** |
|---|---|---|
| Production equipment update rate $X_1$ | $E_1$ basic conditions | E technological innovation |
| Annual input of new equipment $X_2$ | | |
| Employee's machine operation ratio $X_3$ | | |
| Number of research personnel $X_4$ | | |
| Average education level of employee $X_5$ | | |
| Quantity and level of internal research institutions $X_6$ | | |
| Proportion of technological development expenses in sales volume $X_1$ | $E_2$ technology transfer | |
| Number of awards $X_2$ | | |
| Input-output ratio of new product $X_3$ | | |
| Output rate of new product $X_4$ | | |
| Yield rate of technological advance project $X_5$ | | |
| Number of patents $X_6$ | | |
| Construction degree of modern enterprise system $X_1$ | $F_1$ system effectiveness | F institutional innovation |
| Effectiveness of modern enterprise system $X_2$ | | |
| Enterprise cohesion $X_1$ | $F_2$ enterprise culture | |
| Advancement of enterprise culture $X_2$ | | |
| Enterprise influence $X_3$ | | |

| | | |
|---|---|---|
| Communication between superiors and subordinates $X_1$ | $F_3$ internal coordination | |
| Department coordination $X_2$ | | |
| New product channel $X_1$ | $G_1$ business model | G model innovation |
| New product terminal layout network $X_2$ | | |
| Diversification degree $X_3$ | | |
| Marketing digitalization degree $X_4$ | | |
| Enterprise brand value $X_1$ | $G_2$ profitability | |
| Market share of innovative product $X_2$ | | |
| Revenue of innovative product $X_3$ | | |

4.5 Theory Saturation Test

A total of 410 documents are selected in this study and 100 are reserved for verification. When the 240$^{th}$ document is summarized in the coding process, code labels contained in the documents can be included in the set code concepts and new categories and new concepts are not summarized. The reserved 70 documents are recoded and new categories or new concepts are not identified. Based on this, the codes built in this study can meet the requirements for theory saturation and this model is saturated.

4.6 Indicator System Measurement

According to the above index system, mathematical model method is adopted for measurement in this study.

Mathematical model method is a research method of building models using mathematical languages according to the concrete characteristics of the research object to analyze the quantitative relation and the dependence relationship. The academic circle has different opinions about the connotation of mathematical model method, and viewpoints are voiced in a broad sense and in a narrow sense. In a broad sense, mathematical model includes relevant concepts such as model concept

and formula concept, which are mathematical concepts abstracted from the prototype, and mathematical model evaluation is taken as an empirical solution for quantitative analysis. In a narrow sense, mathematical model is a research method of reflecting specific problems in practice or specific objects using mathematic relation structure.

In the modeling process, we should combine accuracy and fuzziness. As to accuracy, the designed mathematical model should have a clear and definite connotation and extension and its mathematical expression can clearly reflect the situation of the research object. Meanwhile, mathematical model should be fuzzy and can give a fuzzy description of connotation and extension of the research object. The uniformity of accuracy and fuzziness is designed for the need of certainty and variability in practice. Mathematical model should meet the requirements for both certainty and variability of practice.

This study separates all influence factors of informal institution intensity and enterprise innovation performance system of industrial park using mathematical model method, specifies abstract influence factors and builds mathematical models to clarify the interconnections between all factors and substantiate the measurement of factors. When the informal institution intensity and enterprise innovation performance system of industrial park are built, investigation data and indexes are complicated due to numerous industrial parks and enterprises. For this reason, this study nondimensionalizes the statistical data and indexes using fuzzy matter element analysis method. In this process, different indexes will be estimated and given different weights using weight calculation method. Since enterprise innovation performance system is directly related to production efficiency, this study scientifically quantifies the informal institution intensity and enterprise

innovation performance system of industrial park. Fuzzy matter element analysis method and weight calculation method will mainly be adopted in this study according to research need.

### 4.6.1 Fuzzy Matter Element Analysis Method

Due to a lot of influence factors of informal institution intensity of industrial park and enterprise innovation performance system, these factors may be superimposed and interact. To solve this problem, fuzzy matter element analysis should be carried out on these factors to identify main influence variables in this study.

To be specific, fuzzy matter element analysis method refers to attributing superimposed information or complex relation in the indexes to some mutually uncorrelated factors through matrix analysis, by proceeding from internal dependence of index, and drawing conclusions through multivariate statistical analysis specific to factor situation. Fuzzy matter element analysis method mainly has exploratory characteristics and helps unearth hidden factors. It can form a factor specific to a common characteristic of different variables in empirical analysis, can effectively reduce the number of variable factors in the concrete analysis process and is conducive to verifying the suppositional relations among variables.

The basic thought of fuzzy matter element analysis method: Variables are divided into different groups specific to different correlations and variables in the same group are highly correlated, but variables in different groups are lowly correlated. Every group of variables should represent a basic structure, that is, each group of variables should have a common factor. Concrete steps of fuzzy matter element analysis method: First, standardize the selected data sample; second, build relevant matrixes according to sample; third, calculate relevant characteristic root values and

feature vectors through matrix; fourth, calculate the quantity of corresponding main factors according to cumulative contribution rate; fifth, introduce main factors into the load matrix; sixth, identify the final factor model; seventh, analyze the factor system according to calculation result.

Objective analysis and evaluation are carried out using fuzzy matter element analysis method in light of different characteristics and advantages of different analysis methods and based on index characteristics, and factor indexes undergo dimension reduction and weight duplication to obtain a more scientific and systematic index system.

In this study, all variables are grouped and analyzed using fuzzy matter element analysis method specific to internal and external relations of all indexes and variables, the necessary connection between independent variable and dependent variable is identified, the non-major variables of subjective factors are eliminated, or the major variables of strongly subjective factors are defined as control variables, to ensure objectivity of final calculation result and research conclusion. From the perspective of information theory, information is the measurement of the order degree of system; on the contrary, entropy is the measurement of the disorder degree of system. While evaluating the index system, the entropy value is determined by the variation degree of the index value: A high degree of variation means comprehensive information contained in the index system, high information contribution degree of system, low uncertainty, low entropy value of index and high weight. Otherwise, a low degree of variation means high entropy value of index and low weight. Index weight will be calculated using entropy weight method in this study as follows:

First, normalize the initial matrix $R=(x_{ij})_{mn}$ to obtain the normalized judgment matrix $B=(b_{ij})_{mn}$. Where:

$$b_{ij}=\frac{x_{ij}-\min x_{ij}}{\max x_{ij}-\min x_{ij}} \tag{4-1}$$

In Formula (4-1), $\max x_{ij}$ ( $\min x_{ij}$ ) represents the most satisfied value (the most dissatisfied value) of different things under the same characteristic.

Second, calculate entropy $H_i$ of characteristic $i$ of event $j$ according to the definition of entropy in information theory:

$$H_i=-\frac{1}{\ln n}\left[\sum_{j=1}^{n} f_{ij}\ln f_{ij}\right] \tag{4-2}$$

Where:

$$f_{ij}=b_{ij}\Big/\sum_{j=1}^{n} b_{ij} \tag{4-3}$$

When $b_{ij}=0$, $f_{ij}$ is 0 and $\ln f_{ij}$ is an infinite value, so $b_{ij}$ should be translated. The modifier formula is:

$$f_{ij}=\frac{A+b_{ij}}{\sum_{j=1}^{n}(A+b_{ij})} \tag{4-4}$$

In Formula (4-4), $A$ is translation amplitude and its value is 1 here.

Third, calculate the entropy value of characteristic:

$$\omega_i=\frac{1-H_i}{m-\sum_{i=1}^{m} H_i} \tag{4-5}$$

In Formula (4-5), $\omega_i$ meets $\sum_{i=1}^{m}\omega_i=1$,

Fourth, calculate the Euclid approach degree ( $\rho H_j$ ) and the compound fuzzy matter element ( $R_{\rho H}$ ) of things:

$$\rho H_j = 1 - \sqrt{\sum_{i=1}^{m} \omega_i \Delta_{ij}} \qquad (4\text{-}6)$$

$$R_{\rho H} = \begin{bmatrix} & M_1 & M_2 & \cdots & M_n \\ \rho H_j & \rho H_1 & \rho H_2 & \cdots & \rho H_n \end{bmatrix} \qquad (4\text{-}7)$$

Approach degree is used to measure the approach degree between all things and the optimal thing. The higher the value is, the closer the measured thing is to the optimal thing.

4.6.2 Fuzzy Matter Element Analysis

The aforesaid fuzzy matter element analysis method can be directly used to process cross-section data or time series data, but if it is used to process panel data, data dimension should be reduced. That is, regard things of different years as a new thing and include them in the original $m$ -dimension compound matter element $R_{m \times n}$ in order to build the following new $m$-dimension compound matter element $R_{m \times n(y)}$:

$$R_{m \times n(y)} = \begin{bmatrix} x_{11(1)} & \cdots & x_{1n(t)} \\ \vdots & \ddots & \vdots \\ x_{m1(1)} & \cdots & x_{mn(t)} \end{bmatrix} \qquad (4\text{-}8)$$

Where, $x_{ij(y)}, (y = 1, 2, \cdots t)$ means the value corresponding to characteristic $j$ of thing $i$ in year $y$.

Since panel data compound matter element $R_{m \times n(y)}$ absorbs the information of time and thing, between-group variance is maintained to ensure comparability of the obtained Euclid approach degree.

Weight reflects the importance of independent indexes in the index system, and weight of index reflects the influence of index on system. Identifying weight will directly affect the final evaluation of index. Presently, fuzzy

matter element weighting method is mainly adopted in practice. With certain advantages in identifying weight, fuzzy matter element weighting method can be used to carry out non-quantitative analysis of goal planning and simplify complex problems when hierarchy remains unchanged. Therefore, fuzzy matter element weighting method has been widely used in practice. Whereas the constitute factors of informal institution intensity of industrial park and enterprise innovation performance system are not weighed and valued in the index design process, index data probably needs to be further corrected and improved.

### 4.6.3 Analysis of Computing Method for Different Weights

To ensure comparability of evaluation indexes, their original values should be standardized in order to eliminate dimension, figure out the value after standardization and use it as a basis for evaluation. For this purpose, index weights of informal institution intensity of industrial park and enterprise innovation performance system will be calculated in this study using analytic hierarchy process, entropy weight method and combination weighting method.

Entropy weight method is an objective valuation method in weight analysis. Compared with subjective weighting method, entropy weight method has wider applicability and it can be used in all stages in the weighting process. Meanwhile, entropy weight method is a main method for analyzing the index weighting system that can be used cooperatively with other methods.

The calculation process of entropy weight method includes original data acquisition and nondimensionalization.

First, acquire original data.

Matrix will be built according to the original data acquired. Suppose there are n index objects, design m relevant indexes to form an original matrix.

$$X = \begin{bmatrix} x_{11} & x_{12} & \ldots & x_{1n} \\ x_{21} & x_{22} & \ldots & x_{2n} \\ \ldots & \ldots & \ldots & .. \\ x_{m1} & x_{m2} & \ldots & x_{mn} \end{bmatrix}_{mxn} \qquad (4\text{-}9)$$

Second, nondimensionalize original data.

There are differences between data attribute and data dimension and they are not comparable in the index system. Thus, original data will be nondimensionalized to eliminate the influence of data dimension on original data to maintain the action of indexes on comprehensive evaluation in the same direction.

There are three common types of indexes in the actual evaluation system, i.e. positive index, negative index and comparative fit index. For fuzziness of index, index is nondimensionalized using quantitative fuzzy method in order to eliminate the dimensional influence of data index, with comparability and difference guaranteed. There are three dimension calculation methods:

Positive index is processed using the following formula:

$$a_{ij} = \left\{ \frac{x_{ij} - \min\limits_{1 \le i \le m}}{\max\limits_{1 \le i \le m} x_{ij} - \min\limits_{1 \le i \le m} x_{ij}} \left( \min x_{ij} \le x_{ij} \le \max x_{ij} \right) \right.$$ . When $x_{ij} = \max\limits_{1 \le i \le m} x_{ij}$ , $a_{ij} = 1$;

when $x_{ij} = \min\limits_{1 \le i \le m} x_{ij}$ , $a_{ij} = 0$. Item j corresponds to the original value of i: Suppose m is the quantity of evaluation indexes and n is the quantity of evaluation objects, $1 \le i \le m; 1 \le j \le n$ .

Negative index is processed using the following formula:

$a_{ij} = \left\{ \frac{\max x_{ij} - x_{ij}}{\max\limits_{1\le i\le m} x_{ij} - \min\limits_{1\le i\le m} x_{ij}} \left( \min\limits_{1\le i\le m} x_{ij} \le x_{ij} \le \max\limits_{1\le i\le m} x_{ij} \right) \right.$. When $x_{ij} = \max\limits_{1\le i\le m} x_{ij}$, $a_{ij}$ =1;

when $x_{ij} = \min\limits_{1\le i\le m} x_{ij}$, $a_{ij}$ =0. When item j corresponding to $x_{ij}$ corresponds to the original value of i: Suppose m is the quantity of evaluation indexes and n is the quantity of evaluation objects, $1 \le i \le m; 1 \le j \le n$.

In order to ensure the effectiveness of the dimensionless value to the result figured out using the function, the result is often corrected using efficiency numerical method in practical application. This study will refer to efficiency coefficient method that Wu and Wang (2020) adopted to value all indexes, with 0.6 as the boundary. If the value is below 0.6, it means unqualified. If the value is above 0.6, it means qualified. The calculation method can be set as: $Y_{ij} = a_{ij} * 0.4 + 0.6$. Where, a qualified corrected result means that any value of $y_{ij}$ should be 0.6≤y≤1. In the concrete evaluation process, the higher the evaluation value, the better the result. A new evaluation matrix can be obtained after the evaluation result is summarized:

$$Y = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{12} & y_{22} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix}_{mxn} \quad (4\text{-}10)$$

After the corrected result is obtained, its characteristic ratio should be figured out using formula $p_{ij} = \frac{y_{ij}}{\sum\limits_{j=1}^{n} y_{ij}}$. Where, i=1, 2, 3.....m; while j=1, 2, 3.....n.

$p_{ij}$ means the ratio of sample j under index i.

Based on the ratio, the entropy weight of index i can be figured out using

formula $e_i = k\sum_{j=1}^{n} p_{ij} \ln p_{ij}$ , where, k=1/lnn. In a general sense, the bigger the difference in the ratio is the smaller the entropy value is. The smaller the difference in the ratio is the larger the entropy value is. Thus, if the entropy value is too large, there is a small difference in the sample and little information is provided. The sample should be eliminated to ensure accuracy of information.

The variation coefficient D of index will be calculated and specific information effectiveness of index is determined by standard variation coefficient. The larger D value is, the greater information effectiveness is and the larger the ratio is. Variation coefficient can be figured out using formula $D_i = 1 - e_i$ (i=1、2、3.....m)

Finally, the entropy weight w of item index can be figured out using formula

$$w_i^{(e)} = \frac{D_i}{\sum_{i=1}^{m} D_i} \quad \text{(i=1, 2, 3.....m)}$$

In this study, index values and final weight are determined using entropy weight method, and the variation coefficient ensures that the index weight is consistent with the reality. The ratio of every index over all indexes of informal institution intensity and enterprise innovation performance of industrial park is determined according to the importance and influence of index, as shown in Table 6 and Table 8, so as to ensure that the final result is consistent with the objective reality.

It should be noted that this study involves 41 industrial parks and 400 park enterprises and related information will be obtained with permission. Out of respect, these industrial parks and enterprises will not be mentioned by name

but by code.

As shown in Table 6, the weight of genetic relationship, geographical relationship, scholarship and karmic connection is different, among which karmic connection has the largest weight, scholarship has the smallest weight and genetic relationship and geographical relationship have an intermediate weight. It indicates that enterprises in Shenzhen value work experience and resources more than scholarship. According to analysis of second-level index weight of scholarship, business education and management training for adult developed well in Shenzhen in recent years, and many educational institutions settled in Shenzhen and opened various training classes. It was common that businessmen participated in training classes in a short time to promote interaction. The second-level index weight of genetic relationship, geographical relationship and scholarship is different, and it will not be described here.

4.6.4 Comprehensive Assessment and Calculation of Informal Institution Intensity and Enterprise Innovation Performance System of Industrial Park

After the weight of general index is identified, the informal institution intensity and enterprise innovation performance of industrial park can be comprehensively evaluated and calculated. The overall evaluation value can be expressed by $T_j$ and figured out using formula $T_j = \sum_{i=1}^{m} y_{ij} w_i$ .

Data is collected mainly in three ways: First, collect data through expert interview; second, evaluate research indexes through questionnaire; third, value objective statistical data. As to expert selection, three types of experts are selected based on the practical situation of this study. The first type is

relevant workers who engage in business management such as managers and department heads. The second type is specialists and scholars who study enterprise innovation performance. The third type is entrepreneurs.

In use, entropy weight method is used to calculate the entropy weight of all indexes using information entropy according to the variation degree of all indexes and correct the weight of all indexes according to entropy weight to figure out a considerable index weight. According to the result in Table 4-1, there are no relevant indexes with little difference in general indexes, so all indexes can be reserved.

Suppose the entropy value corresponding to index i is $e_i$ and variation coefficient is $\partial_i$, calculate entropy weight $w_i^{(e)}$ and figure out T value for overall evaluation on informal institution intensity and enterprise innovation performance of industrial park, as shown in Table 7 and Table 9.

As shown in Table 8, enterprise gives top priority to technological innovation, especially technical transformation, followed by model innovation, and they consider profitability first. Among first-level indexes, institutional innovation has the lowest weight. Among second-level indexes, enterprise values internal coordination least.

1. Index weight and overall evaluation of informal institution intensity of industrial park

Table 6.Index weight of informal institution intensity

| First-level index | Weight | Second-level index | Weight |
|---|---|---|---|
| A genetic relationship | 0.2638 | $A_1$ direct relatives | 0.3624 |
| | | $A_2$ collateral relatives | 0.3146 |
| | | $A_3$ family firm characteristics | 0.3230 |
| B geographical relationship | 0.2417 | $B_1$ village level | 0.2905 |
| | | $B_2$ county/district level | 0.2600 |
| | | $B_3$ prefecture level | 0.2518 |

| | | | |
|---|---|---|---|
| | | $B_4$ provincial level | 0.1977 |
| C scholarship | 0.1821 | $C_1$ primary and middle school classmates | 0.2405 |
| | | $C_2$ university classmates | 0.3016 |
| | | $C_3$ postgraduate classmates | 0.2518 |
| | | $C_4$ training classmates | 0.2277 |
| D karmic connection | 0.3124 | $D_1$ the same department/branch | 0.3501 |
| | | $D_2$ the same enterprise | 0.3131 |
| | | $D_3$ the same industry | 0.3368 |

Table 7. Comprehensive ranking of informal institution intensity of industrial park sample

| Rank | Industrial park No. | Overall evaluation of informal institution intensity | Rank | Industrial park No. | Overall evaluation of informal institution intensity |
|---|---|---|---|---|---|
| 1 | A2 | 0.9675 | 22 | N2 | 0.6114 |
| 2 | K2 | 0.9575 | 23 | W1 | 0.6082 |
| 3 | G2 | 0.9559 | 24 | I1 | 0.5818 |
| 4 | I2 | 0.9529 | 25 | R1 | 0.5674 |
| 5 | M1 | 0.9038 | 26 | F2 | 0.562 |
| 6 | B1 | 0.9034 | 27 | J2 | 0.5568 |
| 7 | L1 | 0.8962 | 28 | S1 | 0.5261 |
| 8 | H1 | 0.8756 | 29 | N1 | 0.4957 |
| 9 | L2 | 0.8631 | 30 | P1 | 0.4534 |
| 10 | Y1 | 0.8553 | 31 | M2 | 0.4442 |
| 11 | A1 | 0.8514 | 32 | F1 | 0.4287 |
| 12 | V1 | 0.7978 | 33 | B2 | 0.4198 |
| 13 | G1 | 0.7886 | 34 | C2 | 0.4161 |
| 14 | O1 | 0.7818 | 35 | U1 | 0.3886 |
| 15 | T1 | 0.7763 | 36 | D1 | 0.3736 |
| 16 | D2 | 0.7623 | 37 | J1 | 0.3286 |
| 17 | K1 | 0.7448 | 38 | H2 | 0.3254 |
| 18 | C1 | 0.7064 | 39 | X1 | 0.2791 |
| 19 | E1 | 0.6778 | 40 | E2 | 0.2578 |
| 20 | Z1 | 0.6503 | 41 | O2 | 0.2518 |
| 21 | Q1 | 0.6445 | | | |

2. Index weight and overall evaluation of enterprise innovation performance system

Table 8. General index weight of enterprise innovation performance system

| First-level index | Weight | Second-level index | Weight |
|---|---|---|---|
| E technological innovation | 0.4538 | $E_1$ basic conditions | 0.3979 |
| | | $E_2$ technical transformation | 0.6021 |
| F institutional innovation | 0.2431 | $F_1$ system effectiveness | 0.4105 |
| | | $F_2$ enterprise culture | 0.3377 |
| | | $F_3$ internal coordination | 0.2518 |
| G model innovation | 0.3031 | $C_1$ business model | 0.4745 |
| | | $C_2$ profitability | 0.5255 |

Table 9. Comprehensive ranking of enterprise innovation performance of industrial park sample

| No. | Enterprise No. | Overall evaluation of innovation performance | No. | Enterprise No. | Overall evaluation of innovation performance |
|---|---|---|---|---|---|
| 1 | V1-1 | 0.975 | 201 | P1-6 | 0.572 |
| 2 | O1-10 | 0.9731 | 202 | N1-6 | 0.5696 |
| 3 | F2-1 | 0.9722 | 203 | O1-4 | 0.5672 |
| 4 | S1-1 | 0.9707 | 204 | F1-5 | 0.5658 |
| 5 | R1-8 | 0.9701 | 205 | T1-10 | 0.5615 |
| 6 | L2-1 | 0.9697 | 206 | I2-4 | 0.5585 |
| 7 | M1-8 | 0.9678 | 207 | A2-9 | 0.5549 |
| 8 | I1-3 | 0.9676 | 208 | H1-1 | 0.5541 |
| 9 | Q1-10 | 0.9668 | 209 | I2-10 | 0.5535 |
| 10 | M2-10 | 0.9632 | 210 | E1-1 | 0.5478 |
| 11 | C1-6 | 0.9626 | 211 | B2-6 | 0.5471 |
| 12 | U1-7 | 0.9613 | 212 | T1-5 | 0.545 |
| 13 | U1-6 | 0.954 | 213 | Q1-7 | 0.5446 |
| 14 | J2-6 | 0.9532 | 214 | G2-9 | 0.5445 |
| 15 | H2-3 | 0.9519 | 215 | N1-5 | 0.5438 |
| 16 | O2-10 | 0.9511 | 216 | K1-2 | 0.5436 |
| 17 | O2-7 | 0.9505 | 217 | N2-4 | 0.5431 |
| 18 | D1-10 | 0.9494 | 218 | J2-9 | 0.5428 |
| 19 | G1-3 | 0.9489 | 219 | B1-2 | 0.5417 |
| 20 | C1-7 | 0.9457 | 220 | E2-4 | 0.5389 |
| 21 | R1-7 | 0.9449 | 221 | O2-5 | 0.5382 |
| 22 | M1-4 | 0.9442 | 222 | K2-2 | 0.5379 |
| 23 | A2-10 | 0.9423 | 223 | L1-1 | 0.5343 |
| 24 | R1-9 | 0.9422 | 224 | K1-8 | 0.5341 |

| | | | | | |
|---|---|---|---|---|---|
| 25 | H2-10 | 0.9419 | 225 | L2-6 | 0.5329 |
| 26 | W1-9 | 0.9411 | 226 | S1-7 | 0.5311 |
| 27 | G1-10 | 0.9389 | 227 | L2-2 | 0.5308 |
| 28 | K1-1 | 0.9357 | 228 | J1-4 | 0.527 |
| 29 | L2-3 | 0.9354 | 229 | G1-4 | 0.5261 |
| 30 | O1-8 | 0.934 | 230 | H1-4 | 0.5212 |
| 31 | P1-9 | 0.9339 | 231 | K1-10 | 0.5196 |
| 32 | G1-6 | 0.9335 | 232 | T1-7 | 0.5188 |
| 33 | P1-3 | 0.933 | 233 | X1-10 | 0.5167 |
| 34 | B1-1 | 0.9298 | 234 | I2-5 | 0.5153 |
| 35 | L1-2 | 0.9248 | 235 | N2-6 | 0.5143 |
| 36 | R1-4 | 0.9237 | 236 | H1-6 | 0.5129 |
| 37 | J2-1 | 0.9231 | 237 | E2-3 | 0.5074 |
| 38 | D2-9 | 0.9221 | 238 | I1-5 | 0.5071 |
| 39 | I1-1 | 0.9218 | 239 | E2-10 | 0.5071 |
| 40 | G1-7 | 0.9213 | 240 | E2-8 | 0.5065 |
| 41 | X1-3 | 0.9208 | 241 | Z1-5 | 0.4979 |
| 42 | V1-10 | 0.9178 | 242 | D2-4 | 0.4961 |
| 43 | S1-8 | 0.9146 | 243 | O1-2 | 0.4951 |
| 44 | F2-5 | 0.9117 | 244 | H1-5 | 0.4926 |
| 45 | I2-3 | 0.911 | 245 | Q1-9 | 0.4924 |
| 46 | A2-4 | 0.9072 | 246 | F1-3 | 0.4922 |
| 47 | M2-8 | 0.9057 | 247 | Y1-1 | 0.4883 |
| 48 | D2-10 | 0.8934 | 248 | Z1-8 | 0.4832 |
| 49 | T1-9 | 0.8922 | 249 | N2-3 | 0.4828 |
| 50 | W1-4 | 0.8921 | 250 | G1-8 | 0.481 |
| 51 | J1-8 | 0.8913 | 251 | X1-1 | 0.4785 |
| 52 | S1-3 | 0.8911 | 252 | W1-5 | 0.4771 |
| 53 | K2-8 | 0.8887 | 253 | J1-10 | 0.4769 |
| 54 | D1-8 | 0.8851 | 254 | A1-7 | 0.475 |
| 55 | Y1-7 | 0.8838 | 255 | L2-5 | 0.4684 |
| 56 | N1-2 | 0.8827 | 256 | J2-10 | 0.4644 |
| 57 | B2-9 | 0.8786 | 257 | I1-6 | 0.463 |
| 58 | P1-8 | 0.8785 | 258 | C2-4 | 0.4618 |
| 59 | B2-2 | 0.8784 | 259 | K2-1 | 0.46 |
| 60 | D1-7 | 0.8778 | 260 | Z1-7 | 0.4579 |
| 61 | D2-3 | 0.8747 | 261 | E2-7 | 0.4553 |
| 62 | J2-5 | 0.8741 | 262 | F2-3 | 0.4546 |

| | | | | | |
|---|---|---|---|---|---|
| 63 | C1-3 | 0.8682 | 263 | C2-9 | 0.4477 |
| 64 | H2-4 | 0.8669 | 264 | K2-6 | 0.4468 |
| 65 | K2-9 | 0.8646 | 265 | C2-6 | 0.446 |
| 66 | V1-4 | 0.8608 | 266 | W1-7 | 0.444 |
| 67 | L2-10 | 0.8599 | 267 | M2-3 | 0.4415 |
| 68 | A1-6 | 0.8566 | 268 | E2-2 | 0.4408 |
| 69 | I2-2 | 0.8511 | 269 | V1-6 | 0.4348 |
| 70 | C2-2 | 0.8476 | 270 | V1-7 | 0.4291 |
| 71 | F2-6 | 0.8462 | 271 | G1-5 | 0.4274 |
| 72 | F2-2 | 0.8459 | 272 | M1-9 | 0.4269 |
| 73 | G2-1 | 0.8441 | 273 | D1-2 | 0.4227 |
| 74 | B2-1 | 0.8371 | 274 | K2-10 | 0.4219 |
| 75 | A2-3 | 0.8331 | 275 | A1-4 | 0.4206 |
| 76 | A1-8 | 0.8317 | 276 | I1-9 | 0.4188 |
| 77 | N2-9 | 0.8289 | 277 | B1-8 | 0.4187 |
| 78 | B1-4 | 0.8279 | 278 | G2-10 | 0.416 |
| 79 | N2-7 | 0.8278 | 279 | L2-7 | 0.4119 |
| 80 | M2-6 | 0.8251 | 280 | I2-8 | 0.4108 |
| 81 | X1-4 | 0.8218 | 281 | M1-10 | 0.4059 |
| 82 | C2-1 | 0.8171 | 282 | D2-7 | 0.4057 |
| 83 | A1-10 | 0.8139 | 283 | K2-7 | 0.4042 |
| 84 | O1-7 | 0.8116 | 284 | T1-8 | 0.4042 |
| 85 | O2-4 | 0.8097 | 285 | S1-4 | 0.4034 |
| 86 | D1-5 | 0.8088 | 286 | K1-7 | 0.402 |
| 87 | H2-9 | 0.8077 | 287 | K1-9 | 0.4013 |
| 88 | B1-3 | 0.8054 | 288 | U1-10 | 0.3998 |
| 89 | F2-7 | 0.7968 | 289 | Y1-6 | 0.3995 |
| 90 | X1-7 | 0.7961 | 290 | U1-4 | 0.3927 |
| 91 | Z1-2 | 0.7954 | 291 | H2-2 | 0.3916 |
| 92 | M1-7 | 0.7948 | 292 | B2-4 | 0.3909 |
| 93 | U1-3 | 0.7943 | 293 | H2-5 | 0.3881 |
| 94 | H2-8 | 0.7941 | 294 | K2-4 | 0.3857 |
| 95 | Z1-4 | 0.7928 | 295 | F2-9 | 0.3834 |
| 96 | K2-5 | 0.7897 | 296 | Z1-6 | 0.3833 |
| 97 | E2-6 | 0.7896 | 297 | L1-10 | 0.382 |
| 98 | N1-7 | 0.789 | 298 | R1-2 | 0.3808 |
| 99 | Z1-9 | 0.787 | 299 | B1-9 | 0.3793 |
| 100 | I1-7 | 0.7857 | 300 | N1-4 | 0.3777 |

| | | | | | |
|---|---|---|---|---|---|
| 101 | F1-1 | 0.7835 | 301 | E2-1 | 0.3768 |
| 102 | T1-6 | 0.7821 | 302 | N2-8 | 0.3768 |
| 103 | S1-2 | 0.7809 | 303 | Q1-4 | 0.3765 |
| 104 | A2-7 | 0.774 | 304 | R1-6 | 0.376 |
| 105 | M1-6 | 0.7682 | 305 | L1-8 | 0.3733 |
| 106 | J1-1 | 0.7605 | 306 | V1-8 | 0.371 |
| 107 | G2-8 | 0.7599 | 307 | U1-5 | 0.3688 |
| 108 | H1-10 | 0.7594 | 308 | Q1-6 | 0.3686 |
| 109 | E2-9 | 0.7562 | 309 | B1-6 | 0.368 |
| 110 | I1-8 | 0.7523 | 310 | I1-4 | 0.3672 |
| 111 | O1-1 | 0.7513 | 311 | B1-5 | 0.3668 |
| 112 | M1-1 | 0.7486 | 312 | E1-2 | 0.3662 |
| 113 | K2-3 | 0.7483 | 313 | O2-11 | 0.365 |
| 114 | F1-7 | 0.7471 | 314 | M2-7 | 0.3633 |
| 115 | A2-5 | 0.7466 | 315 | Y1-3 | 0.3611 |
| 116 | N2-1 | 0.7449 | 316 | M1-3 | 0.361 |
| 117 | T1-1 | 0.7442 | 317 | A2-8 | 0.3599 |
| 118 | D2-2 | 0.7432 | 318 | N1-1 | 0.3586 |
| 119 | F2-10 | 0.742 | 319 | N1-9 | 0.356 |
| 120 | F2-4 | 0.7417 | 320 | J1-7 | 0.3535 |
| 121 | C2-7 | 0.7403 | 321 | B2-8 | 0.3509 |
| 122 | O1-6 | 0.7294 | 322 | N2-2 | 0.3422 |
| 123 | I2-1 | 0.7289 | 323 | K1-5 | 0.3419 |
| 124 | A2-6 | 0.7289 | 324 | G2-2 | 0.3387 |
| 125 | L1-5 | 0.7285 | 325 | I2-6 | 0.3382 |
| 126 | G1-9 | 0.7265 | 326 | O2-2 | 0.3366 |
| 127 | N2-10 | 0.7262 | 327 | D1-3 | 0.3364 |
| 128 | L2-9 | 0.7254 | 328 | W1-3 | 0.3343 |
| 129 | G2-7 | 0.7219 | 329 | M1-2 | 0.3335 |
| 130 | V1-3 | 0.7207 | 330 | K1-3 | 0.3277 |
| 131 | H1-8 | 0.7148 | 331 | P1-4 | 0.3264 |
| 132 | G2-4 | 0.7135 | 332 | C2-10 | 0.3239 |
| 133 | G2-3 | 0.7127 | 333 | B1-7 | 0.3217 |
| 134 | K1-6 | 0.7114 | 334 | D2-5 | 0.3205 |
| 135 | R1-10 | 0.7069 | 335 | C2-3 | 0.3204 |
| 136 | V1-2 | 0.703 | 336 | M2-4 | 0.3168 |
| 137 | R1-5 | 0.7001 | 337 | O2-9 | 0.3134 |
| 138 | A2-2 | 0.6971 | 338 | A1-5 | 0.3127 |

| | | | | | |
|---|---|---|---|---|---|
| 139 | G1-1 | 0.695 | 339 | G2-5 | 0.3117 |
| 140 | A1-3 | 0.6945 | 340 | D1-1 | 0.3113 |
| 141 | F1-10 | 0.6908 | 341 | C1-2 | 0.3102 |
| 142 | A1-1 | 0.6899 | 342 | C2-5 | 0.3087 |
| 143 | K1-4 | 0.6883 | 343 | M2-2 | 0.3086 |
| 144 | N1-3 | 0.6873 | 344 | O1-3 | 0.3075 |
| 145 | P1-10 | 0.686 | 345 | O2-1 | 0.3063 |
| 146 | L2-8 | 0.6811 | 346 | O2-6 | 0.3039 |
| 147 | J1-2 | 0.6811 | 347 | H2-6 | 0.3003 |
| 148 | J1-5 | 0.6805 | 348 | O2-8 | 0.2996 |
| 149 | M2-1 | 0.6795 | 349 | Y1-10 | 0.2988 |
| 150 | U1-8 | 0.6755 | 350 | I1-10 | 0.298 |
| 151 | L1-6 | 0.6733 | 351 | X1-5 | 0.2957 |
| 152 | H1-9 | 0.6721 | 352 | B2-5 | 0.2927 |
| 153 | Q1-1 | 0.6719 | 353 | L1-9 | 0.2917 |
| 154 | C1-5 | 0.6701 | 354 | Q1-3 | 0.2898 |
| 155 | B2-10 | 0.6695 | 355 | U1-2 | 0.2897 |
| 156 | W1-1 | 0.669 | 356 | V1-5 | 0.2895 |
| 157 | N1-8 | 0.668 | 357 | L1-4 | 0.2893 |
| 158 | F2-8 | 0.664 | 358 | P1-7 | 0.2889 |
| 159 | M1-5 | 0.6587 | 359 | L2-4 | 0.2779 |
| 160 | J1-6 | 0.6581 | 360 | R1-1 | 0.2743 |
| 161 | J2-8 | 0.6503 | 361 | D1-4 | 0.2717 |
| 162 | H1-7 | 0.6483 | 362 | S1-6 | 0.2715 |
| 163 | J2-4 | 0.6467 | 363 | H2-7 | 0.2711 |
| 164 | X1-8 | 0.6424 | 364 | Y1-5 | 0.2688 |
| 165 | Y1-4 | 0.6408 | 365 | M2-5 | 0.268 |
| 166 | I1-2 | 0.6362 | 366 | F1-9 | 0.2653 |
| 167 | H1-3 | 0.6358 | 367 | B2-3 | 0.2649 |
| 168 | J2-2 | 0.6334 | 368 | J1-3 | 0.2623 |
| 169 | P1-5 | 0.628 | 369 | C1-4 | 0.2589 |
| 170 | F1-4 | 0.6247 | 370 | S1-9 | 0.2558 |
| 171 | D1-11 | 0.6237 | 371 | N1-10 | 0.2553 |
| 172 | Q1-5 | 0.6194 | 372 | B2-7 | 0.2546 |
| 173 | Z1-1 | 0.6192 | 373 | G1-2 | 0.2536 |
| 174 | O1-5 | 0.6188 | 374 | U1-9 | 0.2505 |
| 175 | F1-8 | 0.6148 | 375 | A1-9 | 0.2503 |
| 176 | W1-2 | 0.6148 | 376 | I2-7 | 0.2448 |

| | | | | | |
|---|---|---|---|---|---|
| 177 | Y1-9 | 0.6128 | 377 | W1-8 | 0.2446 |
| 178 | U1-1 | 0.6098 | 378 | F1-2 | 0.2444 |
| 179 | W1-10 | 0.6055 | 379 | J2-7 | 0.2411 |
| 180 | R1-3 | 0.6022 | 380 | A2-1 | 0.241 |
| 181 | L1-3 | 0.6011 | 381 | A1-2 | 0.2324 |
| 182 | S1-5 | 0.5999 | 382 | X1-2 | 0.2319 |
| 183 | Z1-3 | 0.5998 | 383 | D2-8 | 0.2245 |
| 184 | M2-9 | 0.5971 | 384 | P1-1 | 0.2235 |
| 185 | H2-1 | 0.5937 | 385 | D2-6 | 0.2212 |
| 186 | D1-9 | 0.5932 | 386 | X1-9 | 0.2207 |
| 187 | T1-2 | 0.5915 | 387 | O1-9 | 0.2185 |
| 188 | Y1-8 | 0.5894 | 388 | P1-2 | 0.2178 |
| 189 | J1-9 | 0.5839 | 389 | L1-7 | 0.2176 |
| 190 | Y1-2 | 0.5826 | 390 | D1-6 | 0.2167 |
| 191 | Z1-10 | 0.5785 | 391 | T1-3 | 0.2151 |
| 192 | G2-6 | 0.5769 | 392 | Q1-2 | 0.2143 |
| 193 | V1-9 | 0.5756 | 393 | W1-6 | 0.2134 |
| 194 | T1-4 | 0.5755 | 394 | H1-2 | 0.2128 |
| 195 | Q1-8 | 0.5746 | 395 | O2-3 | 0.2113 |
| 196 | E2-5 | 0.5743 | 396 | F1-6 | 0.2082 |
| 197 | N2-5 | 0.5736 | 397 | D2-1 | 0.2077 |
| 198 | X1-6 | 0.5729 | 398 | C2-8 | 0.2052 |
| 199 | S1-10 | 0.5723 | 399 | C1-1 | 0.2005 |
| 200 | J2-3 | 0.5723 | 400 | I2-9 | 0.1995 |

# Chapter V Enterprise Relationship Network Analysis Based on SNA Method

Apart from geographical dimension and industrial dimension, cluster researchers realize another important dimension of industrial cluster – network dimension. That is, cluster does not mean simple gathering of numerous middle and small-sized enterprises. The interaction among different cluster enterprises often includes specific capacity, position and mutual trust of enterprises in the cluster network. Storper et al. (1992) pointed out a new feature of cluster research was to shift the attention from transportation cost of cluster and inter-enterprise input-output relation to cluster internal institution, social culture and network.

The social network connection among park enterprises is an inexhaustible impetus for industrial cluster to gain competitive edges. Cluster grows out of industrial park, and technical expertise, investment information and market information lay a realistic foundation for the social network of cluster enterprises. Besides, knowledge flow in industrial cluster is realized mainly through cooperation. For example, joint purchase and sale, joint project contracting, service relation, subcontract relation and financial relation of cluster enterprise will be transferred and diffused with knowledge. In other words, technical expertise, market knowledge and cooperation are often a major part of the social network of cluster enterprises, and technical support, market information and partnership of cluster enterprises will guide the development direction of the entire cluster. Thus, the social network of cluster enterprises under industrial park mode is divided into technical network, market network and cooperative network in this study.

In turn, these social relations affect the main composition and development of the social network of cluster enterprises and further the innovation performance of park enterprises. It is just the core research topic of this study and the starting point and the objective of the studies of social relations of enterprises.

Based on the field investigation of industrial parks of Shenzhen City, the author tries to study how node members form the social network of park enterprises, the position of different nodes in the network, their network relations and the similarities and dissimilarities in the network structure and network relation.

## 5.1 Social Network Analysis (SNA) and Data Collection

Social network analysis (SNA) is a research and analysis method specifically for social relation. Natural person and legal person in the society are not a simple individual but a social person directly or indirectly connected to others and the whole society is a social network comprised of social persons. The network includes the relations between nodes and SNA is to analyze the relations in the network and discuss the structure and attributes of the network. UCINET is a kind of powerful and commonly-used social network analysis software developed by Linton Freeman, an authoritative scholar from University of California, for ease of social network analysis. Since UCINET can only identify unique file formats, 0-1 matrix of EXCEL must be converted using UCINET into data files that UCINET can identify before analyzing and studying enterprise relationship network.

The author analyzes the characteristics and structure of technical network, market network and cooperative network of cluster enterprises using Social Network Analysis and analysis software UCINET6.0 and attaches importance to the information value and controlling advantage of the network structure and position of cluster enterprises. The author has an insight into SNA, a "morphological" and "painting" technique, and the deep implication to display who owns resources and who can provide necessary resources in the same network. Attribute data and relational data of enterprises are collected with the support of enthusiastic persons from related departments and the interview results in Appendix 1 and Appendix 2. We first select representative enterprise numbers and make a list. Then, we ask the interviewed responsible persons of enterprises to fill in the serial number of node unit of each relation. We assign the value of related enterprise as 1 and that of unrelated enterprise as 0 by questionnaire. In that case, cluster with n sample nodes will get 3 n*n network structure matrixes and their network rules will be identified using UCINET6.0 analysis and based on specific features of cluster.

There are many variables reflecting the network structure characteristics of industrial cluster, but the author only analyzes major variables from the level of overall structure and individual structure of network and focuses on analyzing network density and individual network structure. Individual network structure is mainly used to measure degree centrality index, out-degree centrality index, in-degree centrality index and betweenness index of a single node.

5.1.1 Network Density

Network density is one of the most important overall structure attributes of network and is the ratio between the quantity of the actual correctly connected nodes and the possibly correctly connected nodes in the network. A high-density network can be defined as the connection of plenty of network nodes.

If an integrated network is an undirected relational network with g doers (nodes), the theoretical maximum probable value of the number of relations contained should be g(g-1)/2. If the actual number of relations contained in the network is L and network density is expressed by ND, the density of the network is "the actual number of relations" divided by "the theoretical maximum number of relations", namely $ND = \frac{L}{g(g-1)/2} = \frac{2L}{g(g-1)}$. If the integrated network is a directed relational network with g doers, the theoretical maximum value of the total number of relations contained may be g(g-1). If the actual number of relations contained in the network is $\sum_{i=1}^{g}\sum_{j=1}^{g} x_{ij}$, i=1~g, j=1~g, $x_{ij}$ is the relations among doers i-j, the density of the network is:

$$ND = \frac{\sum_{i=1}^{g}\sum_{j=1}^{g} x_{ij}}{g(g-1)} \qquad (5\text{-}1)$$

The value of density ND is 0-1. The closer the density value approaches 1, the denser the network; otherwise, the sparser the network. The above formula shows that network density ND is mainly determined by the actual number of relations L in the industrial cluster or $\sum_{i=1}^{g}\sum_{j=1}^{g} x_{ij}$. If L or $\sum_{i=1}^{g}\sum_{j=1}^{g} x_{ij}$ is too high, nodes are connected too closely and there will be plenty of redundant information. If L or $\sum_{i=1}^{g}\sum_{j=1}^{g} x_{ij}$ is too low, nodes are connected too sparsely and knowledge diffusion and flow will be inadequate. Thus, too low network

density is bad for exchange and information sharing of enterprise in the network.

5.1.2 Degree Centrality

Degree centrality is an important network individual structure characteristic and it is an index used to measure the structure and position of a single doer (node) in the network and determine the central person with the best reputation, highest status and greatest power in the network. Degree centrality refers to the total number of various doers connected to a doer in the network. The more closely a doer is connected to doers around, the higher degree centrality is and the more important the doer is in the network, since it is easier for them to acquire information and innovative resources, so as to build prestige in the entire cluster.

For undirected relational network, degree centrality can be figured out using the following formulas. Formula (5-2) is an absolute value and Formula (5-3) is a standard value. Formula (5-2) adds the total number of relations of a doer and Formula (5-3) divides it by the maximum number of relations in the network to compare different networks.

$$C_D(i) = d(i) = \sum_j x_{ij} = \sum_i x_{ij} \quad (5\text{-}2)$$

$$C_{DS}(i) = \frac{C_D(i)}{g-1} = \frac{d(i)}{g-1} \quad (5\text{-}3)$$

If $x_{ij}$ is 0 or 1, it means whether doer j admits that it is related to doer i and g still represents the number of doers in the network. Since the number of nodes in every network is different and there are a lot of big network nodes and relations, the maximum probable number of relations of a node in the network should be divided in the standardization process, namely g-1 relations.

For directed relational network, the degree centrality of a node in the directed graph is divided into two different indexes according to different relation directions among different nodes, namely out-degree centrality and in-degree centrality. Out-degree centrality is the total number of external relations of a node and it is manifested as a node pointing at other nodes in the graph. It is the sum of row data in the directed graph matrix and can be figured out using the following formulas. Formula (5-4) is an absolute value and Formula (5-5) is a standard value:

$$C_{DO}(i) = d_O(i) = \sum x_{ij}, i \neq j \quad (5\text{-}4)$$

$$C_{DO_S}(i) = \frac{d_O(i)}{g-1} = \frac{\sum x_{ij}}{g-1}, i \neq j \quad (5\text{-}5)$$

In-degree centrality is the total number of other nodes connected to a node and it is manifested as other nodes pointing at a node in the graph. It is the sum of column data in the directed graph matrix and can be figured out using the following formulas. Formula (5-6) is an absolute value and Formula (5-7) is a standard value:

$$C_{DI}(i) = d_I(i) = \sum x_{ij}, i \neq j \quad (5\text{-}6)$$

$$C_{DI_S}(i) = \frac{d_I(i)}{g-1} = \frac{\sum x_{ij}}{g-1}, i \neq j \quad (5\text{-}7)$$

5.1.3 Betweenness

Betweenness is another important network individual structure characteristic which reflects the ability of a doer to be a communication medium of other doers, namely the person in the shortest distance of another two persons in a relational network. If this person refuses the medium, the other two persons cannot communicate. The more positions are occupied, the higher rights this person has than the other persons and the more persons must communicate

through this person. In fact, such key persons with a mediating effect are the "bridge" in Burt's "Structural Holes". When a big network is split, the person who acts as a bridge plays a critical role in information exchange, opinion communication and action coordination, and betweenness is used to measure the involvement level of a person as a bridge in Social Network Analysis.

In Freeman's point of view, betweenness is used to measure the probability that a node or an organization appears on the geodesic of a network. In the undirected relational network, the geodesic is the shortest distance between another two points. Suppose $g_{jk}$ is the number of shortcuts (a path, through which the fewest persons reach the destination), through which doer j reaches doer k, $g_{jk}$ (i) is the number of shortcuts of doer i on the shortcut, through which doer j reaches doer k and g is the number of persons in the network. If all shortcuts may be selected by j and k equally, the probability of selecting a specific shortcut is $\frac{1}{g_{jk}}$ and the probability that j and k select a shortcut containing i is $B_{jk} = \frac{g_{jk}(i)}{g_{jk}}$, then, betweenness of doer i is equal to the sum of all two-dimension probabilities in the network and it can be figured out using the following formulas. Formula (5-8) is an absolute value, Formula (5-9) is a standard value of the undirected relational network and Formula (5-10) is a standard value of the directed relational network:

$$C_B(i) = \sum_j^g \sum_k^g B_{jk}(i), i \neq j \neq k \quad (5\text{-}8)$$

$$C_{B_S}(i) = \frac{2C_B(i)}{(g-1)(g-2)} = \frac{2C_B(i)}{g^2-3g+2} \quad (5\text{-}9)$$

$$C_{B_S}(i) = \frac{C_B(i)}{(g-1)(g-2)} = \frac{C_B(i)}{g^2-3g+2} \quad (5\text{-}10)$$

## 5.2 Enterprise Relationship Network Construction

5.2.1 Genetic relationship Network Structure

The genetic relationship network in this study refers to the network comprised of the genetic relations among enterprises in the industrial park, and it represents the direction and degree of the genetic relations among nodes. For the genetic relationship network of cluster, the author designs “which enterprise do you have a genetic relationship with” and “the degree of genetic relationship” and carries out questionnaire survey to confirm whether enterprises have a genetic relationship.

Survey on cluster enterprises in industrial parks of Shenzhen shows that the genetic relationship network of industrial parks of Shenzhen City is obviously a core-periphery structure. On one hand, core enterprises are closely connected; on the other hand, peripheral enterprises especially core enterprises are loosely connected, and peripheral nodes are rarely connected and even they are unconnected. Moreover, node unit without genetic relationship accounts for 22.3% of all nodes, of which manufacturing enterprises account for 35.7%, service enterprises account for 53.6% and intermediaries account for 10.7%. After enterprises closely connected to cluster enterprises of industrials parks of Shenzhen are eliminated, the number of isolated points in the whole genetic relationship network increases and the relational network becomes sparse. It can be seen that besides a few core enterprises, enterprises that introduce and absorb coding knowledge are of very great importance for the genetic relationship network of the entire cluster.

The density value of the core-periphery clusters of the genetic relationship network of industrial parks of Shenzhen is shown in Table 10.

Table 10. The density value of the core-periphery clusters of the genetic relationship network

| | Before closely connected enterprises are eliminated | | After closely connected enterprises are eliminated | |
|---|---|---|---|---|
| | Core | Periphery | Core | Periphery |
| Core | 0.950 | 0.016 | 0.571 | 0.047 |
| Periphery | 0.151 | 0.019 | 0.101 | 0.014 |

As shown in Table 10, the core-core density value (0.950/0.571) is far greater than the periphery-periphery density value (0.019/0.014), and the periphery-core density value (0.151/0.101) is greater than the core-periphery density value (0.016/0.047). It worth noting that the density of core cluster is several times higher than the average density of network, but the periphery density of network is lower than the average density, which demonstrates the cohesion of core and shows that peripheries are around the core. Except technical centers, industry associations and scientific research institutions of universities, the core-core density value (0.571), the periphery-periphery density value (0.014) and the periphery-core density value (0.101) of genetic relationship network are lower than the network density value before these nodes are eliminated and only the core-periphery density value (0.047) increases. The degree centrality of technical centers, industry associations and scientific research institutions of universities is 14.050, 13.223 and 11.570, which is higher than the degree centrality of most cluster enterprises.

As shown in Table 10, four core enterprises in the cluster have high centrality up to 16.322 on average, the average degree centrality of the weakest nodes is 1.446 and the in-degree centrality of core enterprises is higher than the out-degree centrality. This shows that key enterprise in the industrial park plays a critical role in knowledge exchange and information transfer, which is mainly related to a close genetic relationship among these enterprises. Nevertheless, small enterprises have a weaker genetic relationship and their

employees with blood relation are almost common workers with blood relation apart from the business owner. For example, a couple works as common workers respectively in two enterprises in the park. They are relatively not strong in speciality. As the R&D base of the park, core enterprises act in close cooperation and exchange with each other and their new knowledge will infiltrate into adjacent small enterprises with business contact. Especially after people with blood relation master certain knowledge, they will spread experience to other family members while coming into contact with other enterprises. In addition, these core enterprises have high betweenness in the whole network, indicating that they not only own plenty of knowledge resources, but also are the controller of resource allocation of the whole network. They act as the "family gatekeeper" in the genetic relationship network mainly probably because they frequently get in touch with scientific research institutions of universities or government sectors while acquiring external knowledge resources, but some middle and small-sized enterprises seldom and even do not contact these institutions. Scientific research institutions of universities or government sectors must input new knowledge into the whole cluster through these core family firms.

5.2.2 Geographical Relationship Network Structure

The geographical relationship network in this study refers to the network comprised of the geographical relations and exchange relations among cluster enterprises and such geographical information mainly refers to town fellow relationship. Specific to the geographical consulting relationship among all node units in the cluster, the author designs two problems of "geographical relationship". According to survey on the geographical relationship of

industrial parks in Shenzhen, the geographical relationship network of enterprise consists of two groups, namely two sub-groups, with certain differences and they are called big group and small group respectively. The big group contains four core enterprises, many formal enterprises and a few quasi enterprises, whose network structure is a multi-center cored structure. The small group has no core enterprises and the largest number of middle and small-sized enterprises, followed by quasi enterprises (e.g. workshops or studios) and the smallest number of formal enterprises, whose network structure is a coreless structure. Both sub-groups have intermediary or service agencies, the big group has more intermediary or service agencies than the small group, and intermediary or service agencies of the big group have far more network relations than the network relations of corresponding nodes in the small group. Isolated points account for 17.21% of nodes in the whole network, of which enterprises account for 38.10%, institutions account for 47.62% and intermediary or service agencies account for 14.28%.

The ratio between the number of key node members in two sub-groups of industrial parks of Shenzhen and the number of members in the whole network is shown in Table 11.

Table 11. The ratio between the number of key node members (excluding isolated points) in two sub-groups of industrial parks of Shenzhen and the number of members in the whole network

| | Big group (%) | Small group (%) |
|---|---|---|
| Core enterprise | 3.28 | 0 |
| Formal enterprise | 22.13 | 6.56 |
| Quasi enterprise | 8.20 | 13.11 |
| Institution | 11.48 | 9.84 |

| | | |
|---|---|---|
| Intermediary or service agencies | 3.28 | 4.91 |

As shown in Table 11, nodes in the big group have higher degree centrality than those in the small group, indicating that the doers in the big group have more geographical relations than those in the small group. As a result, the doers of the big group acquire more diversified information resources in the local geographical knowledge system.

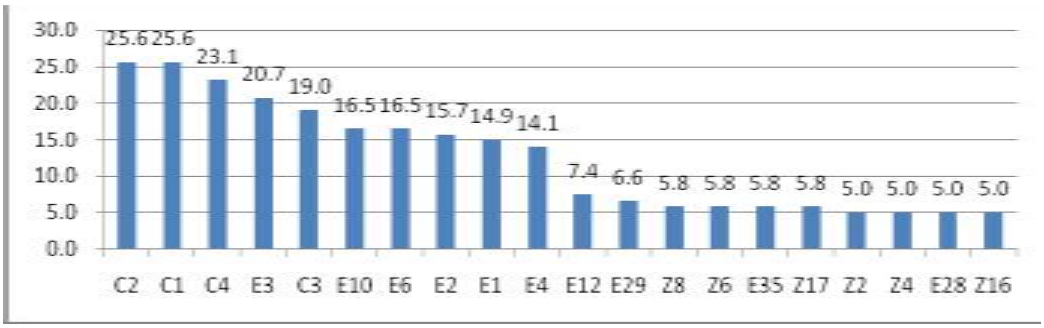


Fig 4. Degree centrality of geographical relationship network of industrial parks of Shenzhen

Although the whole geographical relationship network is divided into two groups, the big group is closer and has higher cohesion, but the small group is not dictatorial and consequently internal struggle and divergence are caused. Investigation shows that such phenomena also exist in the two groups. The investigated several large enterprises, serving as the cluster leader, have a very complicated geographical relationship both inside and outside. For example, Enterprise C1-1 not only is restricted to the geographical relationship among its shareholders, but also has a broad geographical relationship with senior management of upstream and downstream enterprises. Thus, many middle and small-sized enterprises unequal in size will gather around these core enterprises and finally they will form a big group. Small group has a small production scale and a single variety of products and their owners are so

conservative that they seldom contact the outside let alone directly have contact with large enterprises but wait for negotiating with an agent, but they have a small geographical group. For example, the closely connected enterprises discuss market condition, which shows a distant group structure.

5.2.3 Karmic Connection Network Structure

The karmic connection network structure in this study refers to the network comprised of the relationship between colleagues of cluster enterprises. For the karmic connections among nodes in the network, the author designs a series of questions on “karmic connection”, as shown in Appendix 1 and Appendix 2. Survey and analysis of industrial parks of Shenzhen City show the karmic connection network is dense and most nodes are connected in the network. The degree centrality of the karmic connection network of industrial parks of Shenzhen City is shown in Fig. 5.

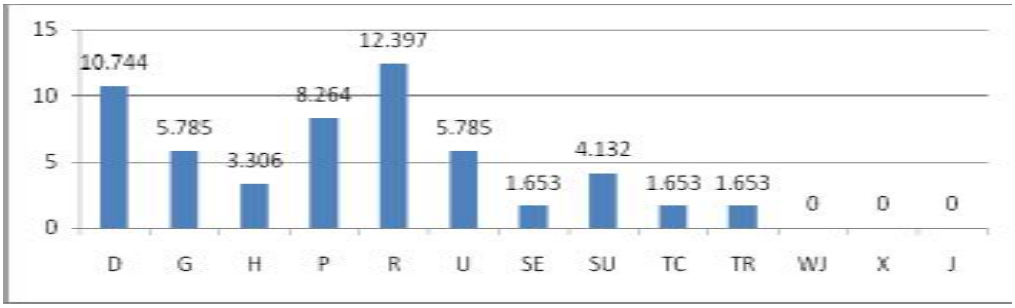


Fig 5. Degree centrality of karmic connection network of industrial parks of Shenzhen

As shown in Fig. 5, except the three isolated points WJ, X and J, D, G, H, P, R and U are in the big group, and SE, SU, TC and TR are in the small group. The degree centrality of karmic connection of intermediary and service agencies in the big group is higher than that of the small group. Except core enterprises, intermediary and service agencies are an important bridge of the karmic connection among cluster enterprises. Enterprise A1-4 has the highest degree centrality up to 12.397, most cluster enterprises are karmically

connected and many middle and small-sized enterprises acquire market information outside the cluster.

In the whole network, the top four betweenness indexes are C1-1 (11.577), F1-10 (6.670), D1-3 (6.307) and Z1-7 (5.657). This study shows that core enterprises are a key medium as they often have broad and complex karmic connection and frequently get in touch with enterprises outside the park, which will help them acquire more valuable or applicable market information at a low cost; while other middle and small-sized enterprises in the park tend to acquire new market information indirectly from large enterprises. According to investigation, core enterprises will, as the coordinator of various relations in the karmic connection network, negotiate with related enterprises and institutions about fixing the prices, so as to contain the instability arising from vicious competition. In the karmic connection network, some other institutions than core enterprises can also function as a bridge, since ordinary enterprises often acquire market information from institutions with karmic connection. These institutions can act as a bond between ordinary enterprises and large enterprises. Generally speaking, cybermediary plays a very important role in motivating network members to learn from each other, especially for park enterprises, a kind of competitive network with a lot of horizontal ties. In a competitive network, node members are reluctant to abandon the barrier enabling them to retain competitive edges and inclined to minimize network communication, so they learn less than other network members. In this case, a powerful karmic connection cybermediary is quite necessary for the formation and maintenance of network relation and it will

help to promote information openness and create network atmosphere necessary for a successful “learning” process.

5.2.4 Scholarship Network Structure

The scholarship network structure in this study refers to the network comprised of the learning relationship among cluster members, and the scholarship of industrial parks of Shenzhen City focuses on horizontal classmate and vertical schoolmate relations. For the scholarship among nodes in the network, the author designs investigation of the educational background of business owner or senior management. Survey and analysis of industrial parks of Shenzhen City show the scholarship network is very dense. The scholarship network relation of the cluster is horizontal and complementary horizontal scholarship, and enterprises with similar competitiveness share public resources of the cluster jointly. The degree centrality of the scholarship network structure of enterprises in industrial parks of Shenzhen City is shown in Fig. 6.

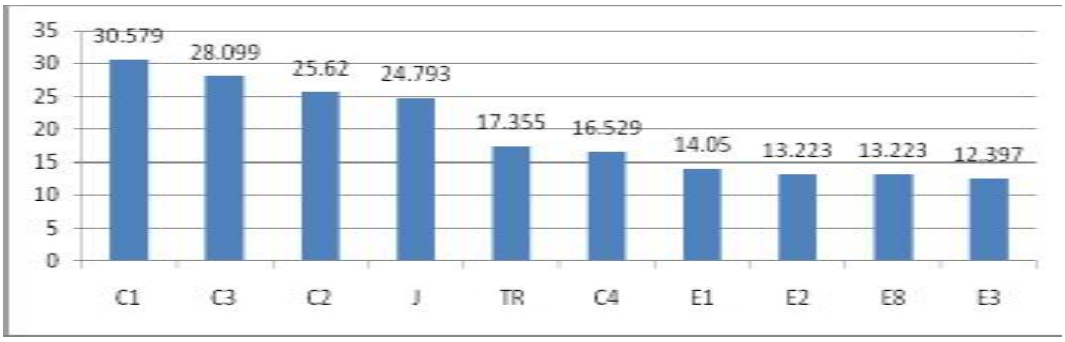


Fig 6 Degree centrality of scholarship network of industrial parks of Shenzhen

A few core enterprises among network members still have the highest degree centrality. Fig. 6 shows the nodes with top 10 degree centrality. For one thing, core enterprises have a close scholarship, which is mainly reflected in

classmate connection. For another, as the “leader” of the cluster, they contact more frequently than classmates of other middle and small-sized enterprises. Obviously, although these core enterprises have obvious competitive edges, they are not conservative but carry out external exchange by classmate relationship. In the accumulated scholarship network relation, they reduce opportunism and keep a good reputation to attract more classmates to have exchanges.

Intermediary (training and learning) organizations and service agencies play a critical role in building a scholarship network among enterprises and institutions. In the scholarship network, the degree centrality of financial (investment counseling) institutions and HR training organizations is 24.793 and 17.355, ranking 4$^{th}$ and 5$^{th}$ among all nodes. For betweenness index, financial (investment counseling) institutions (12.739) and HR training organizations (4.650) rank 1$^{st}$ and 6$^{th}$ among all nodes. Compared with vertical network, enterprises in the horizontal network have less scholarship, and training and educational organizations, such as study classes opened by some universities in the industrial park, play a critical part in scholarship of enterprises.

Based on the above analysis, the SNA result of genetic relationship, geographical relationship, scholarship and karmic connection is basically consistent with the result acquired and inferred from interview, survey and grounded theory, which further demonstrates the function of informal institution in industrial park. Subsequent regression analysis will be carried out with the density of park enterprise relationship as a major variable to avoid colinearity. The author does not assign value to the density of non-business

relation network comprised of genetic relationship, geographical relationship, scholarship and karmic connection but calculates enterprise relationship density using Formula (5-1) through technical network, market network and cooperative network from a general perspective and from the perspective of business relation.

## 5.3 Position Analysis of Enterprise in Enterprise Relationship Network

Enterprise relationship network position refers to the spatial position of enterprise in the park enterprise relationship network. Enterprise relationship network position attribute is mainly measured by centrality. It is the concrete embodiment of rank and order in the network structure and a way of measuring the power and status of enterprise in the network that reflects to what degree the enterprise is in the core position of the network. The higher the centrality of individuals in the network is, the greater power is and the higher status is. Centrality is the concentrated reflection of corporate recognition, reputation and the ability to acquire and control information and resources through direct or indirect relation. Park enterprise with high centrality can help create a way for high-benefit network to acquire resources, and marginal enterprise rarely acquires information inside the network. Other enterprises in the network know nothing about the resource quality of marginal enterprise and can hardly exchange with them too much, since a very long recommendation chain is needed for communication. At the same time, centrality represents the possibility to influence and control others' behavior and even thinking ability, and paramount and powerful enterprises are more likely to achieve this goal through intercepting information flow or distorting

information content during information transfer. What's more, the enterprise relationship network in the network center can acquire more complementary management skills, professional knowledge and skills, cross-regional knowledge, industry experience, technology and innovation, investment opportunity and lessons from failure from other enterprises to bring certain influence to surrounding enterprises. Centrality of point is the most common index used to measure enterprise relationship network position attribute and it is an important index to evaluate the power, influence and prestige of an enterprise relationship network in the social network, including degree centrality, betweenness, closeness centrality, feature vector centrality and power index. Despite different connotation and application scope, these five indexes represent the central position of the doer in the network in varying degrees. The enterprise relationship network position attribute in this study refers to centrality attribute.

5.3.1 Degree Centrality Analysis

The degree centrality of point can be divided into absolute degree centrality and relative degree centrality. The absolute degree centrality of a point is the number of other points directly connected to this point; the relative degree centrality is the standard form of the absolute degree centrality and the ratio between the absolute degree centrality of point and the maximum probable degree of points in the network. For example, in N point diagram, the maximum probable value of the degree of any point is N-1. If the absolute centrality of point VIII is X, its relative degree centrality is X/N-1. In the social network, the higher the degree centrality is, the more enterprises will directly cooperate with an enterprise, the more profits the enterprise will

obtain from informal institution, and the higher the possibility of resource integration or sharing is, so as to realize joint investment or operation and increase influence. Besides, the higher the degree centrality, the more resources such as information and transaction flow enterprise owns in the network. Overseas researchers prove without exception that higher degree centrality of the social network of enterprises promotes harmonious cooperation among enterprises, growth of enterprises and the construction of regional innovative economy.

The degree centrality of sample enterprise is calculated using UCINET6.0. Table 12 shows the statistical data of the degree centrality.

Table 12. Statistical data of degree centrality

| | Absolute degree centrality | Relative degree centrality (%) | Relation share |
|---|---|---|---|
| Mean value | 6.882 | 1.855 | 0.003 |
| Standard deviation | 7.989 | 2.153 | 0.003 |
| Minimum value | 1 | 0.270 | 0 |
| Maximum value | 64 | 17.251 | 0.025 |

As shown in Table 12, the minimum value of the absolute degree centrality of 400 enterprises is 1, the maximum value is 64, the mean value is 6.882 and the standard deviation is 7.989. The minimum value of the relative degree centrality is 0.27%, the maximum value is 17.251%, the percentage of the maximum value is 2.5%, the mean value is 1.855% and the standard deviation is 2.153%. On the whole, enterprises in the industrial parks of Shenzhen are not connected closely, about 7 times on average, and there are big differences among different parks.

Table 13 shows enterprises with top 10 degree centrality.

Table 13. Enterprises with top 10 degree centrality in the whole network

| No. | Enterprise code | Absolute degree centrality | Relative degree centrality (%) | Relation share |
|---|---|---|---|---|
| 1 | C1-1 | 64 | 17.251 | 0.025 |
| 2 | T1-8 | 58 | 15.633 | 0.023 |
| 3 | R1-6 | 47 | 12.668 | 0.018 |
| 4 | G1-1 | 37 | 9.973 | 0.014 |
| 5 | U1-9 | 36 | 9.704 | 0.014 |
| 6 | B2-4 | 33 | 8.895 | 0.013 |
| 7 | X1-6 | 30 | 8.086 | 0.012 |
| 8 | I1-6 | 28 | 7.547 | 0.011 |
| 9 | W1-9 | 28 | 7.547 | 0.011 |
| 10 | K2-1 | 28 | 7.547 | 0.011 |

Table 13 shows the highest degree centrality of enterprise C1-1, followed by T1-8. The relative degree centrality of C1-1 is 17.251% and the absolute degree centrality is 64, indicating its direct cooperation with 64 enterprises in the network. The relation share is 0.025, indicating that the number of relations with other enterprises in the network accounts for 1/40 of the total number of relations and C1-1 has higher degree centrality than other enterprises.

Table 14 shows the absolute degree centrality of all 400 enterprises.

Table 14. Absolute degree centrality distribution of all enterprises

| Range of absolute degree | 1 | 2 | 3 | 4 | 5 | 6-10 | 11-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 54 | 59 | 66 | 47 | 29 | 76 | 46 | 17 | 3 | 1 | 1 | 1 |

Table 14 shows there are only 3 enterprises whose absolute degree centrality is above 40 and that account for less than 1%, while enterprises whose

absolute degree centrality is 10 or below account for 82.75%. It indicates that the degree centrality of enterprises in the network is distributed not uniformly, and most enterprises have low degree centrality and rarely cooperate and exchange with other enterprises. Only a few enterprises have high degree centrality. They frequently cooperate and exchange with other enterprises and are in the center position of the network.

5.3.2 Betweenness Centrality Analysis

Betweenness Centrality refers to the degree to which a node occupies the center position on the shortest route to other nodes to take the center position of the network for other nodes. It represents the degree to which a node is in the center of other nodes in the network and controls others. If the degree centrality measures the direct cooperative ability of enterprises in the network, betweenness measures the intermediate ability and control ability of an enterprise and it is the ability to gather the unrelated enterprises with complementary skills or complementary cooperation opportunities. In the social network, it represents the ability of an enterprise to control contact of other enterprises. The larger the value is, the stronger the control ability is and the higher the position in the network is.

The betweenness index of sample enterprise is calculated using UCINET6.0. Table 15 shows the statistical data of betweenness.

Table 15. Statistical data table of betweenness

| | Absolute betweenness | Relative betweenness |
|---|---|---|
| Mean value | 114.80 | 0.31 |
| Standard deviation | 28.15 | 0.08 |

| | | |
|---|---|---|
| Minimum value | 2.00 | 0.01 |
| Maximum value | 191.50 | 0.52 |

As shown in Table 15, betweenness of sample enterprise is not very high, the mean value of absolute betweenness is 114.80 and that of relative betweenness is 0.31. There is a big difference between the maximum value and the minimum value. The standard deviation is not too high, indicating that betweenness of most enterprises is distributed centrally.

Table 16 shows enterprises with top 10 betweenness.

Table 16. Enterprises with top 10 betweenness in the whole network

| No. | Enterprise code | Absolute betweenness | Relative betweenness |
|---|---|---|---|
| 1 | C1-1 | 191.50 | 0.52 |
| 2 | U1-9 | 189.47 | 0.51 |
| 3 | R1-6 | 178.98 | 0.48 |
| 4 | T1-8 | 166.53 | 0.45 |
| 5 | I1-6 | 164.61 | 0.44 |
| 6 | B2-4 | 163.53 | 0.44 |
| 7 | K2-1 | 162.48 | 0.44 |
| 8 | G1-1 | 161.99 | 0.44 |
| 9 | X1-6 | 159.50 | 0.43 |
| 10 | W1-9 | 156.74 | 0.42 |

Table 16 shows the highest betweenness of C1-1, followed by U1-9. It indicates that they are in the center position of the network and they can benefit from informal institution more. Compared with the degree centrality, enterprises with high degree centrality often have high betweenness, and degree centrality is highly consistent with betweenness.

Table 17 shows betweenness distribution of all 400 enterprises.

Table 17. Betweenness distribution of all enterprises

| Betweenness centrality range | 2-30 | 30-60 | 61-90 | 91-110 | 111-130 | 131-150 | 151-170 | 171-200 |
|---|---|---|---|---|---|---|---|---|
| Number of enterprises | 5 | 12 | 40 | 115 | 129 | 78 | 18 | 3 |

As shown in Table 17, betweenness of enterprises in the network is distributed not uniformly, high in the middle and low on both ends. Enterprises whose betweenness is 90-130 account for 61% and enterprises on both ends account for only nearly 2%. It indicates that betweenness of most enterprises in the network is at a medium level and very few enterprises have high betweenness.

5.3.3 Closeness Centrality Analysis

Closeness Centrality measures the degree of not being controlled by others. If a point has a very short “distance” from other points in the network, it means that this point is very close to other points and it has high closeness centrality. Thus, the closeness centrality of point i can be expressed by the sum of shortcuts between this point and other points in the network using Formula $C_i = \sum_{j=1}^{n} d_{ij}$, of which $C_i$ is the absolute closeness centrality and $d_{ij}$ is the shortcut distance between point i and point j. Only when the distance between a point and other points in the network is 1, the absolute closeness centrality $C_i$ is the smallest and the minimum value is n-1. Thus, the relative closeness centrality $C_{i(nrm)}$ can be expressed by the absolute closeness centrality dividied by n-1, namely $C_{i(nrm)} = C_i/(n-1)$. The smaller $C_{i(nrm)}$ is, the larger the closeness centrality is. If betweenness is an index measuring the ability of a point to control others in the network, the closeness centrality is an

index measuring the ability of a point not to be controlled by others in the network.

The closeness centrality of sample enterprises is calculated using UCINET6.0. Table 18 shows the statistical data of closeness centrality.

Table 18. Statistical data of closeness centrality

| | Absolute betweenness | Relative betweenness |
|---|---|---|
| Mean value | 9619.96 | 26.13 |
| Standard deviation | 137641 | 371 |
| Minimum value | 5052 | 13.98 |
| Maximum value | 19381 | 7.23 |

As shown in Table 18, the mean value of absolute closeness centrality of enterprises in the network is 9619.96 and that of relative closeness centrality is 26.13, indicating that the closeness centrality of enterprises in the industrials parks of Shenzhen is not high enough on the whole. The maximum value of relative closeness centrality is 371, the minimum value is 13.98, there is a big difference between the maximum value and the minimum value and the standard deviation is 7.23, indicating that the closeness centrality of enterprises in the industrial parks is distributed not uniformly and there is a huge difference between the maximum value and the minimum value.

Table 19 shows enterprises with top 10 closeness centrality.

Table 19. Enterprises with top 10 closeness centrality in the network

| No. | Enterprise code | Absolute closeness centrality | Relative closeness centrality |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | C1-1 | 191.50 | 0.52 |
| 2 | U1-9 | 189.47 | 0.51 |
| 3 | I1-4 | 178.98 | 0.48 |
| 4 | B2-4 | 166.53 | 0.45 |
| 5 | A2-7 | 164.61 | 0.44 |
| 6 | T1-8 | 163.53 | 0.44 |
| 7 | R1-6 | 162.48 | 0.44 |
| 8 | K2-1 | 161.99 | 0.44 |
| 9 | K1-10 | 159.50 | 0.43 |
| 10 | I1-6 | 156.74 | 0.42 |

Table 19 shows the highest closeness centrality of C1-1 among enterprises with top 10 closeness centrality, followed by U1-9. It indicates that they are closer to other enterprises and they are hard to be controlled by other points. Compared with betweenness, enterprises with high betweenness often have high closeness centrality and betweenness is highly consistent with closeness centrality.

According to survey and data analysis, there are certain differences in the relations among enterprises in the industrial parks of Shenzhen and their positions. The position in the enterprise relationship network, the relation with industrial cluster and whether they affect enterprise innovation performance will be explored below through empirical analysis.

# Chapter VI Research Design

## 6.1 Research Method and Basic Model

### 6.1.1 Regression Equation Model

A core problem of this study is how the innovation performance of cluster enterprises under industrial park mode is. Based on the thinking and evolution of the core problem, this study will focus on investigating the influence of industrial cluster on enterprise innovation performance, with enterprise relationship and informal institution as intermediate variables.

Since the relationship between enterprises in the park and informal system are taken as intermediate variables, they are objectively existing, i.e. exogenous variables, since they are independent from the operation of industrial parks and enterprises in the park. However, for industrial clusters, the operation of industrial parks is endogenous to the relationship between enterprises and informal institutions. In other words, there is an interactive relationship among the three, and they work together to form industrial agglomeration effect and affect the innovation performance of enterprises, as shown in FIG. 7, which can constitute the basic theoretical framework of this study.

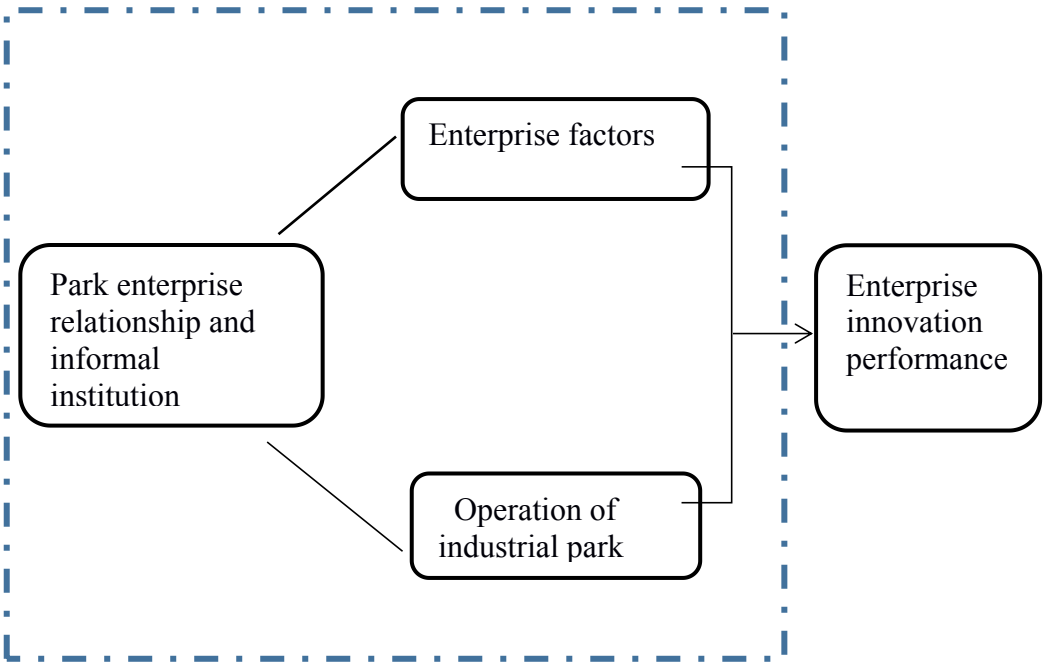


Fig 7. Theoretical framework diagram

Based on the above theoretical framework diagram and according to the author's years of experience in management of industrial park and plenty of previous document researches, surveys and interviews, in order to explore the innovation performance of cluster enterprises under industrial park mode, this study builds a theoretical model with innovation performance of cluster enterprise as the orientation and from the perspective of enterprise, industrial park management, park enterprise relationship and informal institution, as shown in Fig. 8. Industrial park management can directly affect enterprise innovation performance and may affect enterprise innovation performance through park enterprise relationship and informal institution, that is, enterprise relationship and informal institution have a mediating effect. Empirical analysis will be carried out in this study.

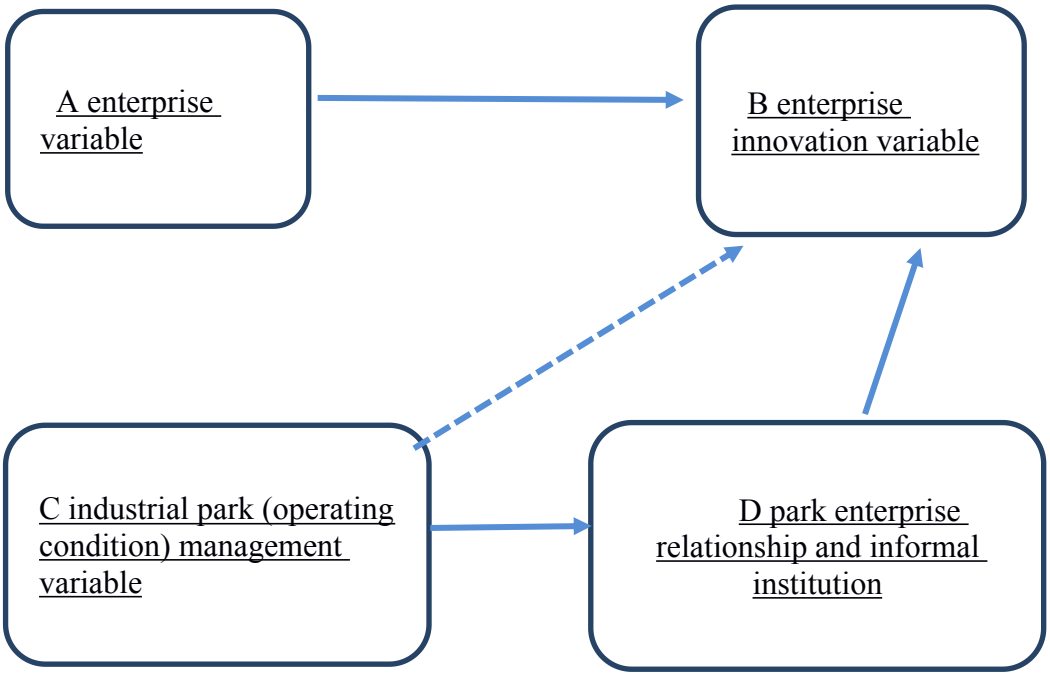


Fig 8. Theoretical model diagram

According to this theoretical model, variables are designed in this study, as shown in Table 20.

Table 20. Variable table

| **Variable type** | **Variable dimension** | **Variable** | **Symbol** | **Description** |
|---|---|---|---|---|
| Explained variable | Enterprise innovation variable | Innovation performance | Inno | The score of innovation performance of all enterprises has been calculated above. |
| Explanatory variable | Enterprise variable | Incorporation time | Time | Use incorporation time as an index. Data is acquired through survey or statistics of industry and commerce departments. |
| | Enterprise variable | Position in the enterprise relationship network | Posi | The absolute betweenness of the closeness centrality of all enterprises has been calculated above using Social Network Analysis. |

| | | | | |
|---|---|---|---|---|
| Explanatory variable | Industrial park (operating condition) management variable | Enterprise diversification degree | Dive | Use the type of industries of cluster enterprises in the park as an index and refer to *Industrial classification for national economic activities* (GB/T4754-2017). Data is acquired through survey or statistics of industry and commerce departments. |
| | Industrial park (operating condition) management variable | Industry agglomeration degree in the park | Indu | It is calculated using spatial Gini coefficient. [4] Related data is acquired through survey or statistics of industry and commerce departments. |
| Intermediate variable | Enterprise relationship variable in the park | Density of enterprise relationship network | Netw | The score of enterprise network density of all parks has been calculated above using Social Network Analysis. |
| | Enterprise relationship variable in the park | Informal institution intensity | Nonf | The score of informal institution density of all parks has been calculated above. |
| Control variable | Enterprise variable | Enterprise scale | Size | Use total assets of enterprise as an index. Data is acquired through survey or statistics of industry and commerce departments. |
| | Enterprise variable | Maximum shareholding ratio | Mgt | Data is disclosed by enterprise or acquired from statistics of industry and commerce departments. |
| | Enterprise variable | Position in the industry | Loca | Calculation method: Total output value of enterprise/mean value of top five of the industry of Shenzhen. Related data is acquired through survey or statistics of industry and commerce departments. |
| | Industrial park (operating condition) management variable | Total output value of industrial park | Tota | Use total output value of industrial park and cluster enterprise as an index. Related data is acquired through survey or statistics of industry and commerce |

[1] Lin Bin, Chen Qi. Review on Research Method for Definition and Identification of Industrial Cluster, Science & Technology Progress and Policy, 2006 (9), 190-192.

| | | | | |
|---|---|---|---|---|
| | | | | departments. |
| | Industrial park (operating condition) management variable | Attribute of industrial park | Natu | This item is set as a dummy variable. Public (including state-owned and collective) is 1 and non-public (including private and foreign-owned) is 0. All state-owned shares should be recorded as state-owned. Data is acquired through survey or statistics of industry and commerce departments. |

To investigate the influence of industrial cluster on enterprise innovation performance with enterprise relationship and informal institution as intermediate variables, a regression equation model is built in this study, as shown in Formula (6-1).

$$Inno = \beta_0 + \beta_1 Nonf + \beta_2 Netw + \beta_3 Indu + \beta_4 Natu + \beta_5 Tota + \beta_6 Dive + \beta_7 Time + \beta_8 Mgt + \beta_9 Posi + \beta_{10} Loca + \beta_{11} Size \quad (6\text{-}1)$$

6.1.2 Structural Equation Model

The structural equation model consists of the measurement model and the structural model and contains latent variable and observational variable and two corresponding paths. It can not only estimate the causal relationship among the observable manifest variables, but also constitute several latent variables through factor analysis and discuss the complex relationship between latent variable and manifest variable or latent variables using the following formulas:

$$\eta = B\eta + \Gamma\xi + \zeta \quad (6\text{-}2)$$

$$\gamma = \Lambda\gamma\eta + \varepsilon \quad (6\text{-}3)$$

$$\chi = \Lambda\chi\xi + \delta \quad (6\text{-}4)$$

Formula (6-2) is the structural model, which shows the internal and external relations of latent variable. Where, η is the endogenous part of latent variable, $B$ is the coefficient of the relationship among the endogenous parts of lalent variable, ξ is the exogenous part of latent variable, Γ is the coefficient of the influence of the exogenous part on the endogenous part of latent variable, and ζ is the error term of the structural model. Formula (6-3) and Formula (6-4) are the measurement model, which shows the relationship between latent variable and observational variable. Where, γ is the endogenous part of observational variable, Λγ is the component matrix of γ on η, and ε is the error term of endogenous observational variable. Similarly, χ is the exogenous part of observational variable, Λχ is the component matrix of χ on ξ, and δ is the error term of exogenous observational variable.

This model has the following advantages. First, it may involve some variables that cannot be measured directly and accurately called latent variables, such as learning motivation and customer satisfaction. However, they can be indirectly measured using some observational indexes and measuring error is allowed. Second, traditional path analysis can be conducted to explain changes in a single path only, but the structural equation model can gradually figure out the optimal fitting model according to the overall degree of fitting of different models.

Based on the aforesaid advantages of the structural equation model and considering that the variables in this study are all latent variables and strong comprehensiveness and subjectivity of their measurement indexes, the structural equation model is adopted for data analysis and model fitting in this study.

## 6.2 Sample and Data Source

In the initial questionnaire design, first read massive research literature, make appropriate adjustments according to research content and design the questionnaire preliminarily. Then, consult the relevant experts and scholars about scale design and modify the questionnaire for the first time. After that, discuss with relevant responsible persons of industrial cluster field and modify the questionnaire for the second time. With the help of relevant responsible persons, distribute the modified questionnaire to enterprises in the industrial parks of Shenzhen City, make questionnaire forecast, modify the questionnaire according to suggestions of responsible person and result of questionnaire forecast and design the final questionnaire as shown in Appendix 3. This study also designs an interview outline to acquire enterprise information from interview. A total of 455 questionnaires are distributed and 411 are collected with 400 valid questionnaires. The recovery rate and the effective rate of questionnaire reach up to 90.33% and 87.91% respectively, since specially-assigned person is responsible for tracking questionnaire survey.

## 6.3 Descriptive Statistics, Reliability and Validity Test

### 6.3.1 Descriptive Statistical Analysis

(1) Overall characteristics of sample enterprise

Valid questionnaires are collated to analyze the samples comprehensively. Enterprise information is shown in Table 21.

Table 21. Basic information of enterprises of interviewees

| Item | Category | Frequency | Percentage | Cumulative percentage |
|---|---|---|---|---|
| Enterprise nature | State-owned | 92 | 23.00% | 23% |

| | | | | |
|---|---|---|---|---|
| | Private | 129 | 32.25% | 55.25% |
| | Joint venture | 62 | 15.50% | 70.75% |
| | Foreign-owned | 79 | 19.75% | 90.50% |
| | Others | 38 | 9.50% | 100.00% |
| Enterprise scale | Less than 50 persons | 5 | 1.25% | 1.25% |
| | 51 - 100 persons | 40 | 10.00% | 11.25% |
| | 101-500 persons | 222 | 55.50% | 66.75% |
| | More than 501 persons | 133 | 33.25% | 100.00% |
| Incorporation time | <1 year | 48 | 12% | 12.00% |
| | 2-5 years | 276 | 69% | 81.00% |
| | 6-10 years | 44 | 11% | 92.00% |
| | >10 years | 32 | 8% | 100.00% |
| Total assets | <500,000 Yuan | 20 | 5% | 5.00% |
| | 510,000-1,000,000 Yuan | 152 | 38% | 43.00% |
| | 1.01 million-5 million Yuan | 164 | 41% | 84.00% |
| | >5.01 million Yuan | 64 | 16% | 100.00% |

Table 21 shows 92 state-owned enterprises, accounting for 23% of the investigated enterprises; 129 private enterprises, accounting for 32.35%; 62 joint venture enterprises, accounting for 15.5%; 79 foreign-owned enterprises, accounting for 19.75%; and 38 other enterprises, accounting for 9.5%. As to enterprise scale, there are 5 enterprises with less than 50 employees, accounting for 1.25%; 40 enterprises with 51-100 employees, accounting for 10%; 222 enterprises with 101-500 employees, accounting for 55.5%; and 133 enterprises with 501 employees, accounting for 33.25%. In these two aspects, the investigated enterprises have a large scale. As to incorporation time, there are 48 enterprises incorporated in 1 year, accounting for 12%; 276 enterprises incorporated 2-5 years ago, accounting for 69%; 44 enterprises incorporated 6-10 years ago, accounting for 11%; and 32 enterprises incorporated more than 10 years ago, accounting for 8%. Among the investigated enterprises, there are 20 enterprises with total assets valued less than 500,000 Yuan,

accounting for 5%; 152 enterprises with total assets valued 510,000-1,000,000 Yuan, accounting for 38%; 164 enterprises with total assets valued 1.01-5.0 million Yuan, accounting for 41%; and 64 enterprises with total assets valued more than 5.01 million Yuan, accounting for 16%.

(2) Descriptive statistics of data

Descriptive statistical items such as maximum value, minimum value, mean value, standard deviation, skewness and peakness of test items in the questionnaire are shown in Table 22.

Table 22. Descriptive statistical table

| Category | Item | Mean value | Standard deviation | Minimum value | Maximum value | Skewness | Peakness |
|---|---|---|---|---|---|---|---|
| Affiliated enterprise | A1 | 2.572 | 1.021 | 1 | 5 | 0.044 | 0.872 |
| | A2 | 3.678 | 0.766 | 1 | 5 | 0.552 | 0.25 |
| | A3 | 3.060 | 0.966 | 2 | 5 | 0.163 | 0.001 |
| | A4 | 2.596 | 0.886 | 1 | 5 | 0.402 | 0.323 |
| | A5 | 3.992 | 0.907 | 1 | 5 | -0.075 | -0.444 |
| | A6 | 2.817 | 1.118 | 1 | 5 | 0.203 | -0.742 |
| | A7 | 2.561 | 0.898 | 1 | 5 | 0.397 | -0.474 |
| | A8 | 2.650 | 0.858 | 2 | 5 | 0.534 | -0.802 |
| | A9 | 4.325 | 1.023 | 1 | 5 | -0.456 | 0.85 |
| | A10 | 4.199 | 0.701 | 2 | 5 | 0.884 | 0.316 |
| | A11 | 3.634 | 1.071 | 1 | 5 | -0.724 | -0.713 |
| | A12 | 4.663 | 0.768 | 1 | 5 | 0.084 | -0.805 |
| | A13 | 4.614 | 1.144 | 1 | 5 | 0.032 | 0.302 |
| | A14 | 3.736 | 1.071 | 2 | 5 | 0.468 | 0.264 |
| | A15 | 3.548 | 0.895 | 1 | 5 | -0.368 | -0.281 |
| | A16 | 2.946 | 1.025 | 1 | 5 | 0.521 | -0.177 |
| | A17 | 4.652 | 0.879 | 1 | 5 | -0.638 | -0.288 |
| | A18 | 4.066 | 1.060 | 1 | 5 | 0.273 | -0.345 |
| | A19 | 3.834 | 0.903 | 2 | 5 | 0.372 | 0.274 |
| | A20 | 3.707 | 0.962 | 1 | 5 | -0.409 | -0.127 |
| | A21 | 3.803 | 1.163 | 1 | 5 | 0.090 | 0.317 |
| | A22 | 2.919 | 0.763 | 1 | 5 | -0.191 | 0.472 |
| | A23 | 4.266 | 1.008 | 1 | 5 | -0.282 | -0.549 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | A24 | 2.604 | 0.745 | 2 | 5 | 0.454 | 0.197 |
| | A25 | 3.353 | 1.158 | 1 | 5 | -0.257 | -0.131 |
| | A26 | 3.957 | 1.180 | 2 | 5 | 0.260 | -0.062 |
| | A27 | 4.141 | 0.982 | 1 | 5 | -0.110 | 0.215 |
| | A28 | 4.686 | 1.130 | 1 | 5 | 0.116 | -0.249 |
| | A29 | 3.644 | 1.198 | 1 | 5 | -0.529 | -0.601 |
| | A30 | 2.954 | 1.017 | 2 | 5 | 0.119 | 0.357 |
| | A31 | 4.459 | 1.162 | 1 | 5 | 0.273 | -0.509 |
| | A32 | 4.394 | 0.790 | 1 | 5 | -0.341 | 0.062 |
| | A33 | 2.941 | 0.906 | 1 | 5 | 0.450 | -0.374 |
| | A34 | 4.448 | 1.072 | 1 | 5 | -0.658 | 0.345 |
| B industrial cluster and industrial park | B1 | 3.610 | 0.763 | 2 | 5 | -0.088 | 0.103 |
| | B2 | 3.918 | 0.920 | 1 | 5 | -0.401 | -0.617 |
| | B3 | 3.292 | 1.153 | 1 | 5 | -0.600 | 0.238 |
| | B4 | 4.173 | 1.081 | 1 | 5 | -0.262 | -0.092 |
| | B5 | 3.514 | 0.953 | 1 | 5 | -0.235 | -0.095 |
| | B6 | 4.373 | 1.039 | 2 | 5 | 0.309 | 0.054 |
| | B7 | 4.671 | 1.134 | 1 | 5 | -0.256 | 0.195 |
| | B8 | 3.219 | 0.997 | 2 | 5 | 0.110 | -0.630 |
| C enterprise relationship and informal institution | C1 | 4.493 | 0.776 | 1 | 5 | -0.165 | -0.650 |
| | C2 | 3.852 | 0.890 | 1 | 5 | 0.181 | 0.466 |
| | C3 | 4.678 | 1.004 | 1 | 5 | 0.025 | -0.194 |
| | C4 | 2.520 | 1.167 | 2 | 5 | 0.372 | -0.067 |
| D innovation management and innovation performance | D1 | 3.546 | 0.910 | 1 | 5 | 0.282 | 0.462 |
| | D2 | 2.890 | 1.034 | 1 | 5 | 0.162 | -0.073 |
| | D3 | 2.525 | 0.726 | 1 | 5 | 0.143 | -0.283 |
| | D4 | 3.939 | 1.165 | 1 | 5 | -0.681 | 0.002 |
| | D5 | 4.644 | 0.875 | 1 | 5 | 0.489 | 0.078 |
| | D6 | 3.787 | 0.929 | 1 | 5 | -0.596 | 0.465 |

As shown in Table 22, peakness and skewness of data approach 0, indicating that sample data is consistent with normality. The above results show that the

samples meet the conditions for normality test and there are no abnormal values, so data can be further fitted.

6.3.2 Reliability Test

Reliability test is conducted to measure the consistency and stability of the measurement object. Presently, most scholars test reliability using α reliability coefficient method. The closer Cronbach 's α value approaches 1, the higher the reliability is. See Table 23 for details.

Table 23. Reliability test criteria

| Value range | Criterion |
|---|---|
| *Cronbach* 's α (0.7, 0.8) | Acceptable |
| *Cronbach* 's α [ 0.8,+) | Good |

In order to evaluate the reliability of every variable more accurately, reliability is tested from the aspect of correlative industry, industrial cluster and industrial enterprise, enterprise relationship ability, and innovation management and innovation performance.

(1) Reliability analysis of correlative industry scale

Reliability analysis result of correlative industry scale is shown in Table 24.

Table 24. Reliability analysis result of correlative industry scale

| Index No. | CITC | Cronbach'α coefficient after this item is deleted | Index No. | CITC | Cronbach'α coefficient after this item is deleted | α coefficient of item |
|---|---|---|---|---|---|---|
| A1 | 0.529 | 0.868 | A18 | 0.589 | 0.831 | 0.893 |
| A2 | 0.599 | 0.859 | A19 | 0.418 | 0.762 | |
| A3 | 0.420 | 0.894 | A20 | 0.663 | 0.813 | |
| A4 | 0.547 | 0.829 | A21 | 0.616 | 0.712 | |
| A5 | 0.482 | 0.708 | A22 | 0.492 | 0.803 | |
| A6 | 0.443 | 0.895 | A23 | 0.562 | 0.741 | |
| A7 | 0.434 | 0.897 | A24 | 0.684 | 0.784 | |
| A8 | 0.415 | 0.707 | A25 | 0.437 | 0.847 | |
| A9 | 0.573 | 0.827 | A26 | 0.618 | 0.814 | |
| A10 | 0.587 | 0.892 | A27 | 0.551 | 0.830 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| A11 | 0.439 | 0.854 | A28 | 0.454 | 0.851 | |
| A12 | 0.613 | 0.892 | A29 | 0.442 | 0.731 | |
| A13 | 0.465 | 0.813 | A30 | 0.528 | 0.889 | |
| A14 | 0.686 | 0.735 | A31 | 0.541 | 0.826 | |
| A15 | 0.526 | 0.881 | A32 | 0.489 | 0.774 | |
| A16 | 0.587 | 0.872 | A33 | 0.488 | 0.866 | |
| A17 | 0.495 | 0.754 | A34 | 0.443 | 0.705 | |

As shown in Table 24, the reliability of all industry-related dimensions is greater than 0.7, the total relevance (CITC) of the corrected item is greater than 0.4, the reliability coefficient will not increase significantly after any item is deleted, and the reliability coefficient of the total scale is 0.893 and consistent with the regulations of this study, so any items in the scale should not be deleted.

(2) Reliability analysis of industrial cluster and industrial park scale

Reliability analysis result of industrial cluster and industrial park scale is shown in Table 25.

Table 25. Reliability analysis result of industrial cluster and industrial park scale

| Index No. | CITC | Cronbach'α coefficient after this item is deleted | Index No. | CITC | Cronbach'α coefficient after this item is deleted | α coefficient of item |
|---|---|---|---|---|---|---|
| B1 | 0.491 | 0.731 | B5 | 0.651 | 0.751 | 0.822 |
| B2 | 0.449 | 0.822 | B6 | 0.619 | 0.897 | |
| B3 | 0.700 | 0.744 | B7 | 0.589 | 0.799 | |
| B4 | 0.467 | 0.900 | B8 | 0.567 | 0.783 | |

As shown in Table 25, the reliability of all dimensions of industrial cluster and industrial park is greater than 0.7, CITC value is greater than 0.4, the reliability coefficient will not increase significantly after any item is deleted, and the reliability coefficient of the total scale is 0.822 and consistent with the regulations of this study, so any items in the scale should not be deleted.

(3) Reliability analysis of enterprise relationship and informal institution

Reliability analysis result of enterprise relationship and informal institution measurement scale is shown in Table 26.

Table 26. Reliability analysis result of enterprise relationship and informal institution

| Index No. | CITC | Cronbach'α coefficient after this item is deleted | α coefficient of item |
|---|---|---|---|
| C1 | 0.595 | 0.792 | 0.791 |
| C2 | 0.469 | 0.862 | |
| C3 | 0.595 | 0.755 | |
| C4 | 0.597 | 0.854 | |

As shown in Table 26, the reliability of all dimensions of enterprise relationship is greater than 0.7, CITC value is greater than 0.4, the reliability coefficient will not increase significantly after any item is deleted, and the reliability coefficient of the total scale is 0.791 and consistent with the regulations of this study, so any items in the scale should not be deleted.

(4) Reliability analysis of innovation management and innovation performance scale

Reliability analysis result of innovation management and innovation performance scale is shown in Table 27.

Table 27. Reliability analysis result of innovation management and innovation performance scale

| Index No. | CITC | Cronbach'α coefficient after this item is deleted | α coefficient of item |
|---|---|---|---|
| A18 | 0.676 | 0.722 | 0.763 |
| A19 | 0.469 | 0.789 | |
| A20 | 0.600 | 0.787 | |
| A21 | 0.639 | 0.763 | |
| A22 | 0.430 | 0.857 | |
| A23 | 0.532 | 0.881 | |

As shown in Table 27, the reliability of all dimensions of innovation management and innovation performance is greater than 0.7, CITC value is

greater than 0.4, the reliability coefficient will not increase significantly after any item is deleted, and the reliability coefficient of the total scale is 0.763 and consistent with the regulations of this study, so any items in the scale should not be deleted.

Test results show that all the designed scales have high consistency and reliability reaches an ideal state, so further analysis can be carried out.

6.3.3 Validity Test

Validity is tested from the aspect of content validity and structural validity in this study:

(1) Content validity

Under the guidance of document analysis and theoretical framework, the author designs the first draft of questionnaire and modifies it twice after consulting domestic and foreign experts. Then, the author tests the questionnaire, further modifies it according to feedback and forms the final draft to ensure the content validity of questionnaire.

(2) Structural validity

It is widely believed among scholars that factor analysis can measure the structure of questionnaire well. The structural validity of sample is tested through KMO test and Bartlett sphericity test in this study and the criteria are shown in Table 28.

Table 28. Validity test criteria

| Value range | Criterion |
|---|---|
| *KM* 0 [9,+) | Perfectly suitable |
| *KM* 0 [0.8, 0.9) | Very suitable |
| *KM* 0 [0.7, 0.8) | Suitable |
| *KM* 0 [0.6, 0.7) | Basically suitable |
| *KM* 0 [0.5, 0.6) | Poor |

| | |
|---|---|
| *KM* 0 <0.5 | Discarded |
| *Bartlett* is significantly greater than 0 | Suitable |

First, the validity of data of the questionnaire is determined through KMO and Bartlett sphericity test and result is shown in Table 29.

Table 29. General KMO and Bartlett sphericity test

| | | |
|---|---|---|
| Sampling adequacy Kaiser-Meyer-Olkin measurement | | 0.942 |
| Bartlett sphericity test | Approximate chi-square | 4939.732 |
| | df | 253 |
| | Sig. | 0.000 |

As shown in Table 29, KMO of the overall scale is greater than 0.9 and the significance level is 0.000, indicating that Bartlett sphericity test is passed, the validity of the scale is high and the index system can be further studied.

The validity of all variables is further tested and result is shown in Table 30.

Table 30. KMO and Bartlett sphericity test of variables

| Latent variable | KMO | | Approximate chi-square | Df | Sig. |
|---|---|---|---|---|---|
| Affiliated enterprise | 0.932 | Bartlett Sphericity test | 1428.005 | 15 | 0.000 |
| Industrial cluster and industrial park | 0.917 | | 1458.927 | 15 | 0.000 |
| Enterprise relationship ability | 0.856 | | 654.546 | 10 | 0.000 |
| Innovation management and innovation performance | 0.941 | | 731.219 | 15 | 0.000 |

According to Kaiser rule, KMO of all variables should be greater than 0.7. As shown in Table 30, all variables meet the validity requirements and can be further analyzed.

Table 31 Coeffienct matrix

| | Inno | Nonf | Netw | Indu | Natu | Tota | Dive | Time | Mgt | Posi | Loca | Size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inno | 1.0000 | | | | | | | | | | | |
| Nonf | .5510** | 1.0000 | | | | | | | | | | |
| | 0.0120 | | | | | | | | | | | |
| Netw | .0170* | 0.2570 | 1.0000 | | | | | | | | | |
| | 0.0000 | 0.0720 | | | | | | | | | | |
| Indu | 0.0260 | 0.1310 | 0.1280 | 1.0000 | | | | | | | | |
| | 0.0680* | 0.3640 | 0.3770 | | | | | | | | | |
| Natu | -0.0510 | 0.0970 | .300* | 0.2280 | 1.0000 | | | | | | | |
| | 0.0050 | 0.5030 | 0.0340 | 0.1110 | | | | | | | | |
| Tota | .0820** | .714** | 0.1820 | 0.1460 | 0.0940 | 1.0000 | | | | | | |
| | 0.0120 | 0.0000 | 0.2070 | 0.3110 | 0.5170 | | | | | | | |
| Dive | .0800** | .415** | .280* | 0.0630 | 0.0910 | .414** | 1.0000 | | | | | |
| | 0.0000 | 0.0030 | 0.0490 | 0.6640 | 0.5290 | 0.0030 | | | | | | |
| Time | .1220** | .598** | -0.0280 | -0.0180 | -0.0450 | .614** | .392** | 1.0000 | | | | |
| | 0.0090 | 0.0000 | 0.8460 | 0.9010 | 0.7570 | 0.4710 | 0.0050 | | | | | |
| Mgt | .2550** | .496** | 0.1650 | -0.0170 | 0.1770 | .422** | 0.2150 | .439** | 1.0000 | | | |
| | 0.0040 | 0.0000 | 0.2520 | 0.9060 | 0.2180 | 0.0020 | 0.1350 | 0.0010 | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Posi | .0020** | .454** | 0.1840 | 0.1460 | 0.0940 | 0.4740 | .414** | .614** | .422** | 1.0000 | | |
| | 0.0030 | 0.0000 | 0.3070 | 0.3150 | 0.5180 | 0.3810 | 0.0130 | 0.2480 | 0.0120 | | | |
| Loca | -0.2000** | .371** | 0.1420 | 0.1460 | 0.0940 | 0.0440 | .414** | .534** | .332** | 0.1240 | 1.0000 | |
| | 0.0440 | 0.0000 | 0.2070 | 0.3110 | 0.7070 | 0.6040 | 0.0010 | 0.2430 | 0.0020 | 0.2170 | | |
| Size | .0690** | .800** | 0.2200 | 0.0120 | 0.1230 | .723** | .434** | .667** | .482** | .723** | .723** | 1.0000 |
| | 0.0230 | 0.0000 | 0.1240 | 0.9360 | 0.3950 | 0.0000 | 0.0020 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | |

** Denotes the statistical significance at the 0.01 level (double-tailed)
* Denotes the statistical significance at the 0.05 level (double-tailed)

According to table 31, all variables are correlated, so this study has significance for variable setting and model construction, and can verify relevant research assumptions.

# Chapter Ⅶ Empirical Analysis

## 7.1 Presentation of Hypothesis

The core question of this study is: how is the innovation performance of enterprises clustered in industrial park mode? Based on the thinking and evolution of core issues, this study focuses on the impact of industrial clusters on firm innovation performance by taking firm relationship and informal institution as intermediate variables. In the previous chapter, research design and survey data testing were carried out. In this chapter, centering on the core research issues, the following research hypotheses were proposed from the aspects of industrial cluster, industrial park and cluster enterprises:

1. Industrial Clusters:

H1-1: The higher the degree of industrial clusters, the stronger the relationship network of cluster enterprises;

Zheng (2017) studied professional markets in Wenzhou, Taizhou and other places, and found that with the development of the market, business relationship, namely, business relationship, became increasingly important and formed a rational market behavior. Therefore, the hypothesis is set in this study: in an industrial park, if the degree of industrial agglomeration is higher, it means that there are more interrelated industries in the same industry, and then more enterprises will enter the industrial park. These enterprises will carry out more cooperation with each other, and through these exchanges and cooperation, a strong relationship network can be established, which makes the whole industry with a high degree of clustering, enterprises will be more connected, that is, the stronger the enterprise network formed.

H1-2: The higher the degree of industrial cluster, the stronger the informal system in the industrial park;

Yao (2008) believed that the development of industrial clusters would reflect the economy and effectiveness of informal systems based on the research on the industrial cluster of plumbing and sanitary ware in Shuikou Town, Nanxiong, Shaoguan, Guangdong province. Therefore, this study also believes that if the degree of industrial cluster is higher, the informal institutional relations in the industrial park will be more related, and the informal institution will be stronger, and there are often obvious informal institutions in the industrial park with high degree of cluster.

H1-3: The higher the degree of industrial cluster, the better the innovation performance of cluster enterprises;

Mo Changwei et al. (2018) discussed the relationship between industrial cluster, technology spillover and enterprise innovation performance, and found that due to industrial cluster, r&d of other enterprises in the same industry has a significant spillover effect on their own innovation, but this spillover effect only exists in areas with a high degree of industrial cluster. Reference the findings, this study set up hypothesis H1-3: the higher the degree of industry cluster, that industrial park integrated enterprises will have more interconnected, and thus produce better innovation performance, makes a comprehensive industrial park to get a better development, and overall improve industrial park development of each index in the studied area, so as to promote the development of the whole industrial park toward a better direction.

2. Industrial Park:

H2-1: The higher the degree of industrial park diversification, the better the innovation performance of cluster enterprises;

Willow discharge Lin (2020) such as impact on the performance of regional innovation mechanism of industrial cluster are studied, probes into the problem of diversification or specialization, points out that the specialization of industry agglomeration and cluster are has significantly positive effects on regional innovation performance, but industrial agglomeration from diversification to the process of specialization, as regional innovation capability has increased, The externalities of industrial agglomeration will be reduced. Du and Liu (2021) has similar research conclusions. This study also found that there are many types of enterprises or institutions in many industrial parks, that is, the degree of diversification in industrial parks is high. Therefore, the hypothesis is set in this study: if the greater the degree of diversification in the industrial park, the more different enterprises in the industrial park, the more significant the innovation performance of cluster enterprises, which can promote the benign development of enterprises. H2-2: The stronger the informal system in the industrial park, the better the innovation performance of cluster enterprises; Chen Xueguang (2008) believes that social resources have a positive impact on technological innovation performance. Draw lessons from the results, this research set up hypothesis H2-2, namely the more informal institution of industrial park, is the park enterprises of blood, geopolitical, edge, edge the closer the relationship, the more complex the non-business relations, communicate more frequently, thus can realize more integration and resource sharing, the better we inspire

creative park enterprises and their employees, Therefore, the innovation performance of cluster enterprises is better.

3. Cluster Enterprises:

H3-1: The more mature cluster enterprises are, the better their innovation performance is; In general, start-ups are mainly about survival and don't invest much in RESEARCH and development. However, mature enterprises have some original accumulation. In the face of fierce competition in the market environment, they need to pay more attention to innovation, maintain enterprise vitality, and continue to create value. Li et al. (2020) also believe that enterprises have different technological logic orientation and innovation behavior at different development stages, thus producing different innovation performance. Therefore, this study assumes that if cluster enterprises become more mature, it indicates that the self-governance and construction of cluster enterprises are more suitable for the development of this field, and they can obtain more resources in the industry, thus creating higher enterprise performance.

H3-2: The stronger the cluster enterprise relationship network is, the better the enterprise innovation performance is;

As in this paper, the fifth chapter analysis, if the strength of the relationship between the enterprise cluster network, shows the status of enterprises in the industrial park is higher, more advantages in such aspects as capital, technology and market, more connection with other companies, from their own development and the internal and external conditions, these need more and more conducive to innovation performance improvement. Chen (2008), Qian (2010) and Fang (2014) also believe that enterprise relationship network

contributes to the improvement of enterprise innovation performance. This is because the research assumes h3-2, that is, the same should be true for the whole park. The stronger the relationship network of enterprises clustered in the industrial park is, the closer the business relationship is, and the more positive it is to enterprise innovation.

H3-3: The more prominent an enterprise is in a cluster, the better its innovation performance will be. As mentioned above, the increasingly prominent position of enterprises in clusters indicates that enterprise clusters have obvious leading effect, which will promote the resource integration of enterprises in parks and other clusters. In order to maintain the dominant position, these enterprises need to ensure the improvement of innovation performance. Qian (2010) and Lin et al. (2012) also pointed out that the position of an enterprise in a relationship will positively promote innovation performance. Therefore, this study sets hypothesis H3-3.

As the variables involved in the above hypothesis, such as the degree of industrial cluster, innovation performance of cluster firms, location of firms and the strength of informal institutions, are all latent variables, they cannot be directly and accurately observed, or they can be observed but need to be calculated by other methods. Therefore, in the process of model construction and econometric analysis, it is necessary to make comprehensive analysis based on the success obtained above.

Based on the theoretical model, the relationship formed by the above assumptions and related variables is shown in FIG. 9. The thesis will carry on the empirical analysis to each hypothesis.

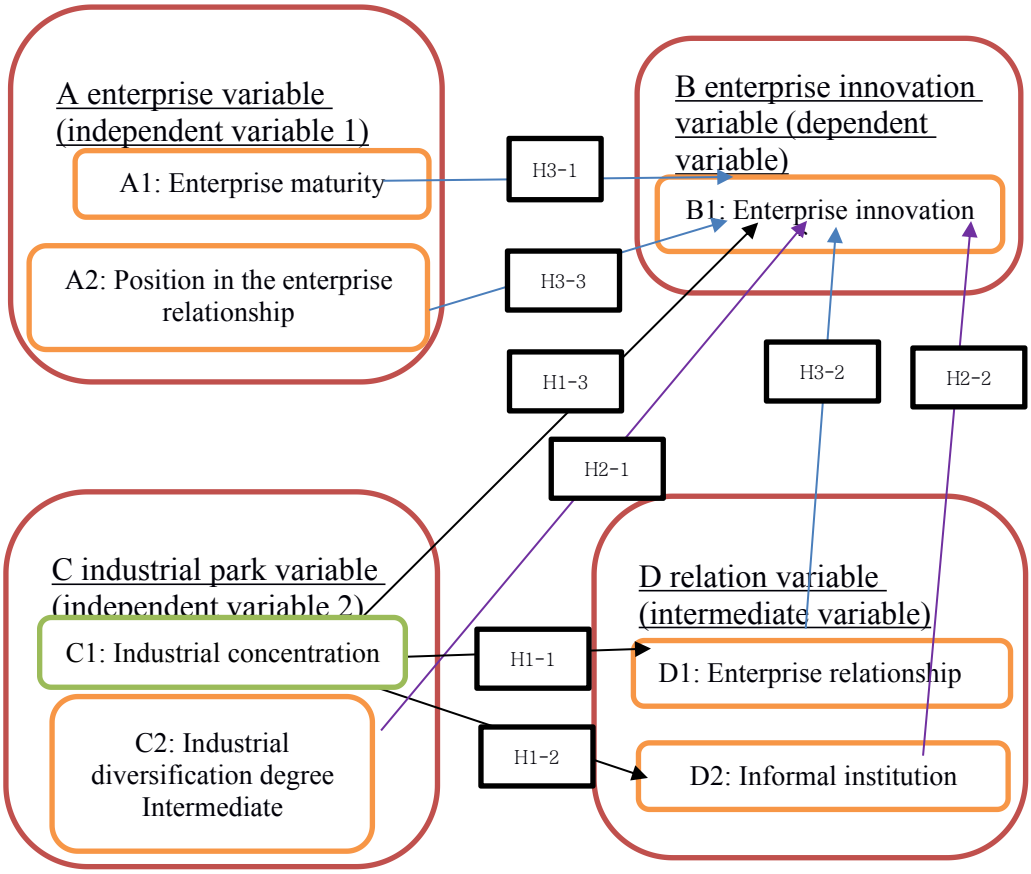


Fig 9. Hypothesis relation diagram

## 7.2 Empirical Analysis Result

### 7.2.1 Regression Estimate Result

The following regression model has been built in the preceding part of this study:

$$Inno = \beta_0 + \beta_1 Nonf + \beta_2 Netw + \beta_3 Indu + \beta_4 Natu + \beta_5 Tota + \beta_6 Dive + \beta_7 Time + \beta_8 Mgt + \beta_9 Posi + \beta_{10} Loca + \beta_{11} Size \quad (7\text{-}1)$$

Where, i is the coefficient of all influence factors. The above equation is regressed using SPSS19.0 and the regression result is obtained, as shown in Table 7-1. The model passes F test of significance level 0.001, which means that the formula has significance. Goodness of fit R is 0.900, $R^2$ is 0.882, DW value is 2.087 and F test value is 50.018, indicating that the regression

equation has good goodness of fit and an ideal effect. Thus, explanatory variables and control variables of the model have a significant impact on the innovation performance of cluster enterprises. Equation (7-1) can be expressed as:

*Inno=0.321+0.551Nonf+0.017Netw+0.026Indu-0.051Natu+0.082Tota+0.080 Dive+0.122Time+0.255Mgt+0.002Posi-0.200Loca+0.069Size*

Specific coefficient and significance level are shown in Table 32.

Table 32. Estimate result of innovation performance equation of cluster enterprises

| Variable | Coefficient | Standard error | t value | Sig. |
|---|---|---|---|---|
| Constant term | 0.321 | 0.022 | 2.594 | 0．012 |
| *Nonf* | 0.551 | 0.012 | 4.259 | 0．000 |
| *Netw* | 0.017 | 0.009 | 1.859 | 0．068 |
| *Indu* | 0.026 | 0.008 | 3.039 | 0．003 |
| *Natu* | -0.051 | 0.018 | -2.905 | 0．005 |
| *Tota* | 0.082 | 0.032 | 2.594 | 0．012 |
| *Dive* | 0.080 | 0.038 | 2.136 | |
| *Time* | 0.122 | 0.045 | -2.706 | 0．009 |
| *Mgt* | 0.255 | 0.085 | 3.004 | 0．004 |
| *Posi* | 0.002 | 0.001 | 3.040 | 0．003 |
| *Loca* | -0.200 | 0.097 | -2.059 | 0．044 |
| *Size* | 0.069 | 0.030 | 2.337 | 0．023 |

### 7.2.2 Empirical Analysis Result of Structural Equation Model

The degree of fitting of the structural equation model is verified using AMOS software. Through repeated modification, the degree of fitting of the model is obtained, as shown in Table 33, indicating that the absolute fit index and relative fit index reach the fit criteria.

Table 33. Adaptability index of model

| Fit index | Fit criteria | Value | Judgment |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Absolute fit index | *RMSEA* | <0.05, fit well;<br>[0.05, 0.08), fit reasonably | 0.075 | Reasonable |
| | *GFI* | [0.90,1), the closer it approaches 1, the better | 0.900 | Reasonable |
| | $x^2$ / *df* | [0,1], the model fits excessively;<br>(1, 3), the model is concise and fits well;<br>[5,+], the model needs to be modified | 2.956 | Reasonable |
| Relative fit index | *CFI* | (0.90,1), the closer it approaches 1, the better | 0.901 | Reasonable |
| | *NFI* | (0.90,1), the closer it approaches 1, the better | 0.912 | Reasonable |

Model hypothesis verification result is shown in Table 34.

Table 34. Model hypothesis verification result

| Hypothesis | Path | Standard path coefficient | T value (significant if T value is >2) | Whether hypothesis is verified |
|---|---|---|---|---|
| H1-1 | Industry agglomeration degree-Cluster enterprise relationship network | 0.08 | 1.96 | No |
| H1-2 | Industry agglomeration degree-Informal institution | 0.33 | 7.15 | Yes |
| H1-3 | Industry agglomeration degree-Innovation performance | 0.56 | 5.25 | Yes |
| H2-1 | Industrial park diversification degree-Innovation performance | 0.39 | 2.96 | Yes |
| H2-2 | Informal institution-Innovation performance | 0.44 | 7.15 | Yes |
| H3-1 | Cluster enterprise maturity -Innovation performance | 0.49 | 5.25 | Yes |
| H3-2 | Cluster enterprise relationship network-Innovation performance | 0.37 | 4.32 | Yes |
| H3-3 | Enterprise location-Innovation performance | 0.49 | 3.65 | Yes |

### 7.2.3 Colinearity Analysis

As shown in the above table, other hypotheses than H1-1 are true, but industry agglomeration degree, cluster enterprise relationship network, informal institution and industrial park diversification degree are probably highly

correlated, so colinearity remains to be further verified, that is, high correlation among several explanatory variables results in the situation that regression coefficient cannot be explained during regression analysis. The colinearity among several variables is often tested mainly using tolerance, eigenvalue, condition index (CI) and variance inflation factor (VIF). Tolerance is the reciprocal of VIF. When tolerance is less than 0.1, independent variables in the regression equation have a serious colinearity problem. When eigenvalue is less than 0.01 or CI is above 30, independent variables also have a serious colinearity problem.

In order to ensure the reasonability of the research model, the colinearity of industry agglomeration degree, cluster enterprise relationship network, informal institution and industrial park diversification degree is tested using SPSS 19.0 data analysis tool, and the analysis result is shown in Table 35.

Table 35. Colinearity analysis result of relevant independent variables

| Variable | VIF | CI | Tolerance | Eigenvalue |
|---|---|---|---|---|
| Industry agglomeration degree | 1.345 | 15.364 | .282 | .051 |
| Informal institution | 2.841 | 12.254 | .275 | .043 |
| Cluster enterprise relationship network | 1.283 | 10.686 | .685 | .015 |
| Industrial park diversification degree | 1.901 | 9.527 | .541 | .017 |

As shown in the above table, the VIF of industry agglomeration degree, cluster enterprise relationship network, informal institution and industrial park diversification degree is obviously less than 10, CI is obviously less than 30, tolerance is greater than 0.10 and eigenvalue is greater than 0.01, indicating that colinearity problem does not exist among factors and colinearity meets the research requirements for regression analysis. The model hypothesis

verification results shown in Table 33 are credible.

### 7.2.4 Mediating Effect Analysis

Fig. 9 shows 3 influence paths of industry agglomeration degree of industrial park on enterprise innovation performance: (1) Direct effect: (H1-3); (2) Indirect effect through enterprise relationship: (H1-1)+(H3-2); (3) Indirect effect through informal institution: (H1-2)+(H2-2).

Nevertheless, H1-1 is not true according to the aforesaid hypothesis verification results, so enterprise relationship cannot have a mediating effect on industrial cluster and enterprise innovation performance. But H1-2 and H2-2 are true, indicating that informal institution can have a mediating effect on industrial cluster and enterprise innovation performance.

To test mediating effect, Wen et al. (2004, 2012) pointed out that the correlation between two variables was the precondition for mediating effect. First, analyze the correlation among industry agglomeration (Indu), informal institution (Nonf) and enterprise innovation performance (Inno); then, build the influence path and structural relationship among all variables using structural equation model; finally, modify and reestimate the initial model, obtain the modified intermediary structural model and analyze the influential effect. Based on this, this study refers to the regression equation in the mediating effect model. Suppose all variables have been centralized or standardized, build the following equation set F-1:

$$Nonf = aIndu + \epsilon_1 \tag{7-2}$$

$$Inno = c'Nonf + bNonf + \epsilon_2 \tag{7-3}$$

$$Inno = cIndu + \epsilon_3 \tag{7-4}$$

Where, $a$ is the path coefficient of industry agglomeration (Indu) to informal institution (Nonf); $b$ is the path coefficient of informal institution (Nonf) to enterprise innovation performance (Inno); $c'$ is the path coefficient of informal institution to enterprise innovation performance (Inno) under control of informal institution (Nonf), namely direct effect; $c$ is the path coefficient of industry agglomeration (Indu) to enterprise innovation performance (Inno), namely total effect; $\epsilon_1, \epsilon_2$ and $\epsilon_3$ are random error terms. Mediating effect is that the indirect effect is equal to the product of coefficients of $a$ and $b$ and the relationship between mediating effect and total effect and direct effect is $c = c' + ab$.

Based on structural equation set F-1 (7-2/7-3, 7-46), carry out regression analysis of dependent variables, independent variables and intervening variables, and inspect whether the regression coefficient of independent variable is significant. If not, it means that informal institution has a total mediating effect on the influence path of industry agglomeration on enterprise innovation performance. If independent variable decreases but it has a significance level, it means that informal institution has a partial mediating effect on the influence path of industry agglomeration on enterprise innovation performance.

Fitting analysis is carried out for the hypothesis research model in this study and the result is shown in Table 36.

Table 36. Structural equation model M1 parameter estimation summary sheet

| Acting path | Standard path coefficient | Standard error | Critical ratio (C.R) | Significance probability |
|---|---|---|---|---|
| Informal institution← industry agglomeration degree | .486 | 0.086 | 4.215 | 0.004 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Enterprise innovation performance← informal institution | | | .313 | | 0.119 | 3.623 | 0.005 | |
| Enterprise innovation performance← industry agglomeration degree | | | .173 | | 0.094 | 3.623 | 0.017 | |
| Goodness of fit | | | | | | | | |
| $\chi^2$/ df | GFI | AGFI | RMSEA | NFI | IFI | CFI | PNFI | PCFI |
| 1.953 | 0.921 | 0.926 | 0.086 | 0.917 | 0.934 | 0.811 | 0.794 | 0.823 |

GFI, AGFI, NFI, IFI, PNFI and PCFI of this model are greater than 0.90 and an ideal value is obtained. RMSEA is 0.081 and greater than 0.080, indicating that the model fits well. Only when CFI is slightly less than the ideal value and within the acceptable range, the initial model fits the obtained data well combined with the above fit indexes.

Data in the above table and regression result of Table 33 show that the regression coefficient of the intervening variable informal institution reaches the significance level, the regression coefficient of other independent variables decreases but still reaches the significance level, and intervening variable has a partial mediating effect. That is, informal institution has a partial mediating effect on the relationship between industry agglomeration and enterprise innovation performance: That is, industry agglomeration both directly affects enterprise innovation performance and indirectly affects it through the intervening variable of informal institution.

## 7.3 Discussion of Empirical Analysis Result

According to the above empirical analysis result, industry agglomeration has no directly significant positive influence on cluster enterprise relationship, but it has positive influence on enterprise innovation performance. Industry

agglomeration has no direct influence on enterprise competitiveness, but it affects enterprise competitiveness through the intervening effect of network relation. In fact, industry agglomeration first refers to the closeness produced by enterprise in the geographic position, but such geographic closeness does not directly act on the overall improvement of enterprise social relation in the industrial park. For a single enterprise, a higher industry agglomeration degree of industrial park indicates park enterprises cooperate with each other more harmoniously in the industry chain, take a more dominant position in the social relation and have a better leading effect, which better improve innovation performance.

A higher industry agglomeration degree indicates that informal institutions in the industrial park will be correlated more closely, informal institution will be stronger and there will be obvious informal institutions in the industrial park. Since small enterprises in the industrial cluster cannot establish a long-term strategic partnership with external institutions due to resource limitations, they may actively use informal institutions such as genetic relationship, geographical relationship, karmic connection and scholarship to explore the possibility of cooperation with other enterprises for the purpose of long-term development. Besides, enterprises cannot grow without the cooperation and assistance of relevant enterprises such as upstream and downstream enterprises and peers and other clusters, so they will actively select complementary and interdependent local strategic partners to build network relations, improve exchange frequency and build mutual trust, so as to gain support from industrial park management, manpower and information. As informal institution of industrial park becomes stronger, they exchange more

frequently to share and integrate more resources and better arouse the creativity of park enterprises and employees to improve innovation performance of cluster enterprises. Moreover, informal institution also has a certain mediating effect on improving innovation performance of industrial cluster and enterprises.

The higher the industrial park diversification degree is, the more enterprises of different types will be in the industrial park and the better the innovation performance of cluster enterprises will be. It should be because the stronger the relational network comprised of enterprises is, the closer the business relations is and the greater the enthusiasm for improvement of enterprise innovation performance is.

The above empirical analysis result is basically consistent with the survey and interview result in this study:

First, in terms of industry agglomeration, industrial park operator will set the industry orientation according to location, industry structure and resource orientation to introduce target enterprises. In most cases, such proactive industry introduction produces very little effect unless requested by the government. On one hand, industry agglomeration has its objective law under the action of market, that is, cluster enterprises will select factory or site according to industry chain, cost-income and supporting service. On the other hand, there are various types of industrial parks in Shenzhen facing intense homogeneous competition and industrial park operator often acts as “the principal tenant” and bears huge financial stress. They often uphold an attitude that “all comers are guests” and lack consideration of industry attribute. They just request rental of a venue.

Second, as to industrial park management, operator will be favored by excellent enterprises for high-quality service. Government-owned middle and large-sized industrial parks have a management committee with industrial park operation management function, governmental and social service function and strong control power, which is unable to provide thoughtful service to some extent. For private industrial park, strong operational capacity and high-quality service are the key to success. Thus, they strive to provide first-class service in park management. Survey shows that many reputable industrial parks are equipped with intelligent management system which provides integrated services such as investment planning, financing, industry & commerce and taxation, pre-listing tutoring and united office.

Third, survey shows that if the park operator and key enterprises or shareholder has advantageous social resources, they can quickly activate the industrial park and bring a lot of benefits to park enterprises. Generally, industrial park operator is willing to carry out fellowship activities in the park to promote enterprise interaction and exchange of social resources. Social network is formed through interaction and exchange so that key park enterprises can maintain the dominant position, become technology leading, realize industrial interaction and promote the development of affiliated enterprises.

Fourth, frequency and effectiveness of such interaction and exchange are largely determined by the intensity of informal institutions in the park. Especially in Shenzhen, informal institutional relations comprised of genetic relationship, geographical relationship, karmic connection and scholarship play a critical role in building industrial parks, selecting partners, establishing

business channels, promoting the development of industrial parks, solving conflicts and increasing capital and production. Therefore, many enterprises encourage their senior managers to participate in various affiliated organizations and study classes and even try to play a role in such institutions as local CPPCC and NPC or social organizations. Meanwhile, in order to build or strengthen informal institution relation, interestingly many industrial parks or key park enterprises are furnished with a dining hall for entertainment and full-time service staffs. The dining hall of some industrial parks even has chefs of Guangdong cuisine, Chaoshan cuisine, Hunan cuisine and Sichuan cuisine serving geographical relationship customers.

Fifth, as to enterprise innovation behavior and performance of park, survey shows that many industrial park operators realize the importance of informal institution, and recognize the importance of enterprise innovation capacity and healthy management. Thus, informal institution relation plays a certain role in investment attraction or non-principled conflict resolution, but in fact, enterprise innovation capacity is considered more. In particular, industrial parks of certain scale attach greater importance to exploiting the potential of innovative enterprise in the “industry upgrading” process and even give them considerable preferential policies and actively guide them to enter the industrial park. After all, it is a complementary and reciprocal thing.

## Chapter Ⅷ Enlightenment for Operation of Industrial Park

### 8.1 Industrial Chain value-added, enlarge industrial agglomeration benefit

As the carrier of industrial gathering, industrial park is not only the spatial carrier of regional economic development and industrial adjustment and upgrading, but also the measure symbol of regional social and economic development level. It shoulders the important mission of gathering innovative resources, cultivating emerging industries and promoting urbanization construction. There are various forms of industrial parks, such as high-tech zones, development zones, science and technology parks, cultural parks, agricultural parks, characteristic industrial parks, as well as science and technology new towns and industrial new towns that have emerged in recent years. As the builders and operators of industrial parks, it is necessary to know the comprehensive background of industrial parks, such as the investment subjects and construction types, the life cycle and development process of the park, the profit model of the park, and so on, so as to take advantage of the trend.

In the upgrading of the industrial park, we can see that the industrial layout of the park is becoming more and more demanding.

The industrial planning of the park is the primary planning content in the park planning, and the industrial planning is the basis of other planning content. Only when the industrial planning is clear, the other planning can be carried out smoothly according to the blueprint. Industrial planning mainly defines core industries, key industries and related industries in the park, and analyzes the composition and relationship of industrial chain and upstream and downstream enterprises on this basis. In fact, the industrial orientation of the

park is to find the intersection of regional development, national industrial policy, industrial development trend and market prospect and other indicators.

For example number I2 park is one of the baoan district culture creative industry clusters, the beginning of construction in 2015, development operation enterprise through to the macro economic and technological environment, the foundation of the regional industry and resources of the comprehensive analysis of the industry positioning on the basis of the technology, with culture as the content of the emerging cultural industries, including animation, network new media, research and development of digital content creation, And creative design, and the related industries are positioned as software and service outsourcing, science and technology services. In the construction and operation, I2 park has been strongly supported by the encouragement policy of bao 'an District's cultural development and prosperity and the industrial policy of the integration of science and technology and culture, and has developed rapidly by fully enjoying the abundant supplies of industrial resources.

Among the 42 parks we surveyed (41 have valid data), science park is a hot word, with 80% claiming to be science parks. But the evaluation system of science park is a comprehensive index system. To develop a relatively mature technology - investment, or clearly positioned new technology park, it is usually to focus on building an industry cluster around one or several industry chains. N2 Park, with integrated circuit industry as the leading and pillar industry, has shown the highest industrial processing level and production capacity, the strongest research and development institutions, and the highest concentration of high-end IC design enterprises.

A technological product from scratch to be used by users generally includes seven links, namely product design and development, raw material procurement, order processing, production and manufacturing, warehousing and logistics, wholesale operation and terminal sales, which constitute an industrial chain. The market is downstream, the profit comes from the market. Vertical integration of industrial chain should focus on the downstream of the industrial chain, close to the market, usually driven by powerful terminal brand enterprises.

Based on the industrial chain of vertical integration, simultaneous lateral resources integration, business integration, in every branch of industry chain link, gather appropriate intermediary consultancy or integrated services, especially "smiling curve" to seize the industry value chain link two high profit, namely research and development design, brand marketing services, to focus on configuration and service. Aiming at the enterprises in the leading industrial chain, the science and Technology Park, on the one hand, attracts investment and introduces professional RESEARCH and development institutions and product design companies to promote industry-university-research cooperation development; On the other hand, market planning and marketing promotion agencies will be introduced to provide in-depth services of market promotion and product trading for enterprises in the park. Thus, it is possible to achieve value-added service income for park operating companies.

Under the background of structural adjustment and industrial upgrading, it is the general trend for old industrial parks and even old factories to eliminate

and abandon backward industries and introduce new industrial projects with high technology content and high added value.

Y1 Park, formerly known as the old park founded in 2003, used to be dominated by chemical industry and old manufacturing industry. It not only brings GDP to the area, but also makes people feel the pressure borne by the environment. In 2016, the park changed its name to Science and Technology Innovation Park, and began to eliminate "low and small scattered" and introduce "high and rich and handsome". On the one hand, more than 10 backward projects were eliminated, which will not be renewed when they expire. On the other hand, instead of introducing new chemical enterprises, high-end equipment manufacturing, automobile and parts, green electronic appliances and other "rich and handsome" emerging industry projects have been replaced, and the development of the park has been advancing rapidly. Before 2016, the total output value of traditional industries such as old crafts and chemical industry was only 1 billion yuan. After changing the way of thinking and development, e-commerce enterprises were attracted to enter the park, and the total output value increased to 6.3 billion yuan in 2019. The same land produces different benefits.

The industry in the park has been adjusted from a single industry to a comprehensive high-tech industry. The reasons, advantages and disadvantages will not be discussed here. Obviously, compared with the above high-tech industrial chain, the bicycle industrial chain must be different in many aspects, such as advanced technology, added value of products, industrial contribution rate and even social and economic benefits.

Therefore, the industrial layout of the park is a strategically important link. There is no industrial planning or vague industrial planning in the park, which will bring confusion and confusion of investment attraction and transportation back to the park. The industrial planning of the park should determine the core industry layer, the key industry layer and the related industry layer, and give appropriate ratio and location arrangement in terms of the number of enterprises and building area for each layer. Many industrial park in order to survive and short-term economic benefit, early investment is more miscellaneous, without increasing restrictions as to the enterprise and industry park operation and development of deep, must be considered in a certain period to adjust to the enterprises entered the clean-up, gradually clear that is beyond the scope of planning or serious enterprise management problems, to make the transition to planning target direction of industry transfer.

8.2 Leveraging social networks and informal institutions to optimize organizational operations

The future depends on operations. Only through operation can the park be endowed with vitality and charm, realize the win-win growth of the park and enterprises, practice the unique operation mode of the park, and realize the sustainable operation and development of the park. The characteristic operation of the park is also the biggest selling point of the industrial park. The operation and management of the park is not like the traditional residential real estate projects. Unlike commercial real estate projects, commercial investment and property management will be done. Industrial real estate, industrial park must achieve the property, business and industry, "three industries" simultaneously, parallel progress.

When enterprises enter industrial parks, they hope to get good entrepreneurial opportunities and entrepreneurial atmosphere, and focus their energy on career development instead of spending too much on non-mainstream businesses. Property management in the park, involving water, electricity, heating, air conditioning, communication network, sanitation, parking, security and other matters, should have a standardized property management system, professional property management and control process, as well as emergency disposal measures. In our survey and feedback data, 80% of the suggestions put forward by park enterprises to park operators are about property management, such as parking lots and charging piles.

The commercial facilities of the park involve all kinds of restaurants, convenient supermarkets, digital quick printing shops, accommodation hotels, shopping malls and other facilities. The industrial park with better supporting facilities will have apartments, banks, telecommunications shops, laundry rooms, coffee shops, gyms and so on. Industrial parks or new industrial towns with considerable scale will be equipped with bars, beauty shops, bookstores, libraries, cinemas and other business and cultural facilities. Commercial supporting facilities and more comprehensive supporting facilities can be called the "welfare" provided by the industrial park to enterprises in the park, so that enterprises in the park can not only enjoy the "basic salary" type of property management, but also enjoy the abundant "social welfare" type of business supporting facilities. There are significant differences between commercial facilities in industrial clusters and industrial parks and those in general commercial complex projects. The operation management of commercial supporting facilities in the park is to carry out commercial

investment promotion, store renewal and commercial property management on the basis of exploring and practicing the operation mode of the park. In the early stage, the park appropriately sacrifices some economic interests and strives for the timely stationing of the urgently needed supporting commercial stores to ensure the operation of the park, so as to ensure the smooth development of industrial investment attraction in the park and the normal operation of enterprises in the park. After the park enters the stable operation cycle, according to the overall needs of the park and the actual needs of enterprises, the commercial format shall be adjusted appropriately, the commercial shops and comprehensive supporting facilities shall be supplemented and updated, and the comprehensive service level of the park shall be effectively improved. In our field survey of 41 parks, business facilities did not reach the ideal level.

Industrial park operation is a relatively new content, many industrial real estate developers who have turned to the industry know little about it. Industrial operation in parks usually includes entrepreneurship incubation, public service platform construction, public relations construction in parks, and endogenous development in parks.

Business incubation is now from the central to the regional government are paying special attention to the work. Due to the need of national independent innovation and alleviating social employment pressure, the government is vigorously advocating and encouraging Chinese people to start their own businesses, and industrial parks (usually equipped with incubators) are ideal places to attract people to start their own businesses. According to the business needs of entrepreneurs in the park, it is necessary for the industrial park to

provide comprehensive incubation services, so that start-ups can get a "warm box" for healthy growth.

The public service platform of the park not only provides incubation services for start-ups, but also provides comprehensive and in-depth catalytic services for growing and mature enterprises, which is commonly referred to as the "incubator + accelerator" model. Public service platform is the core content of industrial park operation. In the construction and operation of the park, it is inevitable to have working contacts and business contacts with the government, industry organizations and relevant social groups, that is, the public relations work of the park. Involved in these public relations, the park a lot of public relations industry operations, such as administration for industry and commerce, taxation, personnel, technology, culture, information and so on various functional departments, newspapers, radio, television, web portal, such as cultural propaganda department, and financial, finance, law, intellectual property, technology transfer, management consulting and so on various areas of intermediary service agencies, All these public relations need to be handled and maintained by the industrial operation department of the park. In the operation and management of industrial parks, the construction of public relations is the most important task.

Our survey found that most of the parks for small and medium-sized enterprises in science and technology innovation promised to provide special guidance services for application such as national high-tech qualification certification and government subsidies. For example, C1 Park provides project declaration services for enterprises in the park. While enterprises obtain government support for industrial park management, the operation service

department of the park appropriately extracts service remuneration. To provide marketing planning and product promotion services to enterprises in the park and obtain sales returns. Through interviews with managers, it can be known that the company intends to directly inject capital into potential entrepreneurial enterprises or become a shareholder of potential enterprises by exchanging services for shares, so as to obtain greater economic returns in the future.

Operators of industrial parks should be good at social network, activate industrial parks and bring superior resources to enterprises in the parks. At the same time, the operators of the industrial park can hold various social activities in the park to promote the interaction of enterprises in the park and the exchange of various social resources. Through these interactions and exchanges, a certain corporate social network will be formed to promote key enterprises in the park to maintain their dominant position, realize technological leadership and industrial interaction, and drive the development of related enterprises.

Moreover, interaction and communication can construct or strengthen the intensity of informal system in the park. Especially in Shenzhen, the informal institutional relationship built by blood relationship, geography, industrial relationship and academic relationship plays an important role in settling industrial parks, choosing partners, building business channels, helping people in growth, resolving conflicts and contradictions, and increasing capital and production. Therefore, park operators can guide corporate executives to participate in various clan organizations, attend various classes, or play certain roles in social organizations.

8.3 Innovation Performance oriented and the growth of enterprises enhanced

This study focuses on the role of industrial parks on enterprise innovation. According to this study, the scale difference and different stages of enterprise life cycle have different impacts on enterprise innovation output.

When it comes to entrepreneurship and innovation of small and medium-sized enterprises, there is a hot word -- "incubator". In the parks investigated and visited by the research team, some of the park operating enterprises were registered with the title of incubator. Business incubator, also known as high-tech entrepreneurship service center in China. It provides physical space and infrastructure for newly established small and medium-sized technology-based enterprises, and provides a series of service support, so as to reduce entrepreneurial risks and costs of entrepreneurs, improve the success rate of entrepreneurship, promote the transformation of scientific and technological achievements, and cultivate successful enterprises and entrepreneurs.

In order to speed up the construction and development of incubators, the Ministry of Finance, the State Administration of Taxation, the Ministry of Science and Technology and the Ministry of Education jointly issued the Notice on Tax Policies on University Science Parks and Makerspaces for Technology Business Incubators, which clearly stipulates that from January 1, 2019 to December 31, 2021, The real estate tax and urban land use tax will be exempted for national and provincial science and technology business incubators, university science parks and national registered mast-making Spaces that are provided for their own use, free of charge or through rental.

The income derived from providing incubation services to incubated objects shall be exempted from value-added tax.

The orientation of the policy has stimulated the innovation of the industrial park, and the social capital is eager to start active operation in the industrial real estate. However incubators are not just open up out of the office space, and need industrial park operators on a line, is the introduction, technical consultation, financial services, marketing and other intermediary service institutions all string, give full play to the intermediary professional service function, make up for the inadequacy of their own experience and ability, deepening inside the incubator for enterprises to provide complete professional services; These points are the bright spots of enterprises with potential and brilliance, and these "potential shares" enterprises are given key support, and even directly integrated into the management of industrial parks and bound to growth. Only the high integration of industrial resources can bring the vitality of incubated enterprises.

"We provide a full range of nanny services for enterprises in the park, including professional entrepreneurship mentors, free legal, financial and tax services, as well as the connection with government resources, the construction of party branches of enterprises, etc." The person in charge of C1 told the researchers that the park would also help enterprises to recruit corporate relations in the park, introduce relevant subsidy policies and organize enterprises to participate in some related exhibitions. At the same time, the park will also hold a number of enterprises within the park relations, scientific and technological achievements exchange activities. Through such a carrier, enterprises with innovation, growth and technological content can be

attracted to the park, so as to gather high-end industries and enterprises within the park, and incubate and grow in the park.

In particular, there are a lot of upstream and downstream relationships and mutual exchange of values in the industrial chain. The upstream link delivers products or services to the downstream link, and the downstream link feeds back information to the upstream link. Generally speaking, an industrial structure often includes basic industry, leading industry and supporting industry, and each link has its own industrial chain composition. They are interdependent and mutually restricted, forming a variety of horizontal and vertical industrial chain connections. With the development of the industry, these industrial chains are gradually separated and refined, or form a close cooperation mode. In the survey of enterprises in the park, quite a number of enterprises talked about the economic impact of upstream and downstream relationship on their own enterprises. In addition, for industrial parks with low degree of industrial agglomeration, a considerable part of the suggestions put forward by enterprises in industrial parks for the development of industrial parks is to carry out activities to enhance the relationship between enterprises, which also indicates that enterprises themselves have realized the potential resources brought by the degree of industrial agglomeration for the innovation and development of enterprises. In fact, for relatively mature enterprises, due to the location of enterprises in the industry and the informal system in the industrial park, the resource integration platform provided by the industrial park does have a positive impact on the R&D input and innovation output of enterprises. Therefore, the current park operators are more concerned about the innovation ability of enterprises. In particular, for industrial parks with a

certain scale, due to industrial upgrading, more attention is paid to tapping the potential of innovative enterprises, and preferential policies are even given to actively guide them to settle in and promote their innovative development.

# Chapter Ⅸ Retrospect and Prospect

## 9.1 Conclusion

With innovation performance of cluster enterprises in the industrial parks of Shenzhen as the research object, the author carries out in-depth investigation, obtains first-hand data and analyzes the social network and informal institution of this cluster using Social Network Analysis. Based on the understanding of the development status and network organization characteristics of industrial park clusters of Shenzhen City, the author introduces informal institution and discusses the innovation performance of cluster enterprises under industrial park mode from the perspective of industry agglomeration and social network relation.

This study shows that industry agglomeration degree has no positive influence on enterprise social relation, but it is positively correlated to enterprise innovation performance. Enterprise social network and informal institution have significant positive influence on enterprise innovation performance. In fact, as to industry agglomeration, industrial park operator will generally set the industry orientation according to location, industry structure and resource orientation to introduce target enterprises. In most cases, such proactive industry introduction produces very little effect unless requested by the government. As to industrial park management, strong operational capacity and high-quality service are the key to success. If the park operator and key enterprises or shareholder has advantageous social resources, they can quickly activate the industrial park and bring a lot of benefits to park enterprises.

Through social network, key park enterprises can maintain the dominant position, become technology leading, realize industrial interaction and market

exploitation and promote the development of affiliated enterprises. Certainly, the establishment and development of informal institution and frequent exchange help enterprise acquire new resources, new channels and new orders to facilitate innovative development. Especially in Shenzhen, informal institutional relations comprised of genetic relationship, geographical relationship, karmic connection and scholarship play a critical role in building industrial parks, selecting partners, establishing business channels, promoting the development of industrial parks, solving conflicts and increasing capital and production.

Through years of development, many park operators realize the importance of informal institution, and recognize the importance of enterprise innovation capacity and healthy management. Therefore, informal institution plays a role in the interaction between industrial park and park enterprise and plays a decisive role in innovation capacity and development potential of enterprise.

## 9.2 Prospect

At present, there are few researches on the social relationship network of enterprise clusters and the impact of social relationship network on the innovation performance of enterprises in clusters. Therefore, due to the author's research ability and the exploratory nature of the research itself, there are inevitably many problems, which are mainly reflected in the following aspects:

(1) Limitations of sample size and selected area. This paper originally intended to comprehensively investigate the information of shenzhen sample industrial park and enterprises in the park, but due to many limited conditions,

data collection is very difficult, so there is room for further improvement in the number of samples and the quality of relevant information. In addition, choosing Shenzhen Industrial Park as the established region of this study may have certain regional characteristics, because this cluster belongs to the industrial park cluster in developed areas, so the research conclusion of this paper may not be applicable to the industrial park cluster in less-developed areas. In addition, due to the historical reasons of shenzhen's characteristics, informal institutions in the general sense have little impact. Therefore, this study constructs an informal institution measurement index system applicable to Shenzhen, which is introduced into the study of industrial park clusters and enterprise innovation performance, thus making the research conclusions have certain particularity.

(2) The research on the social relationship network, informal institution and innovation performance of industrial clusters is relatively complex, and the dynamic research in this paper is insufficient and needs to be strengthened. Industrial park cluster in different stages of development, the social relation network and informal institution may be a change, and the innovation of the enterprise cluster in the different stages of industrial park cluster development may also be influenced by different factors, this article only looked at a certain time section in enterprise cluster networks of social relationship, informal institution and their effects on cluster enterprise innovation performance, Therefore, in order to fully understand the social relationship network and informal institution of industrial park clusters and their impact on the innovation of cluster enterprises, it is necessary to explore how the relevant factors change at each stage of the evolution of industrial park clusters from

the perspective of evolution.

In view of the deficiencies in this paper and the areas that need to be discussed, the following aspects are planned to be improved in the follow-up study:

(1) In the selection of survey objects, in addition to making the questionnaire more targeted, we should also enrich the types of samples, try to give consideration to different types of samples and expand the number of research samples. Because industrial cluster is a complex multi-agent system, it is a heterogeneous network. To study this heterogeneous network, we should extend the network model to all kinds of network members.

(2) Regarding the selection of research areas, this paper only selects Shenzhen, and according to the characteristics of Shenzhen, it sets informal system based on blood relationship, geography, academic relationship and industrial relationship, while ignoring the general significance of informal system. After all, ideology, historical heritage, cultural traditions, customs and habits have always been the main study of informal institutions. Therefore, in future research, several typical and representative regions can be selected for comparative study, and the general significance of informal system can be considered to make the research results more universal. In the future, extensive field research will be conducted to obtain more cluster cases, so as to find commonalities and differences and further improve the conclusions of this study.

(3) Future research can start from longitudinal time series and adopt richer research methods to conduct comprehensive and in-depth analysis. Based on the horizontal comparative study, the dynamic development and evolution mechanism of social relationship network and informal institution is deeply

analyzed, so that the operation mechanism of social relationship network and the development track of informal institution of enterprise cluster can be comprehensively examined from the changing perspective, as well as the impact on the innovation behavior and performance of enterprises in the cluster.

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# Appendix I

***A Research on Innovative Performance of Clustered Enterprises in Industrial Parks***
**Interview Outline for Industrial Parks**
*(Interview should be conducted under the guidance of the following questions and actively guide interactive discussions according to the interview.)*

1. Please briefly introduce the industrial park.

2. What are the location advantages of the industrial park?

3. How many enterprises are there in the industrial park at present? Please give a list.

4. Are there any enterprises in the peripheral areas? Why are they not settled in the industrial park?

5. Which type of enterprises is preferred in the industrial park? Well-developed one or newly established one? What's the actual situation?

6. What's the highest decision-making body of this industrial park? What's the operating organization of this industrial park?

7. What's the composition of shareholders in this industrial park (if any)?

8. Do you think the management of this industrial park is strict? What procedures does an enterprise need to go through to settle in the park?

9. Does this industrial park always show concern about the situation of the enterprises in it? Does the owner or manager of the industrial park often hold networking events in the park?

10.Is there a mechanism to monitor and prevent potential conflicts in cooperation between enterprises in the park? When the enterprises in the park encounter the cooperation crisis, will the Industrial Park help to coordinate? How?

11. Does a settled enterprise need to provide regular business reports to the park owner or manager?

12. In your opinion, what kind of assistance does the industrial park provide to the settled enterprises? Has a corresponding service system been established?

13. What is the development plan or strategy of the industrial park?

14. Does any settled enterprise often default on rent payment? What's the reason?

15. As far as you know, are there any industrial parks of the same type in your city, province, and country? What's their situation? What do you think the industrial park can rank among them and what are the characteristics compared with the same type?

16. Core enterprises refer to the enterprises with high degree of resource acquisition and control in the park. Are there core enterprises in the park? If so, which enterprises are the core enterprises, and are there any connections between these core enterprises? How do they connect (e.g. establishing cooperative relations, holding regular networking events, etc.)? Which enterprises are their affiliated enterprises?

17. How is the status of core enterprises reflected in the park? Is it through the industry, the leading technology, or the relationship between executives?

18. Is there any relationship among the senior staff of each enterprise in the park in terms of family, geography, business or study? If so, how is her/his personal relationship reflected in the corporate relationship?

19. Is there a public canteen / banquet hall in the park? Do enterprises in the park often use these facilities for business hospitality?

## Appendix Ⅱ

***A Research on the Innovative Performance of Clustered Enterprises in Industrial Parks***

**Questionnaire on the Enterprises in Industrial Parks**

*Dear Sir or Madam:*

*As a part of the subject A Research on Innovative Performance of Clustered Enterprise in Industrial Park, this questionnaire aims to learn about the situation of industrial parks/industrial clusters, corporate relationship, innovation performance, etc. and provide a sound basis for improving the operation of industrial park and enterprise innovation. Please answer all questions, and make sure that the evidence is objective and true. Your assistance will make the study results more representative and have reference value. Thank you for your support and assistance! Meanwhile, any opinions provided by you will be strictly kept confidential and used for this study only, and your name and the name of your company will not appear in the report.*

*The grading of all items in this questionnaire has no difference in merits, but only describes the difference of the fact conformity degree. Please fill in according to your company's current situation and your true thoughts. If you have any suggestions or doubts about this study, please let us know. Thank you very much for your help and precious time!*

*The Research Group*

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**Part I Information Completion**

*Please fill the form according to the situation of the enterprise*

1.Enterprise name:

2.Enterprise address:

3.Please indicate the industry park where your company is located

4.City where the enterprise (head office) is located

5.Year of establishment

6.Registered capital (RMB)

7.Total assets:

RMB 2 million and below □RMB 2.01- 5 million □RMB 5.01-10 million □ RMB 10-30 million □ RMB 10 million-30 million □ RMB 30 million- 50 million □ RMB 50 million - 100 million □ RMB 100 million -300 million □RMB 300 million-500 million □500 million-1 billion □1 billion above

8.Staff size (Number of employees):

□50 and below □51~100 □101~200 □201~500 □501~1000 □Above 1000

9.Corporate ownership type (for others, please specify):

□State-owned and state-owned holding enterprise □Collective enterprise □Wholly foreign-owned enterprise □Sino-foreign joint venture □Private and private holding enterprise □Others (please specify)

10. Main industry of the enterprise (for others, please specify):

□Electronic information □Communication and internet □Basic manufacturing □New energy □Petrochemical industry □Biomedicine □Software development □Finance □Service industry □Education and training □Others (please specify)

11. Personal occupational information of the company's chairman, general manager and other managers (pages can be added)

Name: Gender: Date of birth:

Place of birth: ____(Village),____(Street),____(Town),____(County/District),____(City), (Province),_____ (Country)

Native place: ____(Village),____(Street),____(Town),____(County/District),____(City), (Province),_____ (Country)

Registered permanent residence: _____(Village),_____(Street),_____(Town), (County/District),___(City), (Province),_____ (Country)

Graduated from: _____Highest education:_____

Education and training experience:

| Duration | Institution | Certificate |
|---|---|---|
| E.g. Sept. 1992 – Jul. 1996 | Department of History, Foshan University | Undergraduate diploma, bachelor's degree |
| | | |
| | | |
| | | |
| | | |

Work experience

| Duration | Institution | Title |
|---|---|---|
| E.g.: Jul. 1997 – Jul. 1999 | Jianlibao Company | Sales manager |

| | | |
|---|---|---|
| | | |
| | | |
| | | |

12. Did the company have a special R&D institution as of 2019? (Please tick "√" in "□")

□ No □ Yes If yes, please fill in the number of institutions as follows

| | Number |
|---|---|
| Number of scientific research institutions established by the enterprise | |
| Including: National technical center (s) | |
| Provincial technical center(s) | |
| Provincial engineering technology center (s) | |
| Municipal engineering technology center (s) | |

13. Number of employees from 2017 to 2019 (unit: person)

| Indicator | 2017 | 2018 | 2019 |
|---|---|---|---|
| 1. Year-end employees | | | |
| Including: Employee(s) with doctor's degree | | | |
| Employee(s) with master's degree | | | |
| Employee(s) with bachelor's degree | | | |
| Employee(s) with associate degree | | | |
| 2. Personnel engaged in scientific technology activities | | | |
| Including: Personnel engaged in scientific research and experimental development | | | |

14.Corporate Revenue and Expenditure

| Indicator | 2017 | 2018 | 2019 |
|---|---|---|---|
| 1. Total industrial output value (RMB ten thousand) | | | |
| (1) Industrial added value ( RMB ten thousand ) | | | |
| 2. Total revenue (RMB ten thousand) | | | |
| (1) Technical revenue (RMB ten thousand) | | | |
| (2) Products sales revenue ( RMB ten thousand) | | | |
| 3. Total expenditure (RMB ten thousand) | | | |
| (1) Fund for scientific and technological activities (RMB 10 thousand) | | | |
| Including: Fund for scientific research and experimental development (RMB ten thousand) | | | |
| (2) Total taxes paid ( RMB ten thousand) | | | |
| 4. Net profit (RMB ten thousand) | | | |
| 5. Export earnings (USD ten thousand) | | | |

15. Corporate innovation results from 2017 to 2019

| Indicator | Number |
|---|---|
| Number of patents applied | |
| Including: Number of invention patents applied | |
| Number of authorized patents | |
| Including: Number of authorized invention patents | |

| | |
|---|---|
| Number of authorized invention patents | |
| National scientific and technological progress prize | |
| Provincial scientific and technological progress prize | |
| Municipal scientific and technological progress prize | |
| Provincial major scientific and technological achievement award | |
| Municipal major scientific and technological achievement award | |

16. Products innovation implementation (please tick "√" in "□")

If the enterprise carried out the product innovation activities from 2017 to 2019, are there any product innovation projects completed?

No □

Yes □ Yes If yes, please fill in relevant product innovation project

| Product innovation project | Number of projects |
|---|---|
| Number of completed product innovation projects | |
| Including: Number of major product innovation projects | |
| Including: Number of projects directly funded by government | |
| According to types of technological innovation | |
| 1 Original innovation | |
| 2 Integrated innovation | |
| 3 Introducing patents and proprietary technologies | |

| | |
|---|---|
| 4 Introducing equipment | |
| According to the development entity, the product innovation projects are divided into projects | |
| 1 Independently developed by the enterprise | |
| 2 Developed by the enterprise cooperating with other enterprises | |
| 3 Developed by the enterprise cooperating with the scientific research institutions and colleges | |
| 4 Developed by the enterprise cooperating with related foreign institutions | |
| 5 Others | |
| According to novelty, the product innovation projects are divided into the following types: | |
| 1 International-level | |
| 2 Domestic-level | |
| 3 Provincial-level | |
| 4 Corporate-level | |

**Part II Measurement**

*Please indicate the degree of agreement to the sentences on the left of the table below according to the actual situation of your enterprise and grade it. Please tick the corresponding box.*

(I) Measurement of corporate relationship in the industrial park

Affiliated enterprises refer to the connections between enterprises formed by specific means in order to serve specific economic purposes. It has three forms of expression: (1) asset ties. It could be explained as equity participation, so as to form the relationship of holding and shareholding among enterprises; (2) the way of contract maintenance, i.e. the relationship between the upstream and downstream of the supply chain; (3) other ways of contact, namely, the enterprise relationship connected by social groups, organizations or entrepreneurs' social resources. The affiliated enterprises defined in this topic refer to the objects that are located in the same closed geographical space Industrial Park and form enterprise relationship with each other. Please choose the following options for corporate relationships.

| **Content** | **Strongly disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly agree** |
|---|---|---|---|---|---|
| **I.Affiliated enterprises** | | | | | |
| 1.We believe that affiliated enterprises located in the same | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| industrial park can perform their responsibilities appropriately | | | | | |
| 2.We trust the technical expertise of affiliated enterprises located in the same industrial park | 1 | 2 | 3 | 4 | 5 |
| 3.We believe that affiliated enterprises located in the same industrial park will not divulge our secrets | 1 | 2 | 3 | 4 | 5 |
| 4.We trust the accuracy of information provided by affiliated enterprises located in the same industrial park | 1 | 2 | 3 | 4 | 5 |
| 6.In the process of cooperation, we have established good friendship with related personnel of affiliated enterprises located in the same industrial park | 1 | 2 | 3 | 4 | 5 |
| 7.In the cooperation with affiliated enterprises located in the same industrial park, we can share all kinds of resources without reservation | 1 | 2 | 3 | 4 | 5 |
| 8.We promise to cooperate with affiliated enterprises located in the same industrial park based on the principle of mutual benefit | 1 | 2 | 3 | 4 | 5 |
| 9.We are committed to maintaining a long-term partnership with affiliated enterprises located in the same industrial park | 1 | 2 | 3 | 4 | 5 |
| 10. Our company and affiliated enterprises we trust usually benefit from activities held by the industrial park. | 1 | 2 | 3 | 4 | 5 |
| 11.We share the same values with affiliated enterprises located in the same industrial park | 1 | 2 | 3 | 4 | 5 |
| 12. we take participate in networking events held in the industrial park on a regular basis. | 1 | 2 | 3 | 4 | 5 |
| 13. we actively participate in the discussion on governance of the industrial park | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 14. We usually take part in the training together with other enterprises in the same industrial park | 1 | 2 | 3 | 4 | 5 |
| 15. We facilitate the banquet hall for business hospitality | 1 | 2 | 3 | 4 | 5 |
| 16. we hired chefs for banquet hall | 1 | 2 | 3 | 4 | 5 |
| 17. Chief management of our company play a certain social or government service role (e.g. CPPCC member) | 1 | 2 | 3 | 4 | 5 |
| 18.We have been involved in a legal dispute with one or several enterprises in the park | 1 | 2 | 3 | 4 | 5 |
| 19.We have been involved in a legal dispute with one or several enterprises outside the park | 1 | 2 | 3 | 4 | 5 |
| 20.We have a competitive relationship with one or several enterprises in the park | 1 | 2 | 3 | 4 | 5 |
| 21. Compared with affiliated enterprises outside the park, we trust the affiliated enterprises in the park more | 1 | 2 | 3 | 4 | 5 |
| 22. Compared with the affiliated enterprises outside the park, it is easier for us to maintain a good cooperative relationship with the affiliated enterprises in the park | 1 | 2 | 3 | 4 | 5 |
| 23. Compared with the affiliated enterprises outside the park, it is easier for us to solve the disputes | 1 | 2 | 3 | 4 | 5 |
| | | | | | |
| **II.Industrial cluster and industrial park** | | | | | |
| 24.We don't think the local industrial clusters have helped us | 1 | 2 | 3 | 4 | 5 |
| 25.We should be the leading enterprise in our industrial park or industrial cluster and play an important role | 1 | 2 | 3 | 4 | 5 |
| 26.Compared with similar enterprises in this city, we still have great potential for development | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 27.Being located in the Industrial Park broadens our access to innovative information | 1 | 2 | 3 | 4 | 5 |
| 28.Being located in the Industrial Park promotes the development of our technological innovation activities | 1 | 2 | 3 | 4 | 5 |
| 29.Being located in the Industrial Park enhances the possibility of our enterprises to innovate | 1 | 2 | 3 | 4 | 5 |
| 30.Being located in the Industrial Park helps us to eliminate the obstacles to enterprise innovation | 1 | 2 | 3 | 4 | 5 |
| 31.Being located in the Industrial Park helps us protect our intellectual property rights | 1 | 2 | 3 | 4 | 5 |
| 32.Being located in the Industrial Park helps us to obtain governmental support | 1 | 2 | 3 | 4 | 5 |

(II) How does the park affect the performance of technological innovation activities of enterprises? Please grade for the following options according to their significance.

| **Factor** | **Totally disagree** | **Disagree** | **Neutral** | **Agree** | **Totally agree** |
|---|---|---|---|---|---|
| 1.Expanding the product variety, improving product performance | 1 | 2 | 3 | 4 | 5 |
| 2.Entering new markets or expanding the market share | 1 | 2 | 3 | 4 | 5 |
| 3.Improving the product quality | 1 | 2 | 3 | 4 | 5 |
| 4.Improving the production flexibility | 1 | 2 | 3 | 4 | 5 |
| 5.Reducing labor costs | 1 | 2 | 3 | 4 | 5 |
| 6.Saving raw materials | 1 | 2 | 3 | 4 | 5 |
| 7.Reducing energy consumption | 1 | 2 | 3 | 4 | 5 |
| 8.Improving working conditions | 1 | 2 | 3 | 4 | 5 |

(III) Measurement for innovation management and innovation performance

Following items reflect the results of corporate innovation behaviors. Please grade for the following options according to the actual performance.

| **Option** | **Totally disagree** | **Disagree** | **Neutral** | **Agree** | **Totally agree** |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1.We launch new products or services faster than our competitors | 1 | 2 | 3 | 4 | 5 |
| 2.We apply new technologies faster than our competitors | 1 | 2 | 3 | 4 | 5 |
| 3.Our patent application takes less time than that of our competitors | 1 | 2 | 3 | 4 | 5 |
| 4.We invest more in the protection of intellectual property rights than our competitors | 1 | 2 | 3 | 4 | 5 |
| 5.We offer more new products or services than our competitors | 1 | 2 | 3 | 4 | 5 |
| 6.Our new products have a higher success rate than those of our competitors | 1 | 2 | 3 | 4 | 5 |
| 7.Compare with our competitors, our products represent first-class technology. | 1 | 2 | 3 | 4 | 5 |
| 8.相比同行, 我们对于市场信息的反馈速度特别快 We respond to market information more quickly than our competitors. | 1 | 2 | 3 | 4 | 5 |
| 9.相比同行, 我们对于政府创新政策的敏感性高 We are more sensitive to governmental policies of innovation than our competitors | 1 | 2 | 3 | 4 | 5 |
| 10.相比同行, 我们进行产品改进与创新的市场反映良好 We earn better reputation on market of product improvement and innovation than our competitors | 1 | 2 | 3 | 4 | 5 |

(IV) How does the industrial park influence innovative results of enterprises? Please grade for the following options according to importance.

| **Factor** | **Totally disagree** | **Disagree** | **Neutral** | **Agree** | **Totally agree** |
|---|---|---|---|---|---|
| 1.Entrepreneur with the innovation spirit | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 2. Sufficient fund support | 1 | 2 | 3 | 4 | 5 |
| 3. High-quality technological innovation talents | 1 | 2 | 3 | 4 | 5 |
| 4. Internal incentive measures of the enterprise | 1 | 2 | 3 | 4 | 5 |
| 5. Effective technological strategy or plan | 1 | 2 | 3 | 4 | 5 |
| 6. Smooth information channel | 1 | 2 | 3 | 4 | 5 |
| 7. Reliable partners on innovation | 1 | 2 | 3 | 4 | 5 |
| 8. Support of preferential policies | 1 | 2 | 3 | 4 | 5 |
| 9. Sound organization structure | 1 | 2 | 3 | 4 | 5 |

(V) The launch of enterprise innovation activities would face many obstacles. Do you think the park can help enterprises overcome the possible obstacles listed below? Please grade the options according to the degree of possibility.

| **Obstacle** | **Totally disagree** | **Disagree** | **Neutral** | **Agree** | **Totally agree** |
|---|---|---|---|---|---|
| 1. Lack of funds | 1 | 2 | 3 | 4 | 5 |
| 2. High costs of technological innovation | 1 | 2 | 3 | 4 | 5 |
| 3. Lack of technological innovation talents | 1 | 2 | 3 | 4 | 5 |
| 4. No long-term plan formulated yet | 1 | 2 | 3 | 4 | 5 |
| 5. Lack of information | 1 | 2 | 3 | 4 | 5 |
| 6. Lack of technological innovation partners | 1 | 2 | 3 | 4 | 5 |
| 7.Uncertain market demand for technological innovation products | 1 | 2 | 3 | 4 | 5 |
| 8.The market has been controlled by other enterprises | 1 | 2 | 3 | 4 | 5 |
| 9. There have been similar innovations | 1 | 2 | 3 | 4 | 5 |

(VI) Whether the enterprise has gained various kinds of support or not, do you think the park can provide assistance for enterprises to obtain the following policy support? If yes, please grade for the degree of assistance provided by the park.

| **Policy support** | **Totally disagree** | **Disagree** | **Neutral** | **Agree** | **Totally agree** |
|---|---|---|---|---|---|
| 1. Taxes reduction or exemption | 1 | 2 | 3 | 4 | 5 |
| 2. Loans and financing | 1 | 2 | 3 | 4 | 5 |
| 3. Intellectual property protection | 1 | 2 | 3 | 4 | 5 |
| 4. Industrial policy | 1 | 2 | 3 | 4 | 5 |
| 5.Relevant policies to encourage the enterprise to cultivate and attract talents | 1 | 2 | 3 | 4 | 5 |
| 6.Strengthening the scientific and technological innovation base and platform construction | 1 | 2 | 3 | 4 | 5 |
| 7.Scientific and technological program support | 1 | 2 | 3 | 4 | 5 |

**Part III Open questions**

*The following are open questions. Please answer them according to the actual situation:*

1.For what reasons was your company established or did your company enter this industry? When and for what reasons did your company enter this industrial park? Does the industrial park help your company's growth significantly?

2. Please describe the basic situation of the innovation activities carried out by your company. Is it a part of your development strategy to establish a long-term and stable partnership?

3.Please describe what new products or services your company has placed on the market in recent years? What difficulties have you encountered in the development of these products or services, and how were they handled at that time?

4.We define business partner as a way of representation for affiliated enterprises. How does your company choose partners? Are the factors considered in the selection of partners outside the Industrial Park and in the Industrial Park different? What are the specific factors? Do you prefer to choose partners from the companies in the same industrial park?

5.How does your company manage these partners located in the same industrial park, i.e., how to maintain the relationship with them or prevent potential conflicts?

6.What are the characteristics of your affiliated enterprises in the park? For example, it is an asset tie, or upstream and downstream relations of the supply chain, or social relations, or cooperative innovation relations. Which relationships are more important?

7. What obstacles and conflicts have occurred in the process of cooperation with these partners? How were they dealt with?

8. What relevant resources have you inputted in this cooperation? What has the other party inputted?

9.Please describe how the partnership is established for one of the most important innovation partners you consider?

10.Are there any employees of the company acting as representatives in local CPPCC, NPC and other organizations?

11.Has your company established a smooth communication channel and a common code of conduct with your partner in your daily work? Please give an example to briefly describe the interaction with your partner.

12.What external and internal factors influence or determine the effectiveness or success of cooperation?

13.Does the corporate culture of both cooperating parties impact the cooperation activities? If yes, what are the impacts?

14.Does the relationship between the bosses impact the cooperation activities? If yes, what are the impacts?

15.Do you have any advice or suggestions for this industrial park?

16.Are there core enterprises in the park? If so, which enterprises are they? Which ones are their affiliated enterprises in the park?

17.Please specify the five companies that have the closest relationship with your company (if any) and sort by significance. Why do you have close relationship with each other?

18.Does your company have a tacit understanding with other enterprises in the industrial park to form a certain regulations or culture? And how are these regulations or culture formed?

19.Please specify the five companies which have the least intimate relationship with your company (if any) and sort by significance.

20.Are there self-rule organizations or social organizations in the park? Which is the leader? What roles does your company play in the organization?

21.Which enterprise or enterprises in the park are related to your company by relatives (i.e. family relationship)? Please specify the relationship.

22.Which enterprise or enterprises in the park are related to your company by geography (i.e. person from the same hometown)? Please specify the relationship.

23.Which enterprise or enterprises in the park are related to your company by business (i.e. former collage)? Please specify the relationship.

24.Which enterprise or enterprises in the park are related to your company by study (i.e. alumni)? Please specify the relationship.

25. How do you think the factors such as financial support, technical innovation talents, internal incentives, effective technology strategies or plans, or unimpeded information channels affect the innovation achievements of enterprises in the park?

26.Do you think the innovation activities of enterprises in the park face obstacles in capital, talent, information, technology, market or other aspects? If so, how to overcome them?

27.Is there a public canteen/banquet room in the industrial park? Do you often use the banquet room in the park for hospitality?

28.Besides the existing canteen/restaurant in the park, does your company also have a private banquet room? What is the area of the room? How many boxes are there? How many employees are there for the full-time service? How many chefs are there?

End.