Thesis for the Degree of Doctor of Philosophy

Effects of collaborations on financial performance of technology-based start-ups

by

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Graduate School of Management of Technology

Pukyong National University

February 2022

Effects of collaborations on financial performance of technology-based start-ups

(기술 협력이 스타트업 재무성과에 미치는 영향)

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A dissertation submitted in partial fulfillment of the requirements

For the degree of

Doctor of Philosophy

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February 25, 2022

Contents

요약

본 논문은 중국내 주요 산업단지에 있는 기술 스타트 업을 대상으로 기술협력이 이들 기업의 재무성과에 미치는 영향을 분석했다. 같은 산업단지 내 기업들은 지리적 위치가 가깝고 인재 교류가 쉬워 정보 전파가 신속하다. 때문에 산업단지는 기업간 기술이전을 포함한 기술협력에 유리한 조건을 제공한다.

기존 연구는 효과적인 기술협력을 유도하기에는 한계가 있다. 본 논문은 다음과 같은 몇 가지 문제를 연구한다. 기술 협력이 창업실적에 영향을 미치는가? 기술협력과 기술이전 간의 관계는 어떤 것인가? 기술이전이 창업실적에 어떻게 영향을 미치는가? 기술이전이 기술협력과 창업실적에서의 매개효과는 어떻게 나타나는가?

본 논문은 문헌 연구와 설문조사를 결합했다. 501 개 기업에 대한 설문조사 연구와 통계분석을 통해 본 연구는 다음과 같은 가설을 설정했다.

1.기술형 스타트업 간의 기술협력은 창업실적에 긍정적인 영향을 미친다. 2. 기술형 창업 기업 간의 기술협력은 기술이전에 긍정적인 영향을 미친다. 3. 기술형 창업 기업 간의 기술이전은 창업실적에 긍정적인 영향을 미친다. 4. 기술형 창업 기업 간의 기술이전은 기술협력과 창업실적 사이에 매개효과가 존재한다.

데이터 분석에 있어 본 연구는 서술적 통계분석, 상관분석, 신뢰도와 타당도 검증을 통해 주로 Bootstrap 법으로 연구 가설에 대해 실증 검증을 실시하여 다음과 같은 연구 결론을 얻었다. 기술형 스타트업 간의 기술협

력은 창업 실적에 정(+)의 영향을 미친다. 기술형 스타트업 간의 기술협력은 기술이전에 정(+)의 영향을 미친다. 기술형 스타트업 간의 기술이전은 창업실적에 정(+)의 영향을 미친다. 기술형 스타트업 간의 기술이전은 기술협력과 창업실적 사이에 매개효과가 존재한다.

기업 간의 기술 협업이 기업 내부의 혁신을 추진할 수 있고 이런 외부 자원은 기업 내부 혁신 과정의 중요한 보완재가 될 수 있다는 통설을 실증분석을 통해 입증했다.

주제어: 기술협력, 기술이전, 창업실적, 매개효과, 사업단지

I. Introduction

New technologies such as new energy, artificial intelligence, Internet + and the Internet of Things in China are constantly emerging, making it urgent for government, enterprises and even individuals to be innovative China has launched many schemes to create an environment that is conducive to entrepreneurism. At the Summer Davos Forum in 2014, Chinese Premier Li Keqiang made a call for "mass entrepreneurship and innovation," proposing to make use of reform and innovation to promote the development of mass entrepreneurship and grassroots entrepreneurship. In 2015, "mass entrepreneurship and innovation" had become a national strategy, and it was hoped it would become a new engine for China's economic development for a long time to come. Entrepreneurship has played a more and more important role in economic growth, scientific and technological progress and the improvement of international competitiveness. It has also become an important starting point for enterprises to cope with the changing environment. In the context of China's economy entering a new normal and of supply-side structural reform, entrepreneurship has become an important factor in promoting China's economic development.

1.1 Research Background

1.1.1 Current Context

The “Annual Report on the Transformation of Scientific and Technological Achievements in China- Higher Education Institutions and Scientific Research Institutions” (2020) compiled by the China Science and Technology Evaluation and Achievement Management Research Association, China National Science and Technology Evaluation Center, and China Institute of Science and Technology

Information (2020) pointed out that China's scientific and technological achievements arose from transformation policies, specialized transfer institutions and talents, the construction of scientific and technological achievements transformation bases (platforms), the quality and transformation power of scientific and technological achievements, the reform of scientific and technological evaluation mechanisms, and the scientific and technological financial system. At the same time, from the perspective of implementation level, since the concept of technology entrepreneurship was first proposed in the Technology Entrepreneurship Forum of Purdue University in 1971, technology, innovation, management, and entrepreneurship have experienced many years of staggered running-in and development. This has led to certain theoretical and practical advances. Technological innovation and entrepreneurship are the drivers of economic development and research on this topic has gained considerable attention (Qi Ning et al., 2020). For example, in the process of entrepreneurial practice of technology-based entrepreneurial enterprise, there is still a problem of low collaboration efficiency and the interference of subjective factors of the audience, which seriously hinders the entrepreneurial effect of individual technology-based entrepreneurial enterprise or their organizations. Innovation and entrepreneurship can promote new drivers of economic development, so have attracted a great deal of attention from the Chinese government who have introduced a package of support policies to ensure innovation and entrepreneurship activities continue to emerge. Entrepreneurship is the driving force for economic growth and social progress. In the context of China's transformed economy, building an entrepreneurial society is one of the important goals of improving economic system reform, and it is also the foundation of the development for "Belt and Road" and constructing a community with a shared future for mankind.

In 1988, China officially established its first national high-tech zone in Zhong guan cun. In the early 1990s, China built 53 national-level science and technology

parks one after another, which were created for the development of modern high-tech industries with cross-century strategic significance[1]. University science and technology parks and other types of local science and technology parks are gradually appearing. China's industrial park construction started relatively recently. But it is driven by policy guidance and rapid development. Likewise, the establishment and development of these industrial parks have an important role for China's sustained economic growth, talent absorption, training, and enterprise development. At present, the industrial park has become a strong focus of growth China's economic development, advantageous for driving the growth of China's national economy, gathering and training a large number of innovation and entrepreneurial talents, and cultivating a number of Chinese high-tech enterprises (such as DATANG, ZTE, HUAWEI, LENOVO, STONE, etc.). Industrial Parks have played an important role in transforming China’s economy and restructuring China’s industry.

In order to further strengthen the power of scientific and technological innovation, These industrial parks comprehensively promote and deepen the reform of the science and technology system, the economic system and the administrative management system. And they also comprehensively promote the property rights system, distribution system, labor and personnel system, social security system reform and the establishment of the modern enterprise system. In 2019, the 218 national economic development zones achieved a GRP of 10.5 trillion (CNY), 10.6% of China's total imports. Total imports and exports reached 6.4 trillion (CNY), accounting for 20.2% of China's total imports and exports; paid-in foreign investment and foreign-invested enterprises reinvested $54.76 billion (USD), accounting for 22% of China's total foreign investment; 31,000 high-tech enterprises, up 39% compared with late 2018; 478 national incubators and mass innovation space, up 6.2%; 94 invention patents per 10000 people, 7.1 times the average level in China. Industrial

[1] Source: Zhongguancun Science and Technology Park _ Baidu Encyclopedia https://baike.baidu.com/item/%E4%B8%AD%E5%85%B3%E6%9D%91%E7%A7%91%E6%8A%80%E5%9B%AD/1360849?fr=aladdin

parks have become a major force of China's economic development[2].

However, from the enterprises of the current Chinese industrial park, the income scale of the enterprise that are valued at more than 100 million yuan (CNY) reach about 18% of the total enterprises, between 10 million (CNY) and 100 million (CNY) account for about 36%, 5 million (CNY) to 10 million (CNY) is about 10%, income less than 5 million (CNY) of small and medium-sized enterprises is about 36%. Especially in a large number of local industrial parks, the industrial parks are dominated by small (micro) enterprises, which have limited independent innovation ability[3]. On the whole, the lack of interaction and connection among all kinds of industrial parks result in a low overall development quality.

1.1.2 Theoretical background

Resource-based theory holds that it is the differences in the resources held by companies that account for the differences in performance between companies. Those resources that are valuable, scarce, difficult-to-imitate, and irreplaceable and heterogeneous have the greatest determining influence. Strategic theory takes the view that strategic orientation, as a management resource, is the reason for the excellent performance of enterprises. Adherents to strategic theory argue for the necessity of strategic planning, then divided the enterprise strategy and determined the impact of the heterogeneity of enterprise strategy selection on enterprise performance (Peng Xiuqing et al., 2016; Tian Li & Zhang Yuli, 2012). The research shows that the relationship between technical collaboration and enterprise performance is not linear, but presents an inverted U-type curve. Only when there is a moderate level of technical collaboration, will enterprise performance be at the best

[2] Source: In 2019,218 national economic development zones achieved a regional GDP of 10.5 trillion yuan _ Data News _ Industry Information Network https://www.chyxx.com/data/202101/927821.html

[3] Source: Shi Dan.Research Report on Economic Development Quality of China Park (2020 Edition) / National Think Tank Report [M].Beijing: China Social Sciences Press, 2020.

(Wales et al., 2013; Tang et al., 2008; Dong Baobao, 2014; Dong Baobao & Zhou Xiaoyue, 2015). From the above theories and research, it appears that if we want to analyze the performance problems of new enterprises, it is necessary to carry out an in-depth exploration for of all dimensions of enterprises' technical collaboration behaviors and the related implementation effects (Tian Li et al., 2010; Cai Li & Shan Biaoan, 2013).

In addition to the direct action mechanism of technical collaboration on enterprise performance, the question remains whether technology transfer has an intermediary effect on technical collaboration and entrepreneurial performance. And how does technology transfer affect entrepreneurial performance? Technology transfer continues to take place after the establishment of a startup and has a sustained impact (Tian Li et al., 2010). Start-ups are more innovative, risky, and forward-looking, which is mainly due to the background of entrepreneurs and the special social and political environment of entrepreneurial practice. Entrepreneurial enterprises usually choose technology transfer as the initial core of enterprise development. Research has shown that with the development of new enterprises, start-ups will make certain changes in response to the environment. But the results show that the initial strategy at the core level will not change, meaning that only the non-core level strategies and behaviors tend to change. That is to say, the core position of the initial entrepreneurship-oriented strategy is relatively stable, and it limits and affects the subsequent development of entrepreneurial enterprises.

Based on the above theoretical background, this paper focuses on exploring the influence of technical collaboration on entrepreneurial performance combined with the resource-based theory to investigate the action mechanism of technical collaboration on entrepreneurial performance. This paper will explore the impact of technical collaboration on entrepreneurial performance and the mediation effect of technology transfer.

1.2 Research Significance

1.2.1 Theoretical significance

The entrepreneurial performance model of technology transfer was established for China's industrial parks. This study examines in depth the elements and mechanisms of the formation of technical collaboration relationships in the industrial parks, analyzes their particularities and complexities, and provides a new perspective for the research of technical collaboration among the entrepreneurial enterprises.

This paper broadens the scope of research in this area by describing the process by which enterprises achieve performance goals through technical collaboration in industrial parks and considers the role of technology transfer as a mediating variable.

1.2.2 Practical significance

This paper researches the impact of technical collaboration on entrepreneurial performance, and improves the attention of entrepreneurs and entrepreneurial enterprise to them. On the one hand, the formal system in China is often imperfect. For entrepreneurial enterprise with new disadvantages, the use of industrial parks to obtain external resources is a key means for them to participate in market competition and solve the problem of lack of resources. On the other hand, the changes in the external environment bring opportunities and challenges to enterprises. Strategy is the key mean for enterprises to seize the opportunities and respond to the challenges. They need to choose the appropriate strategies to better participate in market competition.

This paper discusses the intermediary role of technology transfer in technical collaboration and entrepreneurial performance so that entrepreneurs realize they need to consider the external environment characteristics and their own capabilities to

better play their roles in the industrial parks. On the one hand, entrepreneurial enterprise needs to realize the economic transformation to form more entrepreneurial opportunities. At the same time the competition among the industries is increasing, the difficulty of enterprises in obtaining external information including market, technology and competitor behavior will increase and restrict their use of the industrial parks to acquire performance target resources needed. On the other hand, entrepreneurial enterprise needs to realize the continuous improvement of technical collaboration and technology transfer capacity in the park environment and obtain the relevant resources needed for the enterprise development through the industrial parks.

1.3 Research Contents

This study investigates entrepreneurial enterprises in Chinese industrial parks and the impact of technical collaboration on entrepreneurial performance, taking technology transfer as the intermediary variable. Based on resource basic theory and innovation theory, most technology-based entrepreneurial enterprises pay attention to collaborative relationship between enterprises and regard these as important resources for enterprises which will lead to technology transfer and promote the creative performance of their own enterprises. However, research shows that this is not the case in reality.

This paper is organized as follows:

Chapter I Introduction. It is divided into five parts: research background, research significance, research content, research methods, and technical routes and innovation points. Under the background of economic development, it explains the necessity and feasibility through the practical and theoretical significance to better solve the research problem. It also proposes the research content and construction; lastly, it selects multiple methods matching the research problem.

Chapter II Literature Review. On the one hand, the literature introduces the core constructs, theoretical logic and application of resource-based theory; and on the other hand, presents a systematic review of technical collaboration, enterprise technology transfer, entrepreneurial performance. This chapter lays a solid theoretical foundation for the construction of a future research framework.

Chapter III Research Model and Hypotheses. First of all, assumptions are put forward based on the above content by researching and understanding the current situation of the technical collaboration in the park and whether it affects entrepreneurial performance. Secondly, according to previous research, the level of technical collaboration effects has a certain impact on the performance of technology-based entrepreneurial enterprise. However, the research found that technical collaboration is affected by many factors such as supply chain collaboration grid structure, technology research and development institutions, consumers, and the whole chain relationship and quality such as the entrepreneurial enterprises and the government and other enterprises in the park, the relationship between technical collaboration and entrepreneurial performance. Thirdly, in copious previous research, the effect of technology transfer is an antecedent variable that has been proved to have a clear and significant impact on the entrepreneurial performance of technology-based entrepreneurial enterprises. The extent of technology transfer will also be influenced by the policy environment, social environment, legal environment, cultural environment and other factors and then put forward research hypotheses on the relationship between technology transfer and entrepreneurial performance. Finally, the relationship between technical collaboration and entrepreneurial performance is scientifically judged. And a set of questionnaires with high reliability and validity are designed to design the empirical research of technical collaboration from the questionnaire construction selection, scale analysis and research method selection so as to clarify the data analysis method of this research.

Chapter IV Empirical analysis and discussion of the results. This chapter mainly includes the basic contents of the questionnaire: the summary, collation and the

analysis of the survey data. The following three parts include details of the questionnaire distribution, the recycling survey process and sample feature analysis; the second part presents a descriptive statistical analysis of the data; the third part shows results gathered from statistical analysis software used to test the entrepreneurial performance of technical collaboration, and tests of the relationship between technical collaboration and entrepreneurial performance variables.

Chapter V Conclusions and Outlook. This chapter mainly explains this paper expounds upon the enlightenment and theoretical contribution to entrepreneurial performance, technical collaboration and technology transfer. It analyzes and summarizes the research and research process shortcomings. At the same time, it points out the key direction of further future research and provides suggestions and ideas for relevant follow-up research.

1.4 Research Methods

The method combines theoretical research with empirical analysis. The research is problem-oriented and the research logic is governed by research objectives. Through the research and summary of relevant documents, a systematic and complete framework for analyzing technical collaboration and its effect on entrepreneurial performance is constructed to provide a theoretical basis for subsequent research. On this basis, the research focuses on the impact of the technical collaboration of Chinese industrial parks on entrepreneurial performance. To elucidate the mechanisms involved, empirical data was gathered by questionnaire and interviews, and analyzed using multiple regression analyses, correlation analysis, analysis of variance and validity tests etc.

The questionnaire survey is combined with the interview survey. Through the method of questionnaire survey, the quantitative measurement of the impact of

technical collaboration on entrepreneurial performance in China is solved. On the basis of reference and a large number of relevant questionnaires, the questionnaire is determined based on the established hypothesis model and index system design, and the survey content is conducted with operable quantitative empirical research. The entrepreneurial behavior of entrepreneurs in Chinese industrial parks is selected. For the questionnaire, middle and senior managers and teams were selected as the respondents to obtain a large amount of first-hand data and provide basic data for in-depth research. Non-structured interviews were conducted at more than a dozen different-sized entrepreneurial enterprises in Shandong and Zhejiang. To obtain first-hand information regarding the multi-angle and multi-level qualitative research impact of technical collaboration on entrepreneurial performance, the interviewees include senior managers, scientific research management team members, technical supervisors, production leaders and general R & D personnel.

Qualitative analysis was combined with quantitative analysis. Statistical analysis is a commonly used method in research. Statistical software was used to empirically test the conceptual model against the sample data. The statistical analysis process includes a variety of specific analysis methods such as descriptive statistics reliability and validity test and correlation analysis to test the sample data. Among them, the descriptive statistics are a summary of the demographic characteristics of the sample data; Correlation analysis is a measure of the correlation between pairs of variables; letter validity analysis and common method bias analyses are assessments of the quality and rigor of data measurements; structural equation models are mainly used to verify the relationship among technical collaboration, technology transfer and entrepreneurial performance. It contains the mediation effect of technology transfer. Validation factor analysis and structural equation model are completed by using the statistical analysis software AMOS24.0. And the descriptive statistical analysis, reliability and validity test, correlation analysis and hierarchical regression analysis

are completed by using the statistical analysis software SPSS25.0.

II. Literature Review

The literature review was concerned with the impact of technical collaboration on entrepreneurial performance and focuses on the mediating role of technology transfer. Therefore, it covers technical collaboration in section 2.1. It firstly explores the reason for collaboration, then the process of collaboration, and finally the relationship among cooperative enterprises within the industrial parks (referred to as 'parks' from hereon in). In section 2.2, technology transfer is studied among different departments and different issues. Due to the model in this research is centered on the mediation effect of technology transfer, it focuses on the mediation role of technology transfer. Section 2.3 studies the impact of technical collaboration on entrepreneurial performance, then the performance of entrepreneurial enterprises is certainly different from mature enterprises. It cannot simply be measured by using conventional financial indicators, therefore, this section looks at the question on how to measure it. In summary, the literature review revolves around research issues.

2.1 Resource-based theory

Resource-based theory has become one of the most influential analytical frameworks in the field of strategic management in recent years. Rooted in the contribution of Penrose (1959), the resource-based theory is based on a within-enterprise perspective, which views enterprises as a collection of heterogeneous resources. And this "heterogeneous" resource can provide economic rent (Werner felt, 1984; Rumelt, 1984; Conner, 1991) and is a source of competitive advantage.

Most of the ideas of resource-based theory can be found in Marshall's writings.

Penrose referred to resource base theory in his 1959 "Enterprise Growth.” In Perros' view, the growth of enterprises is the process of gradually accumulating knowledge to expand the field of production. In 1984, Venafelt published "Enterprise Resources Theory.” Thereafter, Das & Teng (2000) proposed from a resource point of view that there are two main factors for enterprise collaboration: one is to obtain the resources from other organizations, and the other is to retain and develop their own resources by merging or combining the resources of other organizations.

The resource-based theory holds that that the competitive advantage of an enterprise comes from its resources and capabilities; while the sustainable competitive advantage comes from the valuable and scarce resources that cannot be imitated or replaced. One of the manifestations of the reorganization and development of various elements in enterprise organizations is the technological innovation of the enterprise, which is the technological innovation explanation of the resource-based theory. Technological innovation has become an important way for global enterprises to build their core capabilities and consolidate their sustainable competitive advantages. Many scholars have applied resource-based theory and developed it in traditional fields.

Although resource-based theory has become one of the most influential theoretical frameworks in the field of strategic management, the understanding of the two most important concepts of "resource" and "competence" in the field still lack consistency. For example, Werner felt (1984) defines a resource as "tangible and intangible assets that enterprises have now but not permanently own,” while in the Barney (1991) framework, a resource refers to “all assets, capabilities, organizational processes, enterprise attributes, information, and knowledge controlled by an enterprise that can construct and implement strategies to improve efficiency and effectiveness.” A more general and vague definition of resources and capacity is that “a valuable resource is the capacity of an organization” (Collis & Montgomery, 1995).

Therefore, for the needs of follow-up research, this study must clarify and distinguish these two core concepts in resource-based theory: resources and capabilities.

Grant (1991) presents a basic principle for distinguishing resources and capabilities, he notes that resources can be divided into visible resources, intangible resources, and resources rooted in people, while businesses can combine resources to work together to create organizational capabilities to ultimately create a competitive advantage. While Amit (1993) proposes a more clear and precise definition of resources, he describes resources as “a stock of available factors owned or controlled by enterprises.” Ability refers to tasks and activities that usually rely on resources such as material, manpower, and technology. According to Grant (1991), resources themselves do not create value, and similarly, Amit (1993) believes that value is created by a "talent" of the organization that can “configure and integrate resources through the organization's processes to achieve the desired goal.”

From the above analysis, the most important differences in resources and capabilities lie in the static and dynamic differences in the analysis methods. The view that based on resource features adopts static equilibrium analysis, while the view emphasizing ability puts the interaction and coordination of various resources, as well as the workflows and norms of enterprises, into the theoretical system using dynamic analysis methods. The dynamic ability framework of Teece et al. (1997) includes external environment dynamics, which defines the dynamic ability of the enterprise agglomeration, integrates and configures internal and external capabilities to cope with rapidly changing environments, and it further points out that the enterprise competitive advantage comes from excellent management and process, specific asset potential, and path dependence of the evolution of the enterprise. Another difference between the two in the different view of the economic rent acquisition mechanism based on the point of view that enterprises can obtain resources, or more effectively than competitors can enjoy economic rent, and emphasizes that the ability of

enterprises to obtain economic rent is due to the ability to allocate resources more effectively than competitors (Makadok, 2001).

Despite these differences, resources and capacity remain two inseparable concepts in resource-based theory, and both views based on them are organic components of resource-based theory. As Grant (1991) points out, resources are the source of capacity, and ability is the main source of competitive advantage. Therefore, only by including both resources and ability into the investigation scope can we effectively answer the two core questions in the resource foundation theories of "Why enterprises are different?" and "How enterprises acquire and maintain a competitive advantage?"

2.2 Technical collaboration among enterprises in the park

2.2.1 Definition of technical collaboration

Technical collaboration theory began to gradually enter the public view in the late 1980s and was widely paid attention to by scholars, especially American scholars and entrepreneurs.

Perspectives on technical collaboration theory are essentially on four levels. Firstly, on the academic level, scholars discuss the theoretical problems such as the causes, the form and characteristics of technical collaboration in detail. The scholars also analyze and research the technical collaboration behavior from the perspective of practice combined with practical data. Secondly, on the enterprise level, which looks at the specific collaboration methods of different forms of enterprise technical collaboration. Thirdly, on the regional level, the study should classify technical collaboration from the regional level and research the characteristics of specific collaboration methods and the problems that should be paid attention to. Finally, on

the national level, the importance of countries adopting the technical collaboration model and the suggestions for effective technical collaboration among countries are discussed respectively.

Sakakibara (2014) explains the reasons for the ecological power of technical collaboration and innovation. The first is to save cost. The cost of technical collaboration innovation is much lower than the cost of technology purchase or technology exchange. The second point is to monopolize knowledge and technology. If technology is exchanged, the other enterprises can obtain all the core content of the technology, and then the competitive advantage that owns technology will no longer exist. The third is to maintain technology or ability heterogeneity. Ferreira et al., (2014) analyzes the conflict problems in the process of school-enterprise technical collaboration mode. It is mainly manifested in the measurement problem of technology investment between schools and enterprises. Thakor (2011) mainly discusses the motivation of technical collaboration innovation, distinguish doubt, transaction costs, as the main research direction. Moore (2007) believes that the successful technical collaboration between schools and businesses is intrinsically valuable. Brocas (2003) also analyzes the technical collaboration mode among enterprises of different sizes. And the examples of 3M enterprise is analyzed, and finally raises the risk problem of technical collaboration. In terms of school-enterprise collaboration, the practice of developed countries started relatively early. Through continuous improvement and running-in of practice and theory, developed countries have accumulated a lot of important practical experience of school-enterprise collaborative education (AH, 1982; Colleges, 1980). Therefore, correspondingly, the theoretical research on school-enterprise collaboration is relatively in-depth, whether it is the construction of laws and regulations for school-enterprise collaboration, the construction of student training models, or the reform of teaching methods and means. It is said that he has led and demonstrated the sustained and rapid development of

many late-stage countries involved in higher vocational and technical education (Shang,2009; Wu,2020). Regarding the research of the school-enterprise collaboration talent training model, the theory is mainly based on the following two concepts with the highest degree of general knowledge, namely "cooperative education " and " combination of work and study" (Wu, 2012; Li et al. 2018).

Research on technical collaboration started late in China; from about the 1990s, and there has been little relevant research literature so far. From the perspective of the current research results in China, the main research object is the technical collaboration mode of combining school and enterprise, and the main research problems also tend to be related research. Luo Wei, Tang Yuanhu (2001) suggested enterprise technology sharing generally has two purposes: cost sharing or technology sharing. The enterprises hope to achieve the cost reduction purpose by sharing technology when they have similar resources or technology to each other. The enterprises want to share the other's technology through technical collaboration when they have resources that neither party have. Liu Gang & Zhang Haochen (2004), Chen Dan (2009) believe that technology is crucial for high-tech small and medium-sized enterprises. They must speed up technological innovation in order to improve their competitiveness in the market, so technical collaboration has become their best choice. Luo Ronggui & Li Wenjun (2004) claim that the technological spillover of different types of enterprises has different strengthening effects on technical collaboration and innovation, and technical collaboration is the most effective way for enterprises to quickly improve their competitiveness. Xing Li (2006) believes that joint costs and risks are the main motivation for innovation in technical collaboration. Through technical collaboration, enterprises can not only obtain new technologies, but can also share resources, quickly expand enterprise scale and gain external competitive advantages to establish inter-enterprise alliances. Pan Li, Su Zhong feng (2008) divide the basic motives for technical innovation collaboration

into two kinds according to the type of technology or ability. One of them is to obtain tangible resources, and the other is to obtain intangible resources such as knowledge and ability. Zhang Yanfeng (2008) also divides resources into internal and external resources from the perspective of resource owners, and on this basis, he identifies two drivers of technical collaboration and innovation to protect their own valuable resources and obtain external resources. Long Yong (2001) believes that the alliance motives of technical partners should be divided into cost-driven, technology-driven, risk-driven and strategic-driven.

2.2.2 Technical collaboration factors among enterprises in the park

In order to obtain significant competitive advantages and realize the growth of economic interests, enterprises need to carry out diversified technical collaboration with other enterprises in the park. The reintegration and reasonable allocation of resources among enterprises in the park form an economy of scale, which reduces transaction costs. At the same time, technical collaboration with enterprises in the park is beneficial for establishing the stable and trusting relationship and expanding the relational capital of the enterprises. This relational capital will be firmer and more reliable than the enterprises outside the park through the collaboration mechanism, which will help the whole park to form a solid competitive advantage and generate economies of scale and economic benefits (Benedek J & Kocziszky, 2019). From the perspective of enterprises in the park, there are differentiated characteristics in human, financial and social relations among the enterprises. Through technical collaboration, resource sharing and complementary advantages among enterprises in the park, the enterprises can form the synergistic effects. At the same time, collaboration will speed up resource integration among enterprises and improve the effect of innovation. From the perspective of coping with external environment changes and improving the enterprises' own technological innovation, the technical collaboration among

enterprises has a reasonable and strong motivation and irreplaceable advantages (D Madeo & Mocenni, 2020).

1)According to resource-based theory, the resources owned by each enterprise are vastly different, so technical collaboration helps to share resources and complement each other's advantages. The resources among enterprises in the park have both differentiation and homogeneity from the perspective of the overall resources of the park. In order to make full use of the park resource advantages, the enterprises will be bound to engage in resource measurement and evaluation in the process of resource integration and development. And this process is conducive to enterprises to recognize their own resource advantages and resource gaps. In the knowledge search process, only through technical collaboration can enterprises make full use of the resources of other enterprises in the park (Naseer et al., 2021). From the perspective of the enterprise itself, any single enterprise cannot rely only on their own resources and ability to achieve any innovation demand. Enterprises will fully apply their resource endowment to competitive core business. And specialization among enterprises in the park can help enterprises spread their core business. The relative stability and trusting collaboration between enterprises can also help enterprises' long-term collaboration research and development, and integrate their own resources and capabilities with those of cooperative grid enterprises in various ways, so as to effectively integrate enterprises (Lin, 2019).

2)In today's knowledge and economic globalization, the situation of diversified and personalized market demand has been highlighted. The speed of technology renewal is far beyond the situation that a single enterprise can deal with. Therefore, technical collaboration contributes to increase external competitiveness. Enterprises must make full use of the park ecology and grasp the market dynamics quickly to be qualified to participate in the market and gain a firm foothold (Kaufman, 2015). Competitive pressure is not only from the production of similar products, but also

from the large group enterprises outside the park. Individual ideas will inevitably lead enterprises to compete or be defeated, so the enterprises in the park need to fully cooperate to form a community and be against external threats with the advantage of the park's resources and other advantages. At the same time, through the establishment of a park brand enterprises can form their own characteristics and competitive advantages to compete with large enterprises and have a place in the fierce market competition (Mao & Weathers, 2019). The technical collaboration among enterprises is not only designed to cope with the temporary fierce competition, but also is an inevitable choice for obtaining lasting and stable competitive advantages and ensure the sustainable and steady development of enterprises. Even the leading enterprises that temporarily maintain brand advantages and strong technological innovation ability in the competition must maintain their own advantages through park collaboration. It can be said that technical collaboration is the only path for enterprises to external competition, and technical collaboration in the park is one of the best choices for enterprises to external competition (Nicolas & Teece, 2021).

3)The collaborative relationship between enterprises can save knowledge searching and time. Therefore, technical collaboration helps to save social costs. Enterprises exist in the park due to the technical proximity or business needs, they build a collaborative relationship through a formal or informal partnership. This collaboration may be covenant or based on commitment. The emotional basis of mutual trust is formed in the process of collaboration. This kind of relationship on the basis of emotional trust is unable to be imitated by enterprises outside the park. The sharing of knowledge, resources, and the collective learning atmosphere will accelerate the formation of a scale effect. At the same time, in the process of collaboration, this social relationship will be strengthened with the frequent connection. Meanwhile, the collaboration grid structure will save the enterprise costs

through knowledge (Xu, et al., 2019). On the other hand, the division of labor and collaboration among enterprises can effectively reduce enterprise innovation cost and save time. In the park, the overall product production cost will be reduced, but also in the professional field, the enterprises that experience the economy and time cost saving will choose to trust each other and tend to establish long-term stable collaboration relationship, which also will reduce the collaboration cost, and then save the social cost of searching (Rui, et al., 2021).

2.2.3 Process of technical collaboration among enterprises in the park

The process of technical collaboration among enterprises is actually the procedures and activities where knowledge and technology are deliberately transferred from one organization to another. Bapuji & Crossan (2004) believe that the process of enterprise learning can be regarded as learning from enterprises in the same industry and enterprises in different industries, namely inter-bank learning and dislocation learning. Massaro et al., (2019), on the foundation of the potential energy theory in logistics, believes that knowledge transfer is the process by which a knowledge receiver with high knowledge potential energy transmission directs that knowledge to a receiver with low knowledge potential energy. Tian & Siebert (2019) argue that technical collaboration among enterprises is a process of mutual learning and knowledge transfer. Bahl (2020), on the other hand, believes that knowledge transfer is an effective specific application of knowledge in different situations. Through the replication, diffusion and dissemination of value knowledge, we can improve the application scale of knowledge, expand the application scope of knowledge and improve organizational performance.

There are some differences between China and other countries in the research of technical collaboration. The research in China pays more attention to the difference between research subjects and the dissemination of knowledge. For example, Li

Jinghua & Chang Xiaoran (2013) found that the previous research does not consider the difference of knowledge transfer within and among organizations. With the rapid change of the external technical environment and market environment, the investment of knowledge resources, human resources and property in enterprises are limited. And the internal knowledge of the organization is unable to cope with the rapid changes in the external environment (Yin Junjie & Shao Yunfei, 2017). Hence, the researchers' perspective also begins to turn to the technical collaboration among enterprises and the process of knowledge communication among enterprises both at a personal and enterprise level, so the collaboration among organizations is more complex and worthwhile from a research perspective. If the enterprise technical collaboration can be established and knowledge communication can be successful, it can have an important impact on enterprise competitive advantage.

2.2.4 Technical collaboration among enterprises in the park

Within the park, the collaboration relationship among enterprises refers to a relationship between resource exchange and information exchange established due to cooperative innovation. The relationship among subjects is the arrangement of the process of technical collaboration achieved among enterprises based on certain collaboration goals (Cao Xia & Song Qi, 2016). Wu Guobin et al., (2015) believes that the technical collaboration relationship among enterprises describes a state of resource investment interaction, continuous connection among enterprises, mutual running-in and recognition of the behavior mode of the cooperative grid structure. Technical collaboration also belongs to the category of social relations from the perspective of social psychology. Lyu et al. (2020) and Meissner & Carayannis (2019) believe that the collaboration relationship is mainly characterized by the relationship strength and quality of the cooperative parties having an important impact on the cooperative effect.

2.2.4.1 Quality of collaboration relationship

As for the collaboration relationship among enterprises in the context of the park, Chase Rant (2003) believes that the relationship quality among enterprises can be explained via theoretical frameworks such as resource dependence, transaction cost and social exchange. Resource dependence theory can use dependence and uncertainty as the main pre- dependent variables (Basah, et al.,2020) for the quality of relationships among enterprises. The transaction cost theory contends that technical collaboration breaks the original boundaries of enterprises, and the cost of obtaining knowledge through technical collaboration will be lower than the knowledge and technology that enterprises obtain and search for from the external environment. The theory of social exchange believes that the collaboration relationship among enterprises is the process arrangement of related exchanges of information as well as resources and technology, which can help enterprises to realize social exchange more fully and effectively. A collaboration relationship not only exists among different enterprises, but also between enterprises and individuals. It is a collection of information sharing, human history, wealth status, resource and technology ability (Brooks, 2019). The effective use of relationship quality can contribute to the rapid transfer of knowledge and technology, and promote the healthy and stable development of collaboration relationships among enterprises (Beaver & Jennings, 2000; Karlan, et al., 2012).

As for the impact path of relationship quality on cooperative innovation performance, Collins (2013) and Sun et al., (2021) believe that relationship quality can be described through communication, trust and commitment, which can ensure the stability of collaboration relationships. Communication is the bond of relationship maintenance; trust is the hub that the relationship can be established upon; and commitment is the continuous advanced stage of the relationship. Pan Wenan (2006)

established through empirical research that the quality of collaborative relationships among enterprises has a significant positive impact on integration ability and cooperative performance, and integration ability plays an intermediary role. Xie Xuemei et al., (2014) believes that commitment is conducive to deeper integration among enterprises, and that effective communication and positive interaction can increase the activity of cooperative innovation.

2.2.4.2 Intensity of collaboration relationship

Relationship intensity is a comprehensive concept that needs to be characterized by other characteristic variables. Scholars incorporate feature variables that can characterize the intensity of the relationship into the category of their leading factors. If cohesion is shown, Reagans & McEvily (2003) believe that the closeness of the collaboration relationship facilitates enhanced cohesion and makes knowledge source businesses willing to invest more time and effort (Garcia Cabrera 2020; Park, et al. 2021); Regarding relational systems, Mowery,et al. (2015) found that the relationship system affects the choices both parties make in knowledge transfer behavior. For example, under relatively loose systems such as the consortium, knowledge transfer acts more freely on both sides, but it is difficult to achieve unified management. Therefore, it is not conducive to the transfer and acquisition of implicit knowledge (Sikombe, 2020). However, under the relatively close system of mother and son companies, the institutional constraints are more obvious and more conducive to the transfer of invisible knowledge on both sides (Nordin, 2020; Arnett, 2021). About the common vision, Rui & Luo (2019) argue that the high intensity of the relationship means a deeper understanding of each other, so it is easier to have a common vision in pursuing future goals, reducing the contradictions caused by each other due to the differences in culture and concepts as well as promoting the knowledge transfer of both parties and tight connection. Delbono & Lambertini (2014) argue that the high intensity of the relationship can increase trust in each other's abilities and character. A

high level of trust helps to create a good cooperative atmosphere and general willingness to collaborate as well. Each party will take a positive attitude to each other's knowledge needs and knowledge supply to promote cooperative performance (Haahti, et al., 2005; Worthington, 2015).

2.3 Technology transfer in the park

Technology transfer is not an isolated link, but is closely linked to the creation and utilization of knowledge. Technology transfer can be seen as an interaction between knowledge recipients and knowledge providers who acquire the knowledge needed through a variety of channels and then absorb, apply and innovate (Ding, 2012). At present, the research on technology transfer mainly focuses on two aspects, technology transfer among enterprise departments and technology transfer among organizations.

2.3.1 Definition and connotations of technology transfer

Research on technology transfer began in the late 1950s, and it began to attract academic attention in the 1960s, before a rapid development. At present, there is no unified definition of technology transfer, and international technology transfer is usually divided into vertical and horizontal technology transfer. The former refers to the transfer of technology from research and development to application. The latter refers to the transfer of technology from one region or one economic system to another region. In general, technology transfer can be understood as the dynamic process of the transfer of physical technology, scientific knowledge and other system knowledge from a technology source to the selection, use, digestion and absorption of the technology demand party. It is the result of the joint action taken by technology

innovators and technology recipients. Scholars' research on the meaning of technology transfer is conducted according to a different focus. Tatsuya Kobayashi (1981) also holds that the focus of technology transfer is knowledge transfer, and that generalized technology transfer is the redistribution of human knowledge resources. Glass et al., (1998) believes that the focus of technology transfer is technology application, which can be applied widely in terms of social scope. Howells (1996) believes that the focus of technology transfer is on regional field transfer. Technology transfer is the process in which science and technologies generated or used in a certain field are improved or applied in a different field.

The definition of the technical intermediary is generally separated into many aspects: The transfer of system knowledge, it is the transfer of system knowledge to the place of knowledge use (Mattoo, 2001). The transfer among the links of the longitudinal technology movement, that is, the transfer among the links of basic research, application research, development and commercialization (Cameron, 2005). The new application of the existing technology (Hoekman & Javorcik, 2006).

2.3.1.1 Information Asymmetry

Information asymmetry refers to the process of technology transaction during which the technology transfer party grasps far more of the technology than the technology recipient. The transfer party has more “private information”, while the demand party of the technology knows little about the technology to be introduced and is at a relatively disadvantage (Blalock & Gertler, 2008). However, this asymmetry of information is the premise of technology transfer. If the employer has the technical information owned by the technology supplier, the employer will not be willing to incur the costs without protecting an effective IPR system to purchase technical property rights (Glass & Saggi, 1998). Therefore, information asymmetry can be said to be the driving force of productivity development. But on the other hand, the asymmetry of information also increases the cost of both technology transactions.

2.3.1.2 Non-certainty of the value of technology

The application of technical goods in production is a process of further release and creation of the potential value of complex labor. The successful transfer and application of technology to real production will make the technology produce an expansion force so that its value far exceeds the general material goods, bringing excess profits for the development and production of new products, which is the value-added value of technical goods (Friedman & Silberman, 2003). But achieving this value-added process will be affected in many ways. In the technology transfer activities, the existing technical conditions, personnel and management levels of the technology recipient may all be obstacles to the acceptance and understanding of the technology (Howells, 1996). In addition to the complexity of the technology, the technology recipient always expects to get more technical information through the technology transfer than the technical products provided by the technology transfer party. However, it is impossible for the technology provider to transfer all the technology and relevant information the first time, and the technology recipient will also take some time to digest and absorb it. On the other hand, the value of technical commodities is generally relatively high and highly confidential. The technology suppliers are likely to use their own information advantage to deceive the demand side of the technology, exaggerate the technical effect or only transfer part of the technology (Wright et al., 2004). Although technology has high potential value, the realization of this value is uncertain.

2.3.1.3 High transaction costs

The features of information asymmetry, incompleteness and imbalance of technology market information distribution in technology transfer often lead to high search costs (Cameron, et al., 2005). The uniqueness of technology and the implicitness of knowledge make the technology consume a lot of human, material and financial resources in the transfer process so that the transaction cost can further

enhance the technology as a public good, as well as the definition and protection cost of property rights are also very high (Kabiraj, 2016).

2.3.2 Technology transfer among various departments within an enterprise

The earliest research on enterprise internal technology transfer revolves around how multinationals can effectively realize international technology transfer. Vernon (1966) believes that the driving force of multinational enterprise technology transfer is the entrepreneurial consciousness of pursuing profit opportunities. Due to the scarcity of supplier labor and the lack of resource starvation, the marginal income of production in the location of the demand party increased accordingly, and the transfer of production to another country made more profits, so the new knowledge and new technologies are transferred to another country along with the production transfer. Caves (1982) has also confirmed that the strategic expansion of multinational companies from home countries to foreign countries can give them a competitive advantage. Morrison (1995) finds that organizational grid structures tend to have more innovation for multinational companies that support integration activities and resource sharing beyond subsidiary boundaries. Birkin Shaw (2015) finds that enhanced communication through informal relationships among subsidiaries is a key to technology transfer.

Giroud & Mirza (2006) argue that whether a culture within a business encourages sharing has a more pronounced impact on knowledge transfer among departments than specifically designing a set of transfer mechanisms, especially for knowledge recipients. Seetzen & Whitehead (2014) reach similar conclusions, but from another perspective, they believe that transferring knowledge should be explained in advance, allowing training for organizational members receiving knowledge to accept new norms and practices. Perez Cruz (2021) believes that common values or cultural atmospheres are conducive to the sharing and transfer of

knowledge.

At present, the academic research on the factors affecting technology transfer mainly focuses on what factors hinder the smooth progress of knowledge. Goodman (2013) presents three important factors affecting the transfer of the enterprise's knowledge absorption ability. The first one is the receiver's ability to absorb knowledge, especially in the absence of this ability; the second one is knowledge attributes, mainly whether the knowledge to be transferred is embedded in practice; the third one is the type of knowledge, which mainly refers to the acquiescence, scope and complexity of knowledge. The scope and complexity of the knowledge to be transferred is embedded into industrial parks, given the simultaneous transfer or replication in the transfer, absorption, adjustment and application of the corresponding environment (Surender Munjal et al., 2021). The transfer mechanism is also an important influencing factor, with organizational behavior research and sociological research mainly exploring relational factors (Teece, 2003). Lin (2010) argues that formal relationships among departments are conducive to informal technology transfer, which is in some cases more conducive to the flow of knowledge between different sectors than formal transfer.

Wu Xiaoling (2004) borrows from previous research results and proposed that the team-level technology transfer within the organization is divided into five types: continuous transfer, near transfer, far transfer, strategic transfer and expert transfer. Wang Jun & Fan Zhiping (2004) believe that there are three ways of technology transfer in an organization: The first one is the transfer of individual knowledge to organizational knowledge base, that is, individual tacit knowledge is made into explicit organizational knowledge; the second one is the transfer of organizational base knowledge to individuals, that is, the individual recessiveness of organizational explicit knowledge, in this way, individuals in the organization can acquire knowledge through learning in the organization; finally, the direct sharing of (hidden)

knowledge among individuals in the organization, that is, the direct transfer of hidden knowledge among individuals in the organization. The first two kinds of technology transfer are the main ways.

2.3.3 Technology transfer among different organizations

2.3.3.1 Technology transfer in the strategic consortium

Strategic consortium is characterized by tightness, creativity, complementarity and ambiguity of input and output. At present, there is a lot of research on the technology transfer from the perspective of strategic consortium. Reuer & Arino (2007) made an empirical research on the preconditions of marketing technology transfer in the strategic consortium. They found that in a joint venture in the form of equity collaboration, the successful technology transfer requires the correct assessment of knowledge, the appropriate knowledge docking, the knowledge penetration of the joint venture and the cultural compatibility of the partners. In the research on the core ability and grid structure of learning in the international strategic consortium, Dua (2010) finds that learning intention, the knowledge transparency of both sides and absorption ability are the key factors affecting the transnational transfer of knowledge. He believes that internalization is the most important form of technology transfer because internalization can not only avoid the pricing difficulties and moral risks to knowledge of market transactions, but also enables cooperative parties to get the knowledge that they want. This paper considers that knowledge with high transparency is most accessible. Knowledge absorption ability has evaluation of the original knowledge, organizational tolerance and knowledge distance. If all parties in the consortium believe that their original knowledge accumulation is insufficient to deal with the competition and the organization is tolerant enough of the mistakes in the process of exploring new knowledge, new experience and new methods, then the knowledge gap among the parties is not too large it is also easy to transfer knowledge

among enterprises in the consortium.

The analysis of the obstacle factors affecting consortium technology transfer needs to be carried out from the point of view of the accessibility of knowledge, the interactive relationship of consortium grid structure, the learning ability of consortium enterprises, the differences between consortium grid structure and the technology transfer channel. Miesing (2007) believes that the implementation process of technology transfer significantly affects the technology transfer effect; for the potential variable technology transfer implementation process, technology transfer investment, technology transfer mode, and technology transfer situation adaptability has significant positive effects; the information symmetry of both sides of the consortium has a positive and significant effect on the organizational knowledge recognition ability; the direct impact of the organization's knowledge recognition ability on the technology transfer implementation process is not significant. However, it indirectly promotes the technology transfer process by positively and significantly affecting the technology transfer process. The technology transfer ability of the knowledge source and the knowledge absorption ability of the knowledge receiver have a positive impact on the adaptability of the technology transfer situation.

2.3.3.2 Technology transfer in industrial clusters

High-tech industrial clusters can promote the transmission speed and quality of information, which is conducive to the dissemination and sharing of knowledge in the cluster. The perfect infrastructure provides good external conditions for technology transfer. According to the technology transfer channel, the technology transfer mode of industrial clusters can be divided into pairwise mode, intermediary mode, cluster mode, dynamic mode and virtual mode. No matter what mode, technology transfer is a process of interactive learning by cluster participants (Zhu Weimin, 2005). Xu Zhanchen & He Mingsheng (2005) believe that technology transfer and interactive learning in enterprise clusters are the key factors in the formation and maintenance of

their competitive advantages, and the industrial clusters embedded in the economic, social and cultural environment of specific regions can eliminate the obstacles to knowledge flow to a certain extent. Integration ability, internalization ability, externalization ability, re-metaphorical ability, internal socialization ability and internal and external mutual transformation ability constitute the learning ability of the cluster enterprises.

Vecchiato et al. (2019) believes that key technologies and working groups that entrepreneurs and technicians are involved in can offer help in the transfer of those technologies that have overcome the initial life cycle and have been applied in other sectors. Scenario analysis is a more appropriate approach to face global competitive challenges. Although this approach is complex and time and resource consuming, they may be very effective in coordinating the most relevant private and public stakeholders in the region and in enabling them to envision future long-term economic development in the region. Harris et al. (2020) believes that the agglomeration of innovative industries brings a demand for talent and creates a highly skilled labor market. The agglomeration of labor provides favorable opportunities for both individuals and companies to match labor demand with labor supply and is key to continued innovation. Furthermore, the mobility of a highly skilled workforce in clusters is a key mechanism for technology transfer and for facilitating inter-enterprise connections.

2.3.3.3 Technology transfer in the Park

Knowledge and technology are among the most important resources of industrial parks. An important goal of establishing industrial parks is to quickly improve the innovation ability of enterprises through the complementary advantages and collaboration among different organizations. There are three progressive levels in the transfer of hidden knowledge in the park: the hidden knowledge mining and identification layer in the enterprise, the hidden knowledge transfer layer in the

enterprise, and the hidden knowledge transfer layer in the park. It is an effective means to promote the transfer of hidden knowledge to build a good cross-organizational culture, design an incentive mechanism to promote technology transfer, build a flat platform for knowledge flow and transformation and promote the exchange and learning of employees in the park (Sawada Y, 2012) .

At present, research on the internal technology transfer in the park mostly discusses the internal technology transfer process of enterprises in the park from the micro level, and there is a lack of relatively detailed investigation of the macro kinetic behavior characteristics and the connection between the micro level and the macro level presented in the process of technology transfer. Ge Anru and Tang Fangcheng (2019) adopted the virtual experiment method and described the dynamic behavior mode of technology transfer based on the rule system, and discussed the relationship of the interdependence and dependence among adjacent enterprises, technology transfer speed and group size. Zhao Jianyu et al. (2020) discuss the impact of knowledge flow on the industrial grid structure within the park. Liu Guoxin et al. (2021) analyze the technology transfer in the park from the perspective of enterprise innovation and construction principle.

Ashraf et al. (2019) believes that park resources can contribute to improving enterprises' ability to use and reuse knowledge resources. Davide (2021) empirically measured the impact of the degree of licensed technology transfer on the development of the park, yielding an accurate replication strategy that seems to improve economic growth. And the benefits of exact replication knowledge in the first year lasted for several years. It can be seen from the relevant analysis of technology transfer, compared with the technology transfer within organizations, that the technology transfer among organizations is more complex. From the perspective of the research development trend, the space is greater for in-depth expansion.

2.3.4 Mediation role of technology transfer

In order to realize the stable development of industrial parks, we should pay attention to the length of mutual relationship maintenance. Only by long-term interaction and communication among enterprises can we form a relatively long-term and stable collaboration relationship, better promote the sharing of knowledge resources among enterprises and then ensure the improvement of enterprise innovation ability. Mettler & Winter (2016) found that the stable relationship among enterprises in different countries is different. With the more stable the collaboration relationship is, the more the enterprises are familiar with each other and the more convenient the knowledge needed for the enterprise development is, which will ultimately help enterprises improve their innovation ability of products. Establishing a relatively stable relationship among enterprises helps to increase trust among members, promote the spread and sharing of knowledge as soon as possible and then promote the improvement of enterprise innovation ability (Rexhepi et al., 2019). The stability of the park is the guarantee for enterprises' effective communication and interaction (Chakraborty et al., 2019). If the benign interaction and communication is not realized, which makes the emergence of differentiated knowledge in the park, it is not conducive to enterprises to find the knowledge resources they need. It will even weaken the level of enterprise knowledge creation, and it is not conducive to the improvement of enterprise innovation ability (Su et al., 2013).

2.4 Entrepreneurial performance

2.4.1 Connotation of entrepreneurial performance

Entrepreneurial performance is one of the criteria for measuring entrepreneurial

achievements and effectiveness. There are three leading types of research on the influencing factors of entrepreneurial performance. The first one is to analyze the relationship with entrepreneurial performance based on the research perspective of leadership style and entrepreneurial team characteristics focusing on the leadership theory (Yan Ling et al., 2008; Zahra et al., 1999; Davis, 1991), corporate leadership style (Wood, 1989; Rutherford et al., 2007; Wiklund, 2005), entrepreneurship (Agle, 2006; Baker, 2009; Bandura, 1989), entrepreneurial team heterogeneity (Barney, 1986; Bass, 1999; Baum, 2004), and team atmosphere (Baumol, 1989; Begley, 1987). The second one is to analyze the relationship with entrepreneurial performance based on the research perspective of entrepreneurial environment and entrepreneurial ability, focus on the entrepreneurial environment (Bandura, 1997; Bitzenis, 2005; Busenitz, 2003), entrepreneurial behavior (Campbell, 1993; Castro Giovanni, 1991; Chakravarthy, 1982), entrepreneur ability (Chen M J & Hambrick D C, 1995; Child J, 1972), team collaboration (Daniel R. Denison & Aneil K. Mishra, 1995; David A. Nadler & Michael L. Tushman, 1990), and entrepreneurship decisions, (Deng S & Dart J, 1990); the third one is to analyze the relationship between enterprises and entrepreneurial performance based on the perspective of enterprise entrepreneurship and knowledge capital research. The results are mainly focused on innovation (Dess & Beard, 1984; Duchesneau & Gartner, 1985; Dzinkowski, 2000), risk-bearing (Drucker, 2002; Etzioni, 1960; Guth & Ginsberg, 1990; George et al., 1999; Ireland et al., 2003; Jantunen et al., 2005), strategic prospective (Jambulingam,2005; Leonard,1992; Lane,2006; Morris & Lewis, 1995; Motowidlo & Van, 1996), etc.

Research on entrepreneurial performance has demonstrated a complex correlation between enterprise entrepreneurship and enterprise performance, but lacks a comprehensive and clear understanding of the enterprise entrepreneurial action mechanism, processes and related management activities (Zahra & Covin, 1995). Entrepreneurship orientation provides an effective starting point for the research of

entrepreneurial enterprise and interprets the internal mechanism of entrepreneurial performance through entrepreneurship orientation. However, excessive emphasis on entrepreneurship orientation will lead to high risk and lack of resources. Due to the slightly different intermediary variables selected by different scholars, the research conclusions of the overall mechanism of action are different (Baum et al., 2014; Shan Peng & Pei Jiayin, 2018). Therefore, exploring and mining the indirect impact of entrepreneurial orientation and entrepreneurial performance will facilitate a deeper understanding of the mechanisms of action of entrepreneurial orientation and entrepreneurial performance (Rauch et al., 2009).

2.4.2 Measurement of entrepreneurial performance

Scholars believe that entrepreneurship-orientation (EO) is an important predictor of business performance. In field research on China's high-tech enterprises, the relationship system between the interactive memory of risk teams is studied (representing the assignment of team knowledge, integration and utilization) and the EO and the team. The mitigated impact of corporate and environmental factors discover that new entrepreneurial teams' interactive memory systems enhance their entrepreneurial orientation (EO) and the relationship is trusted within the team and provide a positive impact on the structural organization and the environmental vitality of the joint venture. The results provide new insights into the microbasis of TMS when developing EO in new enterprises (Dai et al., 2016). Entrialgo et al. (2000) believes that the goal of all business management and strategy is to create profit, which is to create profit maximization by resource minimization. Entrepreneurial performance is a standard (Rothschild, 1999) used to assess whether the expected entrepreneurial outcomes are met. Shi, Wang, Xing (2015) believes that performance is the overall concept of the final result of business activities to measure the degree to which the enterprise achieves its goals. Heather J et al. (2014) propose that

entrepreneurial performance is the satisfaction of entrepreneurs with their own entrepreneurial achievements, and it is the fundamental way to measure performance. Rieckhoff & Larsen (2012) notes that entrepreneurial performance is a measure of the extent to which startups aim to achieve their long and short-term business goals (Hafeez, 2000). Tang & Hull (2012) defines entrepreneurial performance as the satisfaction of entrepreneurs with the final results of the business operation activities that they create. Beattie & Smith (2010) sees entrepreneurial performance as an important indicator used by enterprises to examine operational activities, and as a measure of the attainment of entrepreneurial goals (Weick, 1979). Kim et al. (2013) believes that entrepreneurial performance is entrepreneurs' satisfaction with the enterprise target standards and operating results. Doorn et al. (2014) defines entrepreneurial performance as the degree of entrepreneurs' satisfaction with the final outcome of the expected target rate. Zhao et al. (2011) explains entrepreneurial performance as saying that entrepreneurs want to achieve fruitful businesses and understand the results of corporate strategy implementation by measuring the extent of work goals achieved. Schillo (2011) notes that entrepreneurial performance can be measured by market share, enterprise sales levels, cost control, profitability, and overall performance, as well as product design, technology development, employee productivity, customer satisfaction, and marketing and enterprise reputation as performance measures (Song et al., 2008).

Liden et al. (1996) believes that the measurement of entrepreneurial performance can be divided into objective and subjective indexes. Objective performance refers to all kinds of financial indicators, such as sales growth rate, net profit, etc., while subjective performance refers to non-financial indicators, including satisfaction and problem resolution (Venkatraman, 1989). Venkatraman & Ramanujam (1986) divides entrepreneurial performance into three dimensions: financial performance, career performance and organizational efficiency. Financial performance is the economic

index of completing the enterprise, such as operating income, profit level, etc. Business performance is mainly operational performance besides financial performance, including market share, product quality and new product launches, etc.; organizational efficiency includes the satisfaction of customers, shareholders and employees with the enterprise. Demirag (1987) indicates that organizational performance can be measured by market share, enterprise sales level, cost control, profitability and overall performance. It can be based on the product design, technology development degree, employee productivity, customer satisfaction and enterprise reputation as performance measures. Zhang Yuli & Li Qian (2009) take four performance measures of market share- sales growth rate, operating net profit, interest rate and investment remuneration rate- by measuring the subjective performance of the initial venture (Ucbasaran, 2001). Cooper (1995) points out that the indicators of entrepreneur satisfaction can be divided into three dimensions: the initial goals of entrepreneurship, expectations and the unique satisfaction attributes of different types of entrepreneurs.

Murphy et al. (2004) distinguishes entrepreneurial performance into financial indicators, operational indicators and multiple component indicators. Financial indicators are mainly in terms of organizational efficiency; operational index is product or service quality and market share; the multiple component index is measured by a combination of financial indicators and operational indicators. Wiklund (1999) claims in the discussion of the relationship between entrepreneurial orientation and performance, the measure of growth performance is to select sales growth rate, growth of employees and compare with competitors. In terms of financial indicators, it takes gross profit margin as a profit-making index (Gnyawali & Fogel, 1994). Lee et al. (2001) believes that in the early stage of entrepreneurship, financial indicators, such as return on investment or interest rate are not applicable as performance measures, and entrepreneurial performance should be measured through

business growth. Gruen et al. (2006) separates entrepreneurial performance into economic indicators (enterprise financial performance indicators) and non-economic indicators (entrepreneur master subjective satisfaction, including personal length and achievement of personal goals). Vickery (1991) proposes performance measures as financial and non-financial indicators, which are mainly measured by profitability (short-term) and enterprise growth (long-term), rather than financial measures by satisfaction and the overall success rate of the enterprise. Yang Minli et al. (2009) believe that financial performance indicators are presented in numbers, and that non-financial indicators tend to be a measure of the subjective satisfaction of entrepreneurs. Zhong Weidong et al. (2007) point out that the characteristics of start-up technology companies determine the personal factors and entrepreneurial environment are the key factors affecting their performance. Entrepreneurial performance includes overall satisfaction and financial satisfaction. The former is an important measure of enterprise marketing activities and a measure of entrepreneurial achievement rate and different from the general organizational performance; the latter is the actual sales and profits compared to pre-startup expectations (Gruen et al., 2007).

2.5 Research differences

This chapter discusses the research progress of resource-based theory, technological collaboration between enterprises in the park, technology transfer in the park, and entrepreneurial performance. Through combing the previous literature, the following understandings are obtained.

Many scholars have studied the technical collaboration inside and outside the park. The study found that the enterprises in the park have different characteristics in terms of human resources, financial resources, and social relations. Through technical

collaboration, it is possible to achieve resource sharing and complementary advantages between enterprises in the park. The synergy effect will accelerate the integration of resources between enterprises and save social costs. However, the existing literature also has two deficiencies.

First, from the perspective of the scope of this research, the related research on technology collaboration, technology transfer, and entrepreneurial performance is relatively mature, but not many researchers have combined these elements. When researching corporate performance, it is generally only a study of the impact of general partnerships on performance, and the partnership is not specifically related to technology transfer.

Second, judging from the research conclusions, different research objects, technology collaboration and technology transfer have different effects on corporate performance. At this stage, in the context of the rise of the Internet economy, the increasing number of entrepreneurial enterprises, and the shortening of enterprise life cycles, what kind of relationship exists between the technical collaboration and entrepreneurial performance of entrepreneurial enterprises needs to be targeted on the basis of predecessors. Empirical research, as an effective supplement to previous research.

Therefore, this study draws on the research results of predecessors. In terms of the research subject, the park is the main research object. It not only considers the technical collaboration relationship between enterprises in the park, but also considers the collaboration relationship between enterprises and universities and scientific research institutions. This study intends to incorporate technology collaboration, technology transfer, and corporate performance into a unified research framework, and conduct quantitative research on the relationship between the three to supplement the deficiencies of the original literature; in the research method, focus on testing the mediating role of technology transfer, and the goal is to go deeper to understand the

mechanism of the relationship between the three, and put forward more specific and feasible countermeasures to improve the performance of entrepreneurial enterprises.

III Research Model and Hypotheses

This paper is intended to explore the relationship and mechanism between the two variables of technical collaboration and technology transfer in technology-based enterprises. Through the analysis and sorting of the theories and literature above, it can be found that the traditional grid structure among enterprises in the park is loose and often a single grid structure. There is a lack of deep association among enterprises upstream and downstream of the industrial chain, among park consortia and among relevant research institutions. At the same time, intra-enterprise collaboration through cooperative projects is relatively limited. The role of technical collaboration and technology transfer in the organization of enterprises is highlighted, and the transfer of innovation development between industrial and service chains is fully emphasized, which forms a grid path with the industrial chain as the horizontal axis and service chain as the vertical axis. The knowledge innovation and technology achievement transformation in the park is fully covered among the nodes.

The grid structure theory of collaboration relationship provides a more comprehensive analytical framework for corporate collaboration. Universities, research institutions and enterprises are in a complex grid structure of collaborative relationships (Tang Yongli, 2008). In the technical collaboration of technology-based enterprises in the park, one member may maintain a collaborative relationship with several other members, but there may also be multiple different divisions of labor between two members simultaneously. Each node relies on the technology department, such as the research institute to realize the technology transfer. The virtuous cycle mechanism, involving "collaborative R&D of a technological project - the transformation of achievements - business incubation - high-tech enterprises to develop and grow - transfer of achievements to obtain revenue - reinvestment of R&D

for a high-tech project," is developed, so as to promote the deep integration and orderly transfer of science and technology, talent, capital, information, market and other innovation factors. In order to better analyze the mechanism of technical collaboration and technology transfer on the entrepreneurial performance of enterprises in the park, this study divides technical collaboration and technology transfer into specific dimensions, conducts in-depth research, constructs specific research models, and proposes preliminary hypotheses.

3.1 Research model

Based on the research Background and contents presented in the introduction of Chapter I and the theoretical basis provided in the literature review of Chapter II, this chapter will construct a conceptual model of the relationship between technical collaboration, technology transfer and entrepreneurial performance variables in the technology-based entrepreneurial enterprise clusters in industrial parks. Furthermore, the corresponding research hypotheses and the construction of a research model based on these research hypotheses will be presented.

In this study, the research of technical collaboration and technology transfer in technology entrepreneurship clusters and entrepreneurial performance are the most important objectives of this study. Moreover, the construction of independent variables that have an impact on the entrepreneurial performance and the technology transfer that mediates the effect among them will be verified.

Existing studies have generally demonstrated that collaboration in the vertical chain of enterprises can effectively stimulate productive innovation in enterprises. Due to the heterogeneity of the knowledge base between the top and bottom agents, the accessibility of knowledge transfer, and the dual logic of technology transfer, technical collaboration in vertical chains of enterprises roughly has a positive impact

on entrepreneurial performance. At the same time, the unique knowledge of an enterprise is an intangible asset of the enterprise, which is non-permanent and implicit, and is likely to generate a loosely coupled system. Therefore, the value content of this system is high and rare, and it cannot be imitated completely because of the impossibility of copying it, which is emphasized in the resource-based theory. Because of this characteristic, the higher the likelihood of achieving entrepreneurial performance if the firm-specific knowledge is adequately transferred between the followers and the followed firms. Accordingly, a general theoretical research framework is constructed in Figure 3-1.

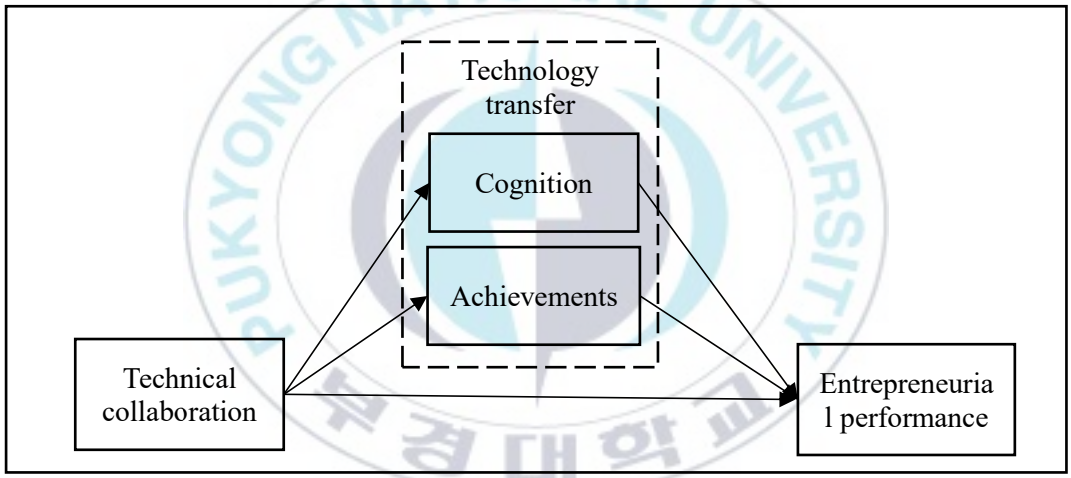

Figure 3-1

3.2 Research hypotheses

3.2.1 Relationship between technical collaboration and entrepreneurial performance

The dynamic capabilities perspective discusses how firms mobilize and deploy

resources and unique capabilities to gain a competitive edge. Social relationships are a source of strategic assets and competitive leadership in a dynamic environment. Firms establish technical collaboration with a range of external organizations (customers, suppliers, government departments, and research institutes) to gain access to information and technology beneficial to firms themselves. In this way, collaboration can improve the quality of information exchange and transfer, as well as reduce the cost and risk of information transfer, and thus promote the innovation performance of enterprises.

A rich variety of technical collaboration can help companies break down internal rigidity in the context of corporate linkages, where innovation is largely recombination of technologies. There are inherent uncertainties associated with innovation and difficulties in identifying the exact skills needed to advance a project. The greater the variety of relationships and complementary resources to which firms with strong technical collaboration capabilities have access, the more competitive firms with different technologies and skills will be. In cases where formal resource allocation procedures may be ineffective, the role of such firms with heterogeneous capabilities that can be extracted is highlighted. At the same time, these firms are more likely to acquire, exchange, and create new technologies in the midst of different types of technological collisions, increasing opportunities for combinations of innovation elements, and the diversity of information pools and sources enhances creativity and allows for the generation of multiple redundant ideas. In a sample of 77 telecommunication equipment manufacturers, Phelps (2010) verified that collaboration enriches technological diversity and improves innovation performance. Rodan & Galunic (2010) analyzed data collected from interviews with managers and conclude that a firm's technical collaboration capability positively impacts overall firm performance. Li Zhengwei et al., (2013) used a sample of 164 manufacturing firms in Zhejiang Province to empirically demonstrate that firms with strong

technological capabilities have more opportunities to collaborate with external firms to obtain more complementary innovation resources, thus contributing to the firm's innovation performance. Hao & Feng (2016) explore the extent to which collaboration can help firms acquire different technologies and promote a breakthrough in innovation performance through three types of linkages: buyer-supplier, peer collaboration, and equity linkages. Fang, Wang & Chen (2016) use data from 144 high-tech firms in Taiwan to empirically demonstrate that technical collaboration can help firms to acquire new technologies and thus improve their innovation performance. Susan & Caner (2016) found that the contact of consortium partners can facilitate technology transfer and learning from the perspective of organizational learning, innovation and grid structure, and help firms to acquire technological heterogeneity in the grid structure. Moreover, their empirical study with panel data of U.S. biopharmaceutical companies found that technical collaboration of enterprise can help firms achieve innovative breakthroughs.

In modern economies, collaborative grid structures seek collaboration, association and synergy, rather than command, power and control. Strong ties and frequent interactions between partners will enable them to receive social support and resources from other collaborative grid structures in return. In an environment of increasing competition and uncertainty, most companies are becoming aware of the importance of collaboration and reciprocity and mutual benefit. Motivated by reciprocity, firms are more willing to communicate and share information with each other, resulting in reciprocal behavior. The willingness of subjects in a cooperative organization to work for the common good facilitates the exchange of information and technology between them, promotes the efficiency of enterprise collaboration, increases the level of trust between them, reduces the cost of enterprises, enables enterprises to have full access to spillover technologies, and improves their innovation performance. Wincent & Anokhin (2010) empirically study and conclude

that efforts to establish and strengthen reciprocity would reduce opportunistic behavior, lower transaction costs, and help improve the performance of participating firms. Xie Hongming et al. (2012) empirically demonstrate that the degree of technical collaboration among enterprises positively contributes to enterprises' technological innovation performance based on the perspective of external social capital, using a sample of 482 technology firms in Guangdong Province. Huang & Li (2017) argue that technical collaboration provides firms with more diverse information and technology and stimulates more ideas, and using listed technology firms in Taiwan as the study population, they find that technical collaboration significantly affects firms' innovation performance. Based on this, this study proposes the following hypotheses on the influence of technical collaboration among technology-based entrepreneurial enterprises on entrepreneurial performance.

H1: Technical collaboration among technology-based entrepreneurial enterprises positively affects entrepreneurial performance.

3.2.2 The relationship between technical collaboration and technology transfer (cognition, achievements)

Technical collaboration has an important impact on enterprise innovation. The purpose of establishing connections with the cooperative grid structure is to share information and technology with other entities in the cooperative grid structure, fill their own technology gaps, and strengthen their own technology reserves. Due to their own resource endowment limitation, enterprises cannot have all the technology for innovation, so they need to obtain technology resources from outside according to the innovative technology to meet the technology demand of innovation activities. In enterprise activities, the enterprise can obtain the technology from suppliers or customers and obtain the technology from suppliers or customers from their own contacts. In the process of repeated interaction between the two parties, technology

transfer is performed. In the case of a gap in technology levels between enterprises, they are more likely to obtain critical information and technology resources from technical collaboration, and in technical collaboration, the enterprises that absorb technology can get more technology resources. Technical collaboration among enterprises helps technology flow and innovation. The more frequent technology exchange among enterprises and multiple partners, the more opportunities for exchange, the stronger the trust among enterprises, the deeper the enterprises' knowledge about technology transfer, and the stronger the willingness to transfer the technology. A study by Wu, Liao & Dai (2015) point out that technical collaboration among enterprises positively affects the technology transfer of entrepreneurial enterprises.

Ideas in exploratory technology innovation may come from previous rules or from making creative feasibility decisions in similar actions (Mark, 2009). However, technological creativity is more likely to derive from the flow of local knowledge embedded in a new environment. In new environments, where exploitative technological innovations may become inefficient or the new environment triggers new opportunities, new knowledge needs to be added to technological innovation activities (Hallikas Jukka et al. 2008). As new technologies are added, various problems may arise from the existing dominant design rules. Most of the technology shared or transferred among organizations is technology that facilitates inter-enterprise learning, and it therefore has a significant impact on the technologies available to the enterprises. When a cooperative grid structure reanalyzes existing technologies, it often leads to innovations. The cooperative grid structure in the technology innovation organization, by means of technology transfer, is constantly exploring new technologies to improve the existing ones, which greatly contributes to the exploratory technology innovation performance.

Exploitative technological innovation consolidates existing technological

innovations based on existing knowledge, within the framework of a dominant design (including concept, technology, product or market) (Gilsing, 2006). Its uncertainty is significantly reduced. The exploitative technological innovation activities in a technological innovation organization mainly improve and apply existing knowledge, so the knowledge flow among organizations tends to be one-way learning. In systemic innovation, each cooperative member tends to accomplish their own set goals and innovation tasks, and consolidate existing knowledge. As a result, the flow of knowledge within the organization or other cooperative grid structures has a limited contribution to exploitative innovation. When the cooperative partners in a technology innovation organization possess specialized knowledge, the improvement of such specialized knowledge can easily lead to innovation, and the flow of knowledge in the cooperative organization no longer makes sense.

The idea of technical collaboration emphasizes collaboration, alliance, and synergy among organizations, i.e., whether the degree of mutual collaboration and interdependence among enterprises and subjects of cooperative organizations (upstream enterprises, downstream enterprises, research institutions, non-research organizations, and financial institutions) is reciprocal. Technical collaboration emphasizes non-unilateral giving, but altruistic behavior based on rewards. Technical collaboration occurs not through discrete exchanges or administrative orders, but through relationships based on mutual trust and reputation, and technology sharing in cooperative organizations of enterprises is fostered by a strong sense of reciprocity. For example, the collaboration among enterprises and their peers represents an enduring reciprocal relationship between competitors, with technological differences constituting the modules of their respective advantageous technologies. Enterprises can identify potentially useful technology elements, effectively combine these elements, and acquire and assimilate these technologies, resulting in technology transfer achievements. Dyer & Singh (1998) argue that technology transfer

achievements act as an effective mechanism to promote inter-firm technical collaboration while lasting reciprocal relationships with customers and suppliers strengthen the ties among cooperative partners and correspondingly facilitate long-term technology transfer and integration. Fritsch (2008) studied nearly 300 companies and research institutes in Germany's 16 regional innovation grid structures. He finds that inter-firm technical collaboration can effectively promote technology transfer and sharing among members of the grid structure while reducing the cost and risk of acquiring technology and promoting the formation of technology transfer achievements. Technical collaboration improves the perception of technology transfer among enterprises and changes the psychology of technical collaboration, improves technical collaboration behavior, and changes the mentality of technology recipients, reduces the loss in the process of technology transfer, and improves the efficiency of technology sharing. Chen & Huang (2010) empirically concluded that the normativity of technical collaboration significantly affects technical collaboration behavior by using data from a sample of 323 virtual communities. BabaMSB & TamjidH et al. (2013) used validated factor analysis and structural equation modeling analysis by surveying information security professionals in a virtual community. They found that there is a strong correlation among attitudes, trust, reciprocity norms and cognition of technology transfer and that technical collaboration has a significant impact on achievements of technology transfer.

H2: Technical collaboration among technology-based entrepreneurial enterprises positively affects technology transfer.

H2-1:Technical collaboration among technology-based entrepreneurial enterprises positively affects technology transfer (cognition).

H2-2:Technical collaboration among technology-based entrepreneurial enterprises positively affects the technology transfer (achievements).

3.2.3 Relationship between technology transfer (cognition, achievements) and entrepreneurial performance

Innovation is an important source of competitive advantage for entrepreneurial enterprises in the era of the knowledge-based economy, and the process of innovation is the process of knowledge learning, transfer, integration and reproduction. In today's rapidly developing economy and rapidly changing knowledge, the knowledge accumulation and internal R&D of any enterprise are no longer sufficient to meet the needs of entrepreneurship. Therefore, technology-based enterprises need exchange and collaboration between enterprises and research institutions, so that enterprises with different types of knowledge and ability and in different technology fields can gather together and exchange information. By integrating knowledge within and outside the organization, it is likely to achieve the output of entrepreneurial achievements faster. But technology transfer does not happen automatically. Some enterprises benefit more from knowledge exchange than others with the same opportunities. This is caused by the gap in the enterprises' inherent capabilities. Cohen et al., (1990) argue that in addition to cognition, understanding, and economic use of external knowledge, enterprises need to develop a special capability; a cognitive ability of technology transfer. The cognitive ability of technology transfer refers to an enterprise's ability to recognize the value of external information and to assimilate and apply it for business purposes. An enterprise's ability to absorb knowledge is influenced by its knowledge base. The more experienced and diverse the knowledge of individuals or technology team members in an organization, the more diverse the information they can interpret and the better they can solve difficult problems.

Cooperative innovation among enterprises benefits from technical collaboration and technology transfer, and technology transfer has received increasing attention from scholars as an important factor affecting knowledge dissemination. Some studies

show that certain technology transfers can promote heterogeneous knowledge dissemination and sharing among partners, stimulate firms to generate new thinking and new ideas, and increase entrepreneurial opportunities for enterprises. Granstrand (1998) also illustrates the important role of technology transfer in the evolution of technology-based enterprises from the perspective of economies of scale and scope. He believes that technology transfer increases the type of technology portfolio and provides new impetus for technological innovation of enterprises, so strong technology transfer capabilities are more conducive to corporate entrepreneurial output. Aldieri (2011) also emphasizes the key role of technology transfer in his study, and that technology transfer with partners enhances coordination among innovation agents, thus promoting interactive learning and improving the efficiency of entrepreneurial activities. Knoben & Oerlemans (2006) also argue that the closer the technology transfer activities among partners, the stronger the ability of enterprises to absorb and transform new knowledge, and the more conducive it is to corporate entrepreneurial collaboration. On the contrary, the looser the technology transfer activities among enterprises, the more frequent interaction is required, which increases the cost of collaboration and affects entrepreneurial collaboration. Therefore, technology transfer has an important impact on knowledge diffusion and technology diffusion, and it also influences organizations' choice of future partners. However, it is also argued that technology transfer can inhibit enterprises' access to new technologies and knowledge, making it difficult to update the technology pool and leading to technology track locking, which in turn constrains firms' innovation. At the same time, as the technological distance between the two partners expands, more heterogeneous resources need to be absorbed, the integration and collaboration costs of enterprises are increasing, and the possibility of friction among members is also increasing. All these factors restrict the redeployment and combination of related technical knowledge, making it difficult to transfer and share technical knowledge

with each other, which is not conducive to the output of entrepreneurial achievements.

A study by Nooteboom et al. (2005) on the relationship between technology transfer and learning, theoretically explores the impact of technology transfer on regional innovation performance, describing the relationship between the outcome of knowledge exchange (the effect of learning or innovation performance) and enterprises' technology transfer activities as a standing peak-shaped relationship. Finally, they conclude the innovation performance of economic entities is highest in the optimal technology transfer activity, i.e., in the appropriate development of technology transfer. In conclusion, technology transfer reflects the closeness of collaboration and entrepreneurship among economic entities, and is the most important prerequisite for interactive learning and entrepreneurship among enterprises and industries.

By acquiring, integrating and learning different types and natures of technologies, enterprises create new ideas or new processes and provide the knowledge and technology required for product innovation. Wu Cuihua & Wan Weiwu (2007) look from the perspective of technology stock and technology flow, on the one hand, technology transfer can introduce new technology resources for firms to fill the technology gap needed for corporate innovation. On the other hand, technology creation in enterprises is driven by the organizational demand for creativity and innovation, which drives frequent inter-firm exchange activities and helps generate new ideas and approaches. The new technologies of corporate innovation are integrated autonomously through technology transfer and applied to innovation activities, which reduces the cost of corporate R&D and lays the technological foundation for the acquisition of complex technologies, thereby contributing to the improvement of corporate innovation performance. Lin, Wang & Kung (2015) use 203 employees of high-tech firms in Taiwan and find that technology transfer positively affects enterprises' innovation performance through partial mediation of

cross-functional collaboration. Wu Cuihua et al., (2015) used factor analysis, correlation analysis, and optimal scale regression to examine valid data from 950 firms empirically and found that technology transfer have a positive effect on firm performance in both the start-ups and growth periods of enterprises.

Inter-firm technology transfer is an important way for enterprises to address the lack or absence of technology in the innovation process. Effective technology transfer promotes organizational and individual learning to accelerate and improve the innovation performance of enterprises. By acquiring new technologies required for innovation from outside through technology transfer, enterprises can obtain more complementary technologies to make up for the shortcomings of their own technology reserves, which can help break the limitation of internal resources and reduce the R&D cost of enterprises. Technology transfer can promote the exchange and transfer of technology among innovation entities. The interconversion of explicit and implicit technologies among enterprises and cooperative organization entities helps to increase the technology stock of enterprises, promote the application of technologies, and facilitate innovation in enterprises. Yli-Renko (2001) empirically investigated the positive effect of technology transfer of customer demand on product innovation using a sample of 180 high-tech enterprises in the U.S. Zhining Wang & Nianxin Wang (2012) empirically examined data from 89 high-tech firms in Jiangsu Province of China and find that the transfer of both explicit and implicit technologies contributes to enterprise innovation. Wang Juanru & Luo Ling (2015) found that key stakeholders' technology transfer behavior has a significant positive impact on R&D performance and innovation of complex products, using R&D teams of firms manufacturing complex products. Based on a survey of 150 Finnish technology-intensive firms, Ritala et al. (2015) find that external technology transfer positively impacts firm innovation performance.

H3: Technology transfer between technology-based entrepreneurial enterprises

positively affects entrepreneurial performance.

H3-1: Technology transfer (cognition) between technology- based entrepreneurial enterprises positively affects entrepreneurial performance.

H3-2: Technology transfer (achievements) between technology-based entrepreneurial enterprises positively affect entrepreneurial performance.

3.2.4 The mediating effect of technology transfer (cognition and achievements) in the relationship between technical collaboration and entrepreneurial performance

Randolph & Dess (1984) studied the effect of the degree of recognition of technology transfer on entrepreneurial enterprises and conclude that the degree of acceptance of technology transfer directly impacts the access to opportunities, survival, and growth of entrepreneurial enterprises. When enterprises have a higher awareness of technology transfer, entrepreneurial enterprises become more intense in their operations and have access to more resources, thus growing rapidly. On the contrary, when enterprises are skeptical about technology transfer, their entrepreneurial ability decreases, their profitability is affected, and continuous competition leads to the survival of the strongest.

Romanelli (1989) studied entrepreneurial performance of enterprises and finds that the greater the entrepreneur's perception of technology transfer for an enterprise, the higher the chance of acquiring entrepreneurial opportunities. Romanelli also found that the greater the adequacy and availability of technological resources in the environment, the more new entrepreneurs are generated. Most scholars agree that the external technological environment plays a crucial role in the emergence of entrepreneurial enterprises. However, few scholars have empirically demonstrated the relationship between entrepreneurial orientation and technological environment and the relationship between technology transfer and enterprise performance. On this basis, there is no research on the relationship between entrepreneurial orientation and

entrepreneurial performance in different environments.

Henri Grundsten (2004) studied the relationship between technology-based enterprises and entrepreneurial performance and finds that technology transfer among enterprises positively affects the growth process of entrepreneurial enterprises. For the technology transferring region, the technology gap is a comparative advantage in technological capability, which can help enterprises occupy a favorable position in the market and have access to more resources for development. For the technology recipient, enterprises can obtain advanced technological achievements through technology transfer, which can help enterprises develop rapidly and reduce R&D costs. Professional technology experience provides a shortcut for entrepreneurs to obtain technology resources in the early stage of entrepreneurship to achieve their entrepreneurial goals better.

At present, the mediating variables of technical collaboration to improve the innovation performance of enterprises are mainly organizational learning, absorptive capacity and knowledge integration. But in fact, the enterprise's own knowledge reserve is not enough to support its innovation activities, so it needs to obtain external information and knowledge through technology transfer with other enterprises, increase the enterprise's internal knowledge reserve, and fill the knowledge gap of innovation activities. In the process of collaboration between technology-based enterprises and many partners in the park, there are intensive links between enterprises engaged in similar technology fields. Therefore, based on the technology transfer (cognition), each enterprise entity is willing to improve its own technology level by means of technology transfer, acquire it with lower cost and higher efficiency, and integrate it deeply and thoroughly, so as to increase the stock of knowledge in the existing technology field of the enterprise. For enterprises in different technology fields, technology transfer can promote the exchange of organizations and personnel with different knowledge backgrounds, and promote the transfer, acquisition,

integration, and reconstruction of technologies in different fields, which can facilitate technology complementation and innovation, and enhance the innovation performance of enterprises, and also develop of technology transfer (achievements) for enterprises. Based on the previous discussion on the relationship between technical writing, technology transfe r(cognition), technology transfer(achievements) and innovation performance, this study proposes the following hypotheses:

H4: Technology transfer between technology-based entrepreneurial enterprises plays a mediating effect on the relationship between technical collaboration and entrepreneurial performance.

H4-1: Technology transfer (cognition) plays a mediating effect on the relationship between technical collaboration and entrepreneurial performance.

H4-2: Technology transfer (achievements) play a mediating effect on the relationship between technical collaboration and entrepreneurial performance.

3.3 Definition of operability of variables

3.3.1 Technology transfer

Technology transfer appeared in economic theory in the mid-1960s. At present, scholars have not yet formed a unified definition of technology transfer, but it can be broadly divided into technology transfer in a narrow sense and technology transfer in a broad sense. Technology transfer in a narrow sense usually refers to the process of movement of know-how, technical knowledge or technology from one organization to another. In a broader sense, technology transfer refers to the process of diffusion of a certain collection of technological knowledge generated around a certain type of technology, i.e., the transfer of various forms of technology and related elements from a technology source to a technology user. It considers both the technology itself and

the transfer of related elements of technology movement. According to Zhao Liming, technology transfer starts from the technological innovation of technology providers. Through technology providers, technology is disseminated or transferred to technology adopters through various technology transfer channels, and then through the introduction process of technology adopters, new technology is acquired and used, digested, absorbed and innovated. In essence, technology transfer is the process of transforming science and technology into productive forces directly into social production and reproduction. Due to the uneven spatial distribution of science and technology, the process of science and technology penetration from some production sectors to other sectors, from some countries to other countries, from some regions to other regions, is the specific process of technology transfer. Technology transfer includes both "soft" technologies such as know-how and "hard" technologies in equipment and machinery. Once a technological innovation emerges, it has a great demonstration effect in the industry, which will attract other imitators. The imitators can buy the innovator's patented or proprietary technology through legal means. Efficient technology transfer enables the diffusion of new products or technologies over a large area, thus promoting the improvement of regional or even national technologies. Leonard Barton (1992) believes that there are two general cases of technology transfer. One is peer-to-peer technology transfer, in which technology is transferred from developers to users. Technology diffusion, on the other hand, is the transfer of technology to multiple users.

Technology transfer can be divided into vertical technology transfer and horizontal technology transfer, depending on the approach of technology transfer. Vertical technology transfer refers to technology transfer from the researcher to the developer and then to the producer. It progresses along the stages of invention, innovation and development, and becomes more commercialized with each passing stage, such as universities transfer technology patents and research achievements to

the industry. Horizontal technology transfer is the transfer of an established technology from one operating environment to another, such as technology transfer from a technology leader to a technology lagger in a regional innovation network.

Technology transfer can be divided into commercial technology transfer and non-commercial technology transfer according to whether the technology transfer goes through the market or not. Commercial technology transfer refers to paid technology transfer through the market based on general commercial terms. And there are two main channels. One is technology traded through the technology market, and the other is technology transfer through commercial contracts with technology components, including the purchase of technology equipment, foreign direct investment, and the conclusion of technology or business consulting contracts. Non-commercial technology transfer refers to technology transfer or technology diffusion in the form of government assistance, manpower flow, technology information exchange, academic exchanges and technology study tours. According to the degree of technology transfer, it can be divided into simple transfer and technology absorption. Simple transfer refers to the direct application of technology by the demander of the technology. The supplier does not care about the demander's industrial base, management or technology level, nor does it ask whether the demander can digest and absorb the transferred technology after adopting it. In some sense, it is a kind of industrial transplantation, which is the transplantation of one country's industry to another country. Technology absorption refers to the process of digesting, absorbing and innovating advanced technology from foreign countries and then creating new technology in combination of national conditions, i.e. the process of localization.

Table 3-1 Definition of the operability of technology transfer

Variable		Operational definition	Source
Technology transfer	Cognition	Technology transfer cognition refers to the cognitive ability of technology transfer in the process of enterprise technology transfer. Because technology has the characteristics of externalities, it is inevitable for companies with higher technological development to produce technology spillovers. Cognitive ability refers to the degree of understanding of advanced technology and its application by enterprises with low technological development, and the higher the cognitive ability of technology transfer, the higher an enterprise absorbs and imitates external technical knowledge, the greater the impact of technology transfer on entrepreneurial performance.	Kathuria (2000) Grinfeld (2006) ZhuandJeon(2007) Marcin and Kolasa (2008)
	Achievements	The technology transfer achievements refers to the technology spillover effect brought by the technology spillover party in the process of technology transfer. The main body of the technical collaboration network constitutes a stable network. The internal enterprises continuously interact and exchange resources with other surrounding entities, which makes it easier for enterprises to obtain complementary resources and realize the sharing of R&D resources. In other words, the main result of technology transfer is the ability to obtain new technologies, products, and management models for enterprises to improve their own R&D level; for enterprises with higher technical levels, the main result of technology transfer is to share or reduce R&D risks and their cost can enter other markets and increase its own market share.	Javorcik (2004)Zhu Huabing et al. (2009), Long Juanjie et al. (2009)Abraham and Konings (2000)

3.3.2 The technical collaboration

Technical collaboration at the micro-level is mainly based around scientific research. At the level of organizational units, Chai Yue et al. (2015) takes the universities included in Project 211 as the research object and constructed a grid structure of scientific collaboration between universities. They found that universities are mainly clustered geographically and supplemented by disciplinary clustering, and the comprehensive universities include in Project 985 with strong research strength are ranked high in intermediary centrality. Yuan Hua et al. (2016) found that the core competencies of collaboration partners, firm sensitivity and inter-firm trust are important aspects for firms to refer to when selecting collaboration partners in using the cooperative grid structure for inter-virtual firm cooperative partner selection. At the macro level, Huang Weiqiang et al. (2012) established a knowledge diffusion model based on the technical collaboration grid structure and find that the cooperative grid structure can improve the depth of knowledge diffusion, diffusion speed, growth rate and resource allocation efficiency. The technical collaboration grid structure has a certain spatial aggregation effect, and the cluster entities tend to cluster with entities that have a similar knowledge level. In studying the grid structure of industry-academia-research collaboration innovations in the ICT industry, Gao Xia & Chen Kaihua (2015) found significant complex grid structure characteristics, obvious small-world nature and scale-free characteristics. Wang Qiuyu et al., (2016) studied the spatial structure, entities structure and evolution law of the collaboration grid structure of the equipment manufacturing industry in China based on collaboration invention patents, using social grid structure analysis and spatial analysis. They found that the position of private enterprises and universities in the collaboration grid structure has been increasing and has become an important source of innovation. The clustering effect of technical collaboration is obvious in developed cities such as municipalities directly under the central government and provincial capitals. Gao Xia & Chen Kaihua (2016) analyze the evolution path of the industry-university-research

collaboration model in the ICT industry, and analyze the grid structure of industry-university-research collaboration and its spatial and temporal evolution from a microscopic perspective. They find that industry-academia research collaboration has changed into an enterprise- led collaboration model, and the collaboration grid structure has gradually increased. The connection efficiency of the grid structure has improved, but the degree of aggregation of the grid structure is still low. On the contrary, Wu Hui & Gu Xiaomin (2017) find that the role and location of universities were most important in their analysis of the grid structure of industry-university-research collaboration in the pharmaceutical manufacturing sector in Shanghai.

Table 3-2 Definition of technical collaboration operability

Variable	Operational definition	Source
Technical collaboration	By measuring the technical exchanges and collaboration between two or more organizations, it generally includes collaboration in various aspects such as resources, technology, collaboration, and information. It can be analyzed from three aspects: the frequency of collaboration, the intensity of resource investment, and the breadth of information exchange.	Wei Jianrong (2015) Yuan Hua et al. (2016) Huang Weiqiang et al. (2012) Chai Yue et al. (2015) Gao Xia, Chen Kaihua (2015) Wang Qiuyu et al. (2016)

3.3.3 Entrepreneurial performance

Entrepreneurial performance is an important measure of the effectiveness of entrepreneurial behavior and the degree to which the goals set at the beginning of entrepreneurship are achieved. The improvement of entrepreneurship reflects the competitive advantage that entrepreneurial enterprises ultimately gain in the marketplace. It is also an important indicator of the success of entrepreneurial

activities of entrepreneurial enterprises. Different scholars from different perspectives have summarized the meaning of entrepreneurial performance. There are three main perspectives on performance: performance as a behavioral activity, performance as the result of a behavior, and performance as a competency. Different scholars have presented their own perspectives on entrepreneurial performance. Campbell (1977) argues that organizational performance is not just a concept, but an integrated concept. In 1990, Campbell further argues that performance is inseparable from individual behaviors controlled by the actor and taken to achieve behavioral goals, and that proficiency of such behavior is a measure of performance. This view is similar to that of Murphy (1990). Bernadin (1995), on the other hand, argues that performance is the end result or achievement of people's behavior and that these achievements are closely related to the strategic goals of the enterprise, a view also recognized by Kane (1996). Chatterji (2009) argues that entrepreneurial performance is the ultimate holistic achievement of entrepreneurial behavior and can be used to measure the extent to which the goals of a firm are achieved at the initial stage of its entrepreneurship. Coombes et al. (2011) also hold a similar view. Carmona (2012) argues that entrepreneurial performance ultimately reflects the competitive advantage that an enterprise has won in the marketplace. According to Cao Zhiran (2011), the concept of entrepreneurial performance has not yet reached a unified result. Wang Chongming (2011) argues that if entrepreneurial performance is used to measure the success of organizational entrepreneurship, further research is needed.

Table 3-3 Definition of the operability of entrepreneurial performance

Variable	Operational definition	Source
Entrepreneurial performance	Entrepreneurship performance is an important standard used to measure the effect of entrepreneurial behavior, and it is a measure of the degree of achievement of the goals set at the beginning of entrepreneurship. The entrepreneurial performance studied in this article refers to the results or effects of a series of entrepreneurial activities carried out by an enterprise under the guidance of the enterprise's development strategy goals, and the manifestation of the entrepreneurial enterprise's ultimate competitive advantage in the market.	Campbell(1977)Murphy (1990)Bernadin (1995)Kane (1996)Chatterji (2009) Coombes et al. (2011)Carmona et al. (2012)Cao Zhiran (2011) Wang Chongming (2011)

3.3.4 Variable measurement

In this study, four main constructs are measured: technical collaboration, technology transfer (cognition), technology transfer (achievements), and entrepreneurial performance. The Likert five-point scale was used to measure all the constructs in the questionnaire. Respondents were asked to make a choice based on their perceptions of what is stated in the questionnaire, with 1 meaning "I strongly disagree," 2 meaning "I disagree," 3 meaning "I neither disagree nor agree," 4 meaning "I agree," and 5 meaning "I strongly agree." The reason for using a five-point scale is that, according to Berdie, a five-point scale is the most reliable in most cases. A three-point scale limits the expression of moderate and strong opinions, and it is difficult for the average person to be discerning enough to make a judgment if there are more than five options for the questions. A five-point scale can indicate the difference between moderate and strong opinions without making it difficult to judge. In addition, the study includes control variables and mediating variables. The significance of the measurement of all variables is described below.

3.3.4.1 Measurement of technical collaboration

The measurement of technical collaboration capability is mainly based on the results of technical collaboration measurement with customers by Wei Jianrong (2015). Technical collaboration in this study refers to the communication and collaboration among enterprises in the process of entrepreneurship in order to achieve a certain entrepreneurial technology goal, which generally includes the collaboration of resources, technology, collaboration, and information. It can be analyzed from three aspects: the frequency of collaboration, resource input intensity, and information exchange breadth.

3.3.4.2 Measurement of technology transfer

The measurement of technology transfer capability is mainly based on the achievements of the operational definition of technology transfer by Ding Hailong (2012). At the same time, it refers to the experience of technology transfer and commercialization by members of the Korean Technology transfer-commercialization status survey report (2019; 2020) and the practice of research in cognition. In the process of entrepreneurial performance, technology-based enterprises must first have an adequate technology transfer (cognition) to ensure the smooth transfer of technological knowledge in the process of corporate technical collaboration. A good technology transfer (cognition) allows the technological knowledge among enterprises to be in a free sharing state. In the case of a deviation in the technology transfer (cognition) among enterprises, it will easily lead to the restriction of enterprise technology within the enterprise and affect the access of other enterprises to important technical knowledge in the technical collaboration chain, thus diminishing the performance of technology entrepreneurship. On the other hand, when all enterprises in the technical collaboration chain can acquire the internal technical knowledge of other firms in the technical collaboration process, it will enable the smooth transfer of technological knowledge to other firms in need, thus

promoting entrepreneurial output of other firms and improving the entrepreneurial performance of firms (Doz, 1996; Gult, 1999; Hansen 1999). Therefore, mutual learning and resource utilization with partners through technology transfer will facilitate the flow of technology among enterprises (Gulati & Singh, 1998; Inkpen & Dinur, 1998; Kale et al., 2000).

3.3.4.3 Measurement of entrepreneurial performance

The measurement of entrepreneurial performance is mainly based on the results of Luan, F. M. (2018) on the performance measurement of start-ups. There has been no definitive formulation of the factors influencing entrepreneurial performance, which often varies according to the research and preferences of research scholars. One of the most widely accepted expressions is the ability of an enterprise to access external system resources as an indicator of the quality of entrepreneurial performance. For an enterprise, the most intuitive indicator of access to external system resources is the enterprise's financial statements.

Table 3-4 Scales of measurement for technical collaboration, technology transfer and entrepreneurial performance

Variable		Item		Source
Technical collaboration		TC 1	We have frequent communication with innovation partner organizations (enterprises/ colleges) and often share technical knowledge with our partners via e-mail, Internet, etc.	Wei Jianrong（2015） Marion Frenza, Grazia Ietto-Gillies（2009） Victor Gilsing et al. (2008)
		TC 2	In collaboration with innovation partner organizations (enterprises/ colleges), we invest a lot of human, material and financial resources to provide our own corporate knowledge to share with our partners, so that we can receive tangible or intangible rewards.	
		TC 3	We communicate with our innovation partner organizations (enterprises/ colleges) on a wide range of production, technology and market information, and regularly compile and document our work related to collaborative technology innovation for a reference of other partners.	
Technology	Cogniti	TTC1	Members, including researchers, actively cooperate and participate in internal (external) technical briefings of the institution (enterprises/ institutes) or consulting project	Ding Hailong（2012）기술

transfer	on		meetings of researchers, etc.	이전•사업화 실태조사 보고서（2019；2020）공공기술이전•사업화 조사표(정부승인통계 제 115022 호) PETER J. LANE et al. (2001)
		TTC2	Members, including researchers, are actively involved in educational programs related to intellectual property application and management, technology transfer, and new technology entrepreneurship offered by the institution (enterprises/ institutes).	
		TTC3	Members, including researchers, actively develop some new technologies to start new technology entrepreneurship (or secondary entrepreneurship within the organization), such as new technology entrepreneurship using technologies like laboratory start-ups.	
		TTC4	For commercialization of technology transfer, members, including researchers, are actively using commercialization support institutions (external investment institutions and technology trading institutions, etc.) or government policies to support commercialization of technology transfer and technological achievements.	
	Achievements	TTA1	Acquire much of the knowledge necessary for basic technology and application technology development from partner institutions (enterprises / colleges).	
		TTA2	Acquire a lot of knowledge on new product design and development from partner institutions (enterprises/ colleges).	
		TTA3	Acquire a lot of knowledge about new production processes and management from partner institutions (enterprises/ colleges).	
Entrepreneurial performance		EP1	Your enterprise has a higher market share growth rate compared to your competitors in the industry.	Luan Fuming (2018)Covin and Slevin(1991) Covin et al. (2006)wang(2008)
		EP2	Your enterprise has a higher sales growth rate compared to your competitors in the industry.	
		EP3	Your enterprise has a higher profit growth rate compared to your competitors in the industry.	
		EP4	Your enterprise has a higher return on assets compared to competitors in your industry	
		EP5	Your enterprise has a higher return on investment compared to competitors in your industry.	

3.4 Questionnaire design and analysis methods

3.4.1 Questionnaire development and design

The thesis focuses on the effect of technical collaboration on entrepreneurial performance in technology-based entrepreneurial enterprises. The variables included in the study are all constructs, and data are collected through questionnaires to achieve the purpose of the empirical study.

In this empirical study, the reliability and validity of the statistical analysis results were largely determined by the design of the variable scale indicators. Therefore, the development and quality control of the research questionnaire was one of the key tasks in this study.

3.4.1.1 Principles of questionnaire development

In this study, the following principles are followed in the design of the variable scales: Firstly, a literature search was conducted to find existing variable scales that have been shown to have good reliability and validity;

Secondly, considering the influence of cultural differences on the measurement of variables, this study tries to use scales that have been used in the Chinese context and have been validated to have good reliability and validity;

Thirdly, if a suitable scale could not be found for one or more variables, the main characteristics of the variable(s) were extracted from the existing literature and the definition of the variable(s) in this study as a measurement scale.

Fourthly, since some scales used in this study come from English and Korean literature, each measure is strictly translated in both languages during the development of the scale to ensure semantic accuracy. In addition, on the premise of not changing the original meaning of the test items, free translation is used as far as possible to make the questionnaire more in line with Chinese people's way of thinking and language habits.

3.4.1.2 Questionnaire preparation process and quality control

In the scale development process, attention was paid to the characteristics of

Chinese cultural background and innovative enterprises, and after structured and semi-structured interviews were conducted with a number of experts and managers that are familiar with the related fields, the research questionnaire is finally formed. Prior to the formal survey, a pre- survey is conducted, with project analysis of the pre-survey data. The formal survey scale was formed after making appropriate textual revisions to the scale items. In order to improve the reliability and validity of the questionnaire, this study summarized the relevant literature and found that most of the scales used in the prior research literature were empirically tested and approved by relevant scholars, and it is also convenient to compare with previous studies. Therefore, this study focuses on selecting variables and question items with reference to the prior research literature.

Using the method of tracing back to the source, tracking down the source of the scale, finding and understanding the initial intention of the original designer of the scale, and translate the question items of the scale into Chinese. Then, the help of professionals was sought to compare the translated Chinese with the original Korean text and adjust the discrepancies. After continuous revision, the Chinese scale was finalized to ensure that the Chinese scale is the most accurate representation of the original Korean scale.

The survey is designed in the form of a structured (fill-in-the-blank and multiple-choice questions) questionnaire. The questionnaire's content is divided into three parts, including the description of the study, basic information about the respondents and each question item. To ensure that the respondents fill in the questionnaire correctly and effectively, the purpose of this study was stated in the first part of the questionnaire, along with a guarantee that the questionnaire will be used for academic research only and that not personal information about the respondents will not be disclosed disclose any information about the respondents so that the respondents can fill in the true information and options with confidence and facilitate

their active participation in the survey. In the second part of the questionnaire, the main concern is to ensure the authenticity of the questionnaire. It assures the respondents that the basic information will be kept confidential so that they will not be wary. In the third part of the questionnaire for question items, to help the respondents to understand the questions and make choices, different aspects of the questions and use the Likert five-point scale to measure the respondents' cognition of the options.

3.4.2 Data analysis methods

This paper describes the basic situation of the research subjects and the variables involved in the study by means of descriptive statistical analysis. The study mainly includes descriptive statistical analysis of the operation time, scale of operation, region and variables of the enterprises investigated. The quality of the questionnaire design is tested by means of reliability and validity analysis. Correlation analysis was used to analyze the interrelationships between the variables, as it can reflect the degree and direction of correlation among variables. Bootstrap analysis was performed to test the hypotheses by repeated sampling analysis of the sample.

IV Empirical analysis and result discussion

In this chapter, the relationship among the variables is further discussed, analyzed and tested on the basis of sorting out relevant theories, putting forward research hypotheses, constructing theoretical framework, and referring to results of interview and pre- survey. The correlation and the model of structural equation are further analyzed by testing whether there is any deviation in descriptive information, reliability, validity and common method of the samples and variables. Then, the technical collaboration, technology transfer (cognition), as well as the relationship between the entrepreneurial performance and the technology transfer (achievements) are tested and judged. The analytical procedure consists of four parts, including the descriptive statistical analysis of samples and variables, the reliability and validity test of the scale, the test of research hypothesis, and the analysis and discussion of the experimental results.

4.1 The Analysis of Basic Information

The respondents of this questionnaire are mainly entrepreneurs in the industrial park or core personnel in the enterprises. In the practical survey process, each new enterprise being surveyed can only take one piece of questionnaire. The questionnaire respondents were enterprise founders (i.e. the entrepreneur), or core member of the entrepreneurial team if the enterprise is operated by the team. The formal questionnaire are finally completed by repeatedly revised according to the results of interview and pre- survey.

In this study, the data was collected by means of collecting both paper questionnaires (field survey) and electronic questionnaires (Questionnaire Star,

Wechat and e-mail that contains questionnaire links). The formal data collecting lasted for 2 months from early May to the end of June in 2021, by distributing those questionnaires. In this survey, the respondents were required to finish the questionnaire anonymously, and they were informed in the preface of the purpose of this study and assured of the confidentiality of the research process. These were to eliminate the concerns of questionnaire respondents about personal privacy and divulging corporate secrets. By the time of June 30, 2021, 501 valid questionnaires had been retrieved (556 questionnaires have been retrieved in total, with 55 invalid questionnaires being excluded), so the effective recovery rate is 90.11%. A descriptive statistical analysis of the survey samples and variables are made following careful summary and arrangement. The results are as the following:

4.1.1 Personal characteristics of respondents

The first part is the gender and age. Entrepreneurs of different genders often have great differences in the mode of thinking and the logic of behavior. As a result, the gender analysis is essential in analyzing the characteristics of respondents. In the gender distribution of respondents in this study, male respondents accounted for 53.69% and female respondents for 46.31%. The proportion of female entrepreneurs in this study is thus 7.38% less than that of males. It also indicates that compared with the entrepreneurial performance of the men, women's performance still has room to rise in the future.

Table4-1：The results of the frequency analysis

Factor	Items	frequency	Percentage (%)	Cumulative Percentage (%)
Gender	Male	269	53.69	53.69
	Female	232	46.31	100.00
Age	Below 30 (30 included)	117	23.35	23.35

31～40	166	33.13	56.49
41～50	144	28.74	85.23
Above 51(51 included)	74	14.77	100.00

4.1.2 Respondent resume analysis

For the entrepreneurs, the difference of age often indicates the different work or entrepreneurial experience, which can influence decisions. As a result, the age of the respondents is taken into account.

It can be concluded from the analysis results that the age range with the highest concentration is that 31 to 40 years old, accounting for 33.13%, followed by the age from 41 to 50 years old, accounting for 28.74%. So it can be seen that young and middle-aged entrepreneurs are the main groups of entrepreneurs.

The education level of the respondents in this study is illustrated in Table 4-2. Entrepreneurs with different educational backgrounds can have different attitudes and approaches, entrepreneurial methods and favor different types of industry. It can be concluded from the distribution results that the education level of respondents is generally college (28.54%) and undergraduate (45.11%). What's more, entrepreneurs have generally received a high level of education (as college degree or above accounts for 90.02%). Work experience is an important part of the life of the respondents. As for the work experience, the proportion with one period of prior work experience is the highest, accounting for 32.73%, and the proportion without work experience and taking entrepreneurs as their first job, accounting for 25.75%. The distribution proportion of work experience indicates that entrepreneurs still have less work experience.

Table 4-2 The results of the frequency analysis

Factor	Items	Frequency	Percentage (%)	Cumulative Percentage (%)
Education level	High school and below	50	9.98	9.98
	College	143	28.54	38.52
	Undergraduate	226	45.11	83.63
	Master	76	15.17	98.80
	Doctor	6	1.20	100.00
Work experience (except the current work)	Without work experience	129	25.75	25.75
	One period	164	32.73	58.48
	Two periods	98	19.56	78.04
	Three periods and above	110	21.96	100.00

4.1.3 Analysis of interviewed enterprises

Other factors that were considered were of the number of staff, the time of the establishment, the category of the industry and the type of the business of the enterprises. By judging the personnel scale of the enterprises, it can be found that the proportion of "51-100" is the largest, accounting for 34.93%, followed by "less than 50", accounting for 29.94%. This indicates that most of the entrepreneurial enterprises, by considering the economic and social benefits, tend to choose the small-scale team to start a business. Talking about the time of establishment, the result indicates that the proportion of enterprises with existing less than one year (11.38%), one year (11.98%), two years (15.37) and three years (14.77%) is large, which indicates that most enterprises have not operated for a long time. The sample shows enterprises in three industries, namely “information transmission, software and information technology services”, manufacturing and scientific research and technology services,

are the most, while the enterprises in another three industries, namely mining, power, heat, gas, and production and supply, water conservancy, environment protecting, as well as public facilities management, are the least. This shows that the proportion of industry categories is affected by the latest market trends. Most of the registered enterprises are from the domestic part, accounting for 42.71%, followed by invested enterprises from Hong Kong, Macao and Taiwan, accounting for 29.54%. That means the domestic enterprises and Hong Kong, Macao and Taiwan invested enterprises are the main forms of entity of the research object.

Table 4-3 The results of the frequency analysis

Factor	Items	Frequency	Percentage (%)	Cumulative Percentage (%)
Personnel size of your enterprise:	Less than 50	150	29.94	29.94
	51-100	175	34.93	64.87
	101-200	87	17.37	82.24
	More than 201	89	17.76	100
Years from the establishment	Less than 1 year	57	11.38	11.38
	1 year	60	11.98	23.35
	2 years	77	15.37	38.72
	3 years	74	14.77	53.49
	4 years	49	9.78	63.27
	5 years	39	7.78	71.06
	6 years	30	5.99	77.05
	7 years	44	8.78	85.83
	8 years or more	71	14.17	100
Industry that the enterprise belongs to:	Agriculture, forestry, animal husbandry and fishery	22	4.39	4.39
	Mining	19	3.79	8.18
	Manufacturing	36	7.19	15.37

Electricity, heat, gas and water production and supply	18	3.59	18.96
Construction	22	4.39	23.35
Wholesale and retail	25	4.99	28.34
Transportation, storage and postal services	20	3.99	32.34
Accommodation and catering	20	3.99	36.33
Information transmission, software and information technology services	40	7.98	44.31
Finance	23	4.59	48.9
Real estate	23	4.59	53.49
Leasing and business services	22	4.39	57.88
Scientific research and technology services	34	6.79	64.67
Water conservancy, environment and public facilities management	17	3.39	68.06
Residential services, repair and other services	28	5.59	73.65
Education	28	5.59	79.24
Health and social work	29	5.79	85.03
Culture, sports and entertainment	23	4.59	89.62
Public administration, social security and social organizations	32	6.39	96.01
International organization	20	3.99	100

Registration type of the enterprise:	Domestic funded enterprises (state-owned enterprises, collective-owned enterprises, joint stock cooperative enterprises, associated enterprises, limited liability companies, joint stock limited companies, private enterprises)	214	42.71	42.71
	Hong Kong, Macao and Taiwan invested enterprises	148	29.54	72.26
	Foreign-invested enterprise	132	26.35	98.6
	Others:	7	1.4	100

4.1.4 Geographical level analysis of interviewed enterprises

The region where the sample companies are located are generally in North China, East China and South China. They account for 20.96%, 19.16% and 16.97% respectively, and for 57.09% in total. In every region, the enterprises are mainly in Beijing, Shanghai, Guangdong and similar cities. This shows that most entrepreneurs will choose to start their businesses in the eastern coastal areas and the main economic and political centers. At for the industrial park level, most of the enterprises of the samples are "parks at the level of municipalities directly under the central government, provinces, autonomous regions and special administrative regions", with a total of 167, accounting for 33.33%, and national level industrial parks accounting for 26.95%. This shows that entrepreneurs generally choose national parks, municipalities directly under the central government, provinces, autonomous regions and special administrative regions as the location to realize the rapid growth of the enterprise by relying on the supporting policies.

Table 4-4 The results of the frequency analysis

Factor	Items	Frequency	Percentage (%)	Cumulative Percentage (%)
Region where the enterprise is located:	Northeast China (Heilongjiang, Jilin, Liaoning)	79	15.77	15.77
	North China (Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia)	105	20.96	36.73
	Central China (Henan, Hubei, Hunan)	75	14.97	51.70
	East China (Shandong, Jiangsu, Anhui, Shanghai, Zhejiang, Jiangxi, Fujian, Taiwan)	96	19.16	70.86
	South China (Guangdong, Guangxi, Hainan, Hong Kong, Macao)	85	16.97	87.82
	Northwest China (Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang)	37	7.39	95.21
	Southwest China (Sichuan, Guizhou, Yunnan, Chongqing, Tibet)	24	4.79	100.00
The level of the park the enterprise is in:	National level industrial parks	135	26.95	26.95
	Parks at the level of municipalities directly under the central government, provinces, autonomous regions and special administrative regions	167	33.33	60.28
	Prefecture level cities, autonomous prefectures and league level parks	89	17.76	78.04
	County and district level parks	89	17.76	95.81
	Township and town level parks	17	3.39	99.20
	Others:	4	0.80	100.00
	Summation	501	100.00	100.00

4.2 The Analysis of Reliability and Validity

4.2.1 Reliability analysis

In this study, the value of the Cronbach coefficient is used as the measure of the reliability of the scale (analyzed by spss25.0) to judge the specific reliability test results. In the research using the Cronbach coefficient as the standard of the reliability test, 0.7 is generally believed by the academic community to be the lowest acceptable value. From the analysis results, it can be concluded that the Cronbach coefficient values of entrepreneurial performance, technical collaboration, technology transfer (cognition) and technology transfer (achievements) are above 0.7. At the same time, deleting any item cannot significantly improve the value of the Cronbach coefficient. Therefore, the reliability of the scale used in this study is acceptable.

The values of the Cronbach's Alpha coefficient corresponding to the four scales of the questionnaire is greater than 0.7 (among them, technical collaboration includes 3 items, and its Cronbach's Alpha value is 0.811; technology transfer includes 7 items, and its Cronbach's Alpha value is 0.845; entrepreneurial performance includes 5 items, and its Cronbach's Alpha value is 0.841), showing that the internal consistency of the questionnaire is acceptable. As a result, the reliability of the results of this survey is excellent. At the same time, the Cronbach's Alpha value deleted in most items is lower than the general Cronbach's Alpha reliability coefficient of the corresponding dimension. Therefore, all questions are the measurement of the same concept, and delete any of the question is unnecessary.

4.2.2 Validity analysis

When measuring validity, four aspects are analyzed: content validity, construction validity, aggregation validity and discriminant validity.

Firstly, in terms of specific measurement methods, lessons are drawn from the mature scale developed by scholars for each variable to ensure the rationality and

effectiveness of the questionnaire. At the same time, in- depth interviews with entrepreneurs and core members of the entrepreneurial team are conducted, based on which, the specific questions are adjusted. Then, based on the results of the pre-survey, the structure, content and specific expression of the questionnaire are integrated again, and the scale is revised repeatedly. Thus, a formal questionnaire is formed to be used in the formal survey. As a result, the content validity of the scale in this survey is good.

Secondly, the factor analysis of the data was conducted using SPSS25.0 to verify the validity of the construction. The results are shown in Table 4-5. The KMO values of technical collaboration, technology transfer and entrepreneurial performance were all above 0.7 (0.75, 0.849 and 0.862 respectively). Consequently, using the method of main component analysis and maximum variance rotation, the factor analyses are made for each scale (technical collaboration, technology transfer and entrepreneurial performance). According to the above conclusion, technical collaboration gets one common factor, technology transfer gets two common factors and entrepreneurial performance gets one common factor. In terms of the interpretation of cumulative variance, the value of technical collaboration is 72.649%, the value of technology transfer (cognition) is 52.112%, the value of technology transfer (achievements) is 17.625% and the value of entrepreneurial performance is 61.190%. The common factors extracted in this study have a high degree of interpretation of the question variance in the original scale, and it also indicates that this study has good validity.

Table 4-5 Exploring the results of factor analysis

No.	1	2	3	4	common factor	KMO	sig	Character value	Variance explanation
TC1	0.043	-0.060	0.060	0.922	0.728				
TC2	0.098	0.089	0.166	0.810	0.771	0.705	0	2.179	72.649
TC3	0.221	0.116	-0.071	0.775	0.681				

TT1	0.025	0.929	0.021	0.023	0.646				
TT2	0.027	0.766	0.146	0.045	0.666			3.648	52.112
TT3	0.175	0.784	0.081	0.000	0.677				
TT4	0.128	0.827	0.141	0.096	0.695	0.849	0		
TT5	0.115	0.154	0.903	0.021	0.751				
TT6	0.187	0.136	0.827	0.051	0.698			1.234	17.625
TT7	0.043	0.075	0.833	0.079	0.750				
EP1	0.888	0.069	0.053	0.037	0.599				
EP2	0.829	0.063	0.116	0.123	0.615				
EP3	0.773	-0.007	0.226	0.115	0.577	0.862	0	3.06	61.19
EP4	0.819	0.059	-0.032	0.094	0.629				
EP5	0.704	0.263	0.103	0.092	0.639				

4.2.3 Confirmatory factor analysis

Despite that the maturity scale developed by scholars for different variables is adopted, the applicability of this study still needs to be tested by confirmatory factor analysis (Wu Minglong, 2015). In this study, the confirmatory factor analysis for technical collaboration, technology transfer (cognition) and technology transfer (achievements) scale are conducted using AMOS24.0 software. The results are illustrated in Table 4-7 and Table 4-8. The results show that the factor loads (path coefficient of latent variable corresponding to each significant variable) are all above 0.5, the CR values are above 0.7, and the AVE values are above 0.5. That is to say, the scale used in the study has good constructive validity. As the fitting index reflects whether the relative value is in an acceptable range, the consistency between the model and the sample data are also tested. The results are also shown in Table 4-6. The value of χ^2/df is not more than 2, which meets the standard that is put forward by Wu Minglong (2015). The equivalent values of RFI, IFI, TLI, CFI, GFI and AGFI are all above 0.9, which meets the standards put forward by Wen Zhonglin (2004). At the same time, the RMSEA value does not exceed 0.1, which meets the standard

proposed by Steiger (1990). It shows that the scale used has good aggregation validity

4.2.3.1 The fitting degree of the model

By comparing the items in the above table, it can be found that the indicators including CMIN/DF, NFI, IFI, TLI, CFI, GFI and RMSEA are all above 0.9, meaning most of the fitting indicators are suitable. To sum up, the overall fitting effect of the model proposed in this hypothesis is good, and the fitting degree of the model is ideal.

Table 4-6 The index of model fitting

Common indicators	χ^2	df	p	χ^2/df	GFI	RMSEA	CFI	NFI	TLI	AGFI	IFI
Judgment criteria	-	-	>0.05	<3	>0.9	<0.10	>0.9	>0.9	>0.9	>0.9	>0.9
Value	129.143	125	0.382	1.033	0.972	0.008	0.999	0.969	0.999	0.962	0.999

4.2.3.2 Coefficient of factor load

The absolute values of standardized load systems are greater than 0.6 and show significance, which means that there is a good measurement relationship.

Table 4-7 Coefficient of factor load

Factor	Item	Nonstandard load coefficient	Standard error	CR	p	Standard load coefficient
Technical collaboration	TC1	1	-	-	-	0.791
	TC2	0.993	0.055	18.075	0.000	0.809
	TC3	0.808	0.051	15.737	0.000	0.708
Technology Transfer (cognition)	TT1	1	-	-	-	0.718
	TT2	1.033	0.068	15.274	0.000	0.754
	TT3	1.062	0.07	15.137	0.000	0.746

Technology Transfer (achievements)	TT4	1.084	0.069	15.698	0.000	0.778
	TT5	1	-	-	-	0.787
	TT6	0.869	0.057	15.235	0.000	0.719
	TT7	1.057	0.064	16.616	0.000	0.816
Entrepreneurial Performance	EP1	1	-	-	-	0.699
	EP2	0.949	0.066	14.356	0.000	0.724
	EP3	0.92	0.068	13.567	0.000	0.68
	EP4	0.977	0.067	14.66	0.000	0.742
	EP5	1.011	0.069	14.63	0.000	0.74

4.2.3.3 The convergent validity

The combination reliability (CR) and average variance extraction (AVE) are used as the evaluation criteria of convergence validity. For each factor, when the CR value is greater than 0.7 and the ave value is greater than 0.50, it is generally considered that the convergence validity is good. In addition, when the square root of AVE of each factor is higher than the correlation coefficient between this factor and other factors, the discriminant validity is high. The test results of relevant indicators of convergence validity and discriminant validity are listed in the table. It can be seen from the table that, for each dimension, the basic AVE value is greater than 0.5 and the CR value is greater than 0.7, indicating that the convergence validity of this dimension is high.

Table 4-8 Index results of model AVE and CR

Factor	AVE	CR
Technical Collaboration	0.599	0.816
Technology Transfer (cognition)	0.561	0.836
Technology Transfer (achievements)	0.604	0.820

Table 4-8 Index results of model AVE and CR

Factor	AVE	CR
Entrepreneurial Performance	0.514	0.841

4.3 The correlation analysis

From Table 4-9, correlation analysis is used to study the correlation relationship among technical collaboration, technology transfer, technology transfer (cognition), technology transfer (achievements) and entrepreneurial performance. Pearson correlation coefficient test shows that there is a significant positive correlation between these variables. The specific results are as the follows:

The correlation coefficient between entrepreneurial performance and technical collaboration is 0.393, and indicates a significant level of 0.01, which shows that there is a significant positive correlation between entrepreneurial performance and technical collaboration. The correlation coefficient between entrepreneurial performance and technology transfer is 0.548, and indicates the significant level of 0.01, which shows that there is a significant positive correlation between entrepreneurial performance and technology transfer. The correlation coefficient between entrepreneurial performance and technology transfer (cognition) is 0.549, and indicates a significant level of 0.01, which shows that there is a significant positive correlation between entrepreneurial performance and technology transfer (cognition). The correlation coefficient between entrepreneurial performance and technology transfer results is 0.387, and shows a significant level of 0.01, which indicates that there is a significant positive correlation between entrepreneurial performance and technology transfer results.

Table 4-9 Correlation analysis of variables

	Mean	Standar	Technical	Technolog	Technolog	Technolog	Entreprene

	Value	d Deviation	collaboration	y Transfer	y Transfer (cognition)	y Transfer (achievements)	urial Performance
Technical Collaboration	3.975	0.852	1.000				
Technology Transfer	3.977	0.700	0.387**	1.000			
Technology Transfer (cognition)	4.116	0.747	0.364**	0.877**	1.000		
Technology Transfer (achievements)	3.791	0.898	0.300**	0.846**	0.487**	1.000	
Entrepreneurial Performance	4.127	0.676	0.393**	0.548**	0.549**	0.387**	1.000

4.4 The hypothesis test

To test the hypothesis proposed in this study, a structural equation model (SEM) is constructed through empirical methods. After dealing with the measured variables and the dimensions of variables, a structural equation model (SEM) is constructed to analyze the specific relationship between different variables, and observe the significance of the variable relationship path, so as to judge whether the hypothesis is tenable.

Structural equation modeling (SEM) is a very common empirical analysis technique in management related research. By exploring the structure and relationship between latent variables, structural equation modeling can verify whether the research model assumptions proposed in the specific research are reasonable. Compared with other empirical analysis methods, structural equation modeling has five advantages: it

can deal with multiple dependent variables simultaneously, and consider the impact of other dependent variables on the empirical results; it can deal with variable measurement error automatically; it can estimate the factor structure and factor relationship simultaneously; measurement models with greater elasticity is allowed; the method of estimating the fitting degree of the model is provided. The structural equation model can simulate the fitting degree of a sample data and different models simultaneously, which enables the researchers to choose the model that can better reflects the real relationship among the data from different models.

4.4.1 The structural equation model

4.4.1.1 Second order model fitting degree

Construct two first-order variables of the second-order hypothetical model, namely technical collaboration and entrepreneurial performance (EP). Construct a two-order variable consisted of two one-order variables, namely technology transfer (cognition) and technology transfer (achievements). The question for each variable is explicit variable construction. The diagram of the model is as the follows:

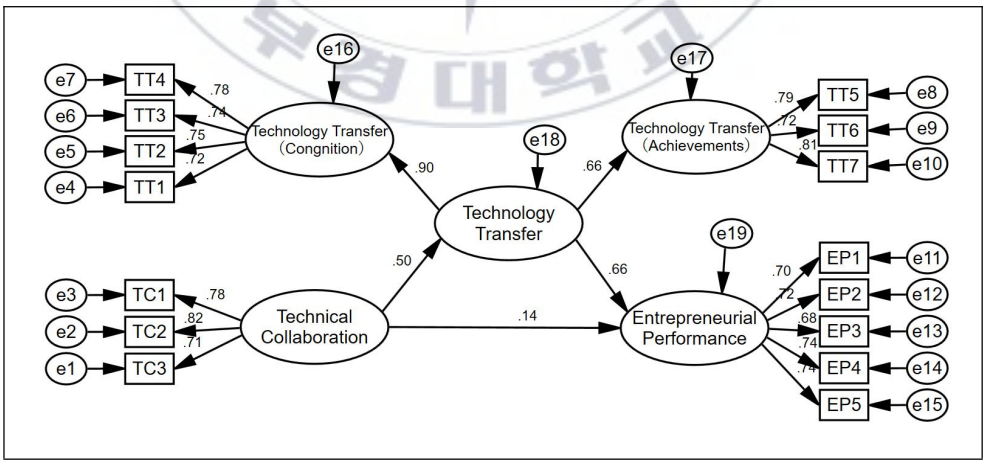

Diagram 4-1

In this study, AMOS 24.0 is used to analyze the fitting degree of the model, and

the specific adaptation index is shown in Table 4-10.

Table 4-10 The index of model fitting

Common indicators	χ^2	df	p	χ^2/df	GFI	RMSEA	CFI	NFI	TLI	AGFI	GFI
Judgment criteria	-	-	>0.05	<3	>0.9	<0.10	>0.9	>0.9	>0.9	>0.9	>0.9
Value	83.034	85	0.54	0.977	0.979	0	1	0.974	1.001	0.97	0.979

AMOS24.0 software is used to estimate the initial model, and the estimation method is maximum likelihood. By clicking the Estimates (result estimation) and Model fit (model adaptation) at the menu View Text (output result text) of software AMOS24.0, the model non standardized regression coefficient and model fit index are obtained. It can be known that the regression coefficient of the model has basically reached the standard, and the adaptation effect of the model is very good. Through the comparison of the items in the above table, it can be found that the indexes including CMIN/DF, NFI, IFI, TLI, CFI, GFI and RMSEA are all above 0.9, most of whose fitting indexes are suitable. To sum up, the overall fitting effect of the model proposed in this hypothesis is good, and the model fitting is ideal

4.4.1.2 Path coefficient results of the second order model

Table 4-11 The path coefficient of the model (verification results of second order hypothesis)

No.	Path	Standard path coefficie	Nonstandard path coefficient	S.E.	C.R.	P

			nt					
H2	Technology transfer	<---	Technical collaboration	0.496	0.437	0.056	7.855	***
H3	Entrepreneurial performance	<---	Technology transfer	0.663	0.716	0.099	7.252	***
H1	Entrepreneurial performance	<---	Technical collaboration	0.137	0.13	0.058	2.258	0.024
	Technology transfer (achievements)	<---	Technology transfer	0.655	0.927	0.103	8.958	***
	Technology transfer (cognition)	<---	Technology transfer	0.897	1			

The results of structural model path coefficient are shown in Table 4-11 above, and the model paths are all tested. Technical collaboration has a significant positive path impact on technology transfer, that is (β =0.496, P<0.05), so the hypothesis H2 is verified. Technology transfer has a significant positive path impact on technical collaboration, that is (β =0.496， P<0.05), so the hypothesis H3 is verified. Technical collaboration has a significant positive path impact on entrepreneurial performance, that is (β =0.137， P<0.05), so the hypothesis H1 is verified.

4.4.1.3 Medium test results of second order model

Table 4-12 Medium test of the second model

Medium path	Effect	Effect value	lower	upper	p	Effect proportion

Technical collaboration→technology transfer→entrepreneurial performance	Total effect	0.466	0.35	0.584	0	-
	Direct effect	0.137	-0.011	0.277	0.062	29.40%
	Indirect effect	0.329	0.214	0.481	0	70.60%

By calculating of the proportion of medium effect, it can be found that the value of the direct effect of technical collaboration → entrepreneurial performance is 0.137, and the direct effect accounts for 29.40% (0.137 / 0.466) of the total effect. The indirect effect value of the medium path of technical collaboration → technology transfer (achievements) → entrepreneurial performance is 0.329, with the intermediary effect accounting for 70.60% (0.329 / 0.466) of the total effect. They imply that technical collaboration can predict not only the entrepreneurial performance directly, but also can do it indirectly through the medium role of technology transfer, and hypothesis H4 is thus verified.

4.4.1.4 The fitting degree of the first order model

A first order hypothetical model with four variables was constructed. In the model, technical collaboration, technology transfer (cognition), technology transfer (achievements) and entrepreneurial performance are for potential model, and the questions from each variable are for significant variables. The diagram of the model is shown below:

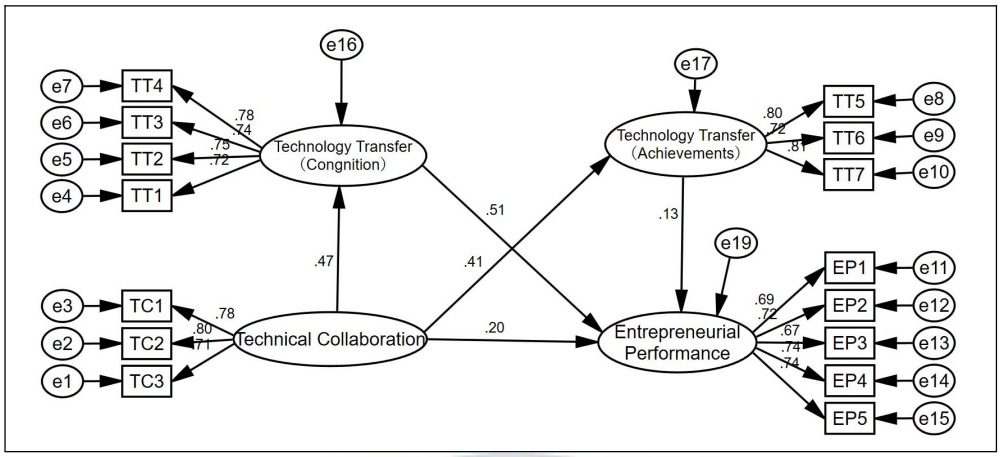

Diagram 4-2

In this study, AMOS 24.0 is used to analyze the fitting degree of the model, and the specific adaptation index is shown in Table 4-13.

Table 4-13 Fitting index of the model

Common indicators	χ^2	df	p	χ^2/df	GFI	RMSEA	CFI	NFI	TLI	AGFI	IFI
Judgment criteria	-	-	>0.05	<3	>0.9	<0.10	>0.9	>0.9	>0.9	>0.9	>0.9
Value	169.596	85	0	1.995	0.958	0.045	0.973	0.947	0.966	0.94	0.973

AMOS24.0 software is used to estimate the initial model, and the estimation method is maximum likelihood. By clicking the Estimates (result estimation) and Model fit (model adaptation) at the menu View Text (output result text) of software AMOS24.0, the model non standardized regression coefficient and model fit index are obtained. It can be known that the regression coefficient of the model has basically reached the standard, and the adaptation effect of the model is very good.

Through the comparison of the items in the above table, it can be found that the indexes including CMIN/DF, NFI, IFI, TLI, CFI, GFI and RMSEA are all above 0.9, most of whose fitting indexes are suitable. To sum up, the overall fitting effect of the first order model proposed in this hypothesis is good, and the model fitting is ideal.

4.4.1.5 Path coefficient of the first order model

Table 4-14 Coefficient of the model path (the results of first order hypothesis verification)

No.				Standard path coefficient	Nonstandard path coefficient	S.E.	C.R.	P
H2-1	Technology transfer (cognition)	<---	Technical collaboration	0.472	0.461	0.057	8.106	***
H2-2	Technology transfer (achievements)	<---	Technical collaboration	0.412	0.519	0.071	7.274	***
H1	entrepreneurial performance	<---	Technical collaboration	0.203	0.189	0.056	3.406	***

H3-1	entrepreneurial performance	<---	Technology transfer (cognition)	0.51	0.488	0.059	8.293	***
H3-2	entrepreneurial performance	<---	Technology transfer (achievements)	0.128	0.095	0.037	2.549	0.011

The results of structural model path coefficient are shown in Table 4-14 above, and the model paths are all tested. Technical collaboration has a significant positive path impact on technology transfer (cognition), that is (β =0.472, P<0.05), so the hypothesis H2-1 is verified. Technical collaboration has a significant positive path impact on technology transfer (achievements), that is (β =0.412, P<0.05), so the hypothesis H2-2 is verified. Technical collaboration has a significant positive path impact on entrepreneurial performance, that is (β =0.203, P<0.05), so the hypothesis H1 is verified. Technology transfer (cognition) has a significant positive path impact on entrepreneurial performance, that is (β =0.203, P<0.05), so the hypothesis H3-1 is verified. Technology transfer (achievements) has a significant positive path impact on entrepreneurial performance, that is (β =0.128, P<0.05), so the hypothesis H3-2 is verified.

4.4.1.6 Mediation test of the first order model

Table 4-15 mediation test of the first order model

Mediation path	Mediation effect	lower	upper	p	Effect proportion
Technical collaboration→technology transfer (cognition)→entrepreneurial performance	0.241	0.153	0.355	0	81.97%

Technical collaboration→technology transfer (achievements)→entrepreneurial performance	0.053	0.014	0.101	0.007	18.03%
Overall mediation	0.294	0.194	0.418	0	

The two mediating variables, technology transfer (cognition) and technology transfer (achievements), play an intermediary role in the impact of technical collaboration on entrepreneurial performance. The mediation effect results of each path of the sub mediation variables were obtained by conducting Bootstrap sampling for 5000 times on the basis of code defining. The mediating effect value of technical collaboration → technology transfer (cognition) → entrepreneurial performance is 0.241, with the confidence interval excluding 0. So the mediating effect is significant, accounting for 81.97% of the total mediating effect. The mediating effect value of technical collaboration → technology transfer (achievements) → entrepreneurial performance is 0.053, with the confidence interval excluding 0. So the mediating effect is also significant, accounting for 18.03% of the total mediating effect. They imply that technical collaboration can predict not only the entrepreneurial performance directly, but also can do it indirectly through the medium role of technology transfer (cognition) and technology transfer (achievements), and hypothesis H4-1 and H4-2 are thus verified.

4.4.2 The collecting of hypothesis tests

Table 4-16 The collecting of hypothesis tests

No.	The specific hypothesis	Result
H1	Among the technology-based entrepreneurial enterprise, technical	Verified

	collaboration has a positive impact on entrepreneurial performance	
H2	Among the technology-based entrepreneurial enterprise, technical collaboration has a positive impact on technology transfer	Verified
H2-1	Among the technology-based entrepreneurial enterprise, technical collaboration has a positive impact on technology transfer (cognition)	Verified
H2-2	Among the technology-based entrepreneurial enterprise, technical collaboration has a positive impact on technology transfer (achievements)	Verified
H3	Among the technology-based entrepreneurial enterprise, technology transfer has a positive impact on entrepreneurial performance	Verified
H3-1	Among the technology-based entrepreneurial enterprise, technology transfer (cognition) has a positive impact on entrepreneurial performance	Verified
H3-2	Among the technology-based entrepreneurial enterprise, Technology transfer (achievements) has a positive impact on entrepreneurial performance	Verified
H4	Among the technology-based entrepreneurial enterprise, technology transfer has a mediating effect between technical collaboration and entrepreneurial performance	Verified
H4-1	The technology transfer (cognition) has a mediating effect between technical collaboration and entrepreneurial performance	Verified
H4-2	The technology transfer (achievements) has a mediating effect between technical collaboration and entrepreneurial performance	Verified

By testing the 10 hypotheses in this study, the results are proved to basically meet the expectations, and the relationships in the variables are verified.

As is shown by the empirical data, technical collaboration helps to improve the entrepreneurial performance of the start-ups, and the sub dimensions of technology transfer (cognition) and technology transfer (achievements), also help to improve their entrepreneurial performance. Technical collaboration helps to promote the technology transfer of start-ups. So the hypotheses H1, H2, H3, H3-1 and H3-2 are

verified.

Technical collaboration helps to promote the technology transfer, as well as to improve the technology transfer (cognition) and to transform the technology transfer (achievements). So the hypotheses H2-1 and H2-2 are verified.

Of the effect path of technical collaboration on the entrepreneurial performance of the start-ups, technology transfer is a mediation variable between the both. Considering the defects of traditional regression methods, 5000 times Bootstrap sampling of SEM are conducted to ensure the preciseness of this research. It is shown that the mediation effect of the technology transfer is significant. In addition, to completely analyze the sub dimensions of technology transfer, the two sub dimensions of technology transfer, technology transfer (cognition) and technology transfer (achievements), are utilized to formulate first order models for testing. It is shown that technology transfer (cognition) and technology transfer (achievements) also play an mediation role in the effect path of technical collaboration on the entrepreneurial performance of the start-ups. So, hypothesis H4 and its sub hypotheses H4-1 and H4-2 are verified.

V Conclusions and Outlook

5.1 Research findings and insights

This study aims to analyze the important impact of industry-academia technical collaboration on entrepreneurial performance through theoretical analysis, field research, interviews and questionnaires. Specifically, this study focused on the following questions: What is the impact of industry-academia technical collaboration on entrepreneurial performance? What is the mechanism of the impact of technology transfer on entrepreneurial performance? How does the entrepreneurial effect of technology transfer manifest in technical collaboration and entrepreneurial performance? In order to explain the above research questions, this study used a combination of theoretical and empirical research, literature research and survey interviews, and qualitative and quantitative research to propose four groups of 10 hypotheses, and tested the hypotheses through questionnaire research and statistical analysis of 501 enterprises, and the main conclusions are as follows.

5.1.1 Conclusions

Based on the collation of relevant studies by previous scholars, this study re-analyzes the subject, object and collaboration process of the occurrence of collaboration relationships among enterprises in the park. Regarding the characteristics of technical collaboration subjects, this paper argues that the matching perspective does not ignore heterogeneity, but precisely proposes a matching perspective based on the heterogeneity among enterprises. Regarding the object of technical collaboration, this study considers that the content of technical collaboration is broad, with both explicit and tacit knowledge, and collaboration involves both

enterprise-level and individual-level knowledge. Regarding the research perspective of technical collaboration, most of the previous studies have been conducted from a single perspective of individual enterprises, and there is a lack of research on knowledge collaboration relationships from the cross-view of enterprises at the meso level. This paper argues that collaboration relationships are the intersection of innovative behavior among enterprises, which necessarily involves the relationship between the subjects of collaboration and the characteristics of cooperative elements. Therefore, this paper is innovative in that it studies the characteristics of inter-enterprise elements and collaboration relationships from the perspective of inter-enterprise meso-level intersection. Through theoretical model construction and derivation, which reveals the inner laws and mechanisms of action of technical collaboration affecting entrepreneurial performance, this study expands the research methods of related studies, and provides the foundation and prerequisites for subsequent empirical studies of collaboration relationships, as well as expanding the scope of technical collaboration research. In addition, this study demonstrates the mediating role of technology transfer between technical collaboration and entrepreneurial performance. The knowledge resources possessed by enterprises do not generate performance by themselves; it is the full integration and innovation of knowledge resources that bring about performance, and thus only through the mediating role of knowledge transfer, organizational learning, and knowledge sharing can promote open innovation in enterprises. However, the mechanism of the role of the relationship between the characteristics of inter-enterprise technical collaboration and performance is still under-explored. This paper selects “technology transfer” as a mediating variable and follows the basic research logic of “Inter-enterprise technical collaboration - Technology transfer - Performance” to further deepen the study of open innovation theory based on the relationship perspective.

1)Positive effects of technical collaboration among technology-based

entrepreneurial enterprises on entrepreneurial performance. By calculating the percentage of mediating effects, it can find that the effect value of the direct effect of technical collaboration → entrepreneurial performance is 0.137 and the direct effect accounts for 29.40% of the total effect (0.137/0.466). The above results are consistent with previous findings, indicating that the technical collaboration among enterprises in industrial parks at all levels studied in this paper is also consistent with the general rule of previous studies that technical collaboration can promote entrepreneurial performance. With the intensification of technological complexity, technological innovation uncertainty and innovation technology integration, the innovation capabilities of individual enterprises are increasingly challenged, and cooperative innovation is beginning to become commonplace. Inter-enterprise partnerships promote intra-enterprise innovation and such external resources are an important complement to the internal innovation process. The exchange and collaboration of resources and information within the enterprise's value chain facilitates the emergence of cooperative effects in production, organization, and critical knowledge transfer, which in turn facilitates the generation of high levels of product and process innovation. From the regional level, the enterprise technology innovation system, as the micro foundation of the regional innovation system, largely determines the direction and speed of technological innovation evolution, and is an important source to enhance the competitiveness of enterprises and regional innovation capacity.

In addition, technical collaboration among entrepreneurial enterprise complement the social capital of enterprises and provide a broader space for innovation. Partnerships can provide new factors of production for enterprise innovation by integrating internal and external resources. It has unique advantages in promoting enterprise innovation, including knowledge spillover and learning sharing mechanisms that facilitate the spread of innovation; resource integration and economies of scale mechanisms that help reduce innovation costs; and effective

coordination with “internalization of grid structure” transactions that help reduce innovation risks and effectively increase the speed and success rate of innovation.

2)Technical collaboration among technology-based entrepreneurial enterprises has a positive impact on technology transfer. There is a significant positive path effect of technical collaboration on technology transfer, i.e. (β =0.496, $p<0.05$). Specifically, technical collaboration among technology-based entrepreneurial enterprises positively influences technology transfer perceptions, and technical collaboration among technology-based entrepreneurial enterprises positively influences technology transfer outcomes. In terms of connotation, technical collaboration and technology transfer among technology-based entrepreneurial enterprises are closely related but also fundamentally different. Technical collaboration is an interactive relationship with no direction, and various knowledge, technology and capital flow in both directions; technology transfer is a one-way movement with clear direction and one-way transfer of knowledge and capital. This paper argues that technical collaboration can significantly promote transfer, mainly because in the R&D collaboration between entrepreneurial enterprises and other organizations, the more participants in an enterprise’s R&D collaboration the greater the likelihood of technology transfer, i.e., the scale of R&D collaboration has a positive effect on the transfer of technology outcomes. Mechanistically, technology transfer is the process by which knowledge, information, and innovations are transferred from universities, research institutions, and government laboratories to individuals, businesses, and other organizations. Technology transfer among technology-based entrepreneurial enterprises is rich in connotations and involves various forms of patent transfer, spin-off enterprises, and scientist mobility, all of which are based on stable and extensive technical collaboration.

3)Technology transfer among technology-based entrepreneurial enterprises has a positive impact on entrepreneurial performance. There is a significant positive path

effect of technology transfer on entrepreneurial performance, i.e. (β =0.663, p<0.05). Specifically, technology transfer perceptions among technology-based entrepreneurial enterprises positively affect entrepreneurial performance; technology transfer outcomes among technology-based entrepreneurial enterprises positively affect entrepreneurial performance. With the intensification of global competition, the acceleration of technological change and the surge of market demand, enterprises realize the need to promote not only knowledge sharing among employees and departments, but also inter-organizational knowledge transfer in order to expand the enterprise knowledge base and thus improve enterprise performance. Inter-enterprise knowledge transfer can help knowledge-receiving enterprises capture higher sales, increase product profitability and market share, and improve operational efficiency. Technology can be regarded as a form of knowledge, and acquiring and integrating technology from external knowledge sources, which is a key element for enterprises to enhance their own technological capabilities and build competitive advantages. Technology transfer facilitates technology-receiving enterprises to increase their product range, improve the quality and image of their products, and expand the market share of their products. Therefore, both purposeful and organized technical collaboration and technology transfer activities enable technology receiving companies to expand their own technology base. Combined with an enterprise's own technology platform, they are more conducive to the development of new products and thus improve enterprise performance.

4)There is a mediating effect of technology transfer within technology-based entrepreneurial enterprise between technical collaboration and entrepreneurial performance, and the mediating effect is highly significant. By calculating the percentage of mediating effects, this study can find that the effect value of the direct effect of technical collaboration → entrepreneurial performance is 0.137 and the direct effect accounts for 29.40% of the total effect (0.137/0.466); the combined

indirect effect value of the mediated path of technical collaboration → technology transfer outcomes → entrepreneurial performance is 0.329, and the mediated effect accounts for 70.60% of the total effect (0.329/0.466), indicating that technical collaboration not only predicts entrepreneurial performance directly, but also through the mediating role of technology transfer. Further, there is a mediating effect of technology transfer perceptions between technical collaboration and entrepreneurial performance; and a mediating effect of technology transfer outcomes between technical collaboration and entrepreneurial performance. This suggests that technology transfer is a substantial and intrinsic reason for the positive effect of technical collaboration on entrepreneurial performance, and that, for this reason, technical collaboration involves a narrower dimension and is not sufficient to help technology-receiving enterprises solve a set of technological challenges. In contrast, technology transfer involves a larger range of activities and higher-level organizational rules, and is accompanied by long-term, cross-organizational and multi-team in-depth communication, thus, the knowledge involved is more complex, implicit and ambiguous. When enterprises need more complex technical support, technology transfer is more conducive to technology-receiving enterprises to acquire the core technology capabilities of their partners, thus effectively improving enterprise performance. Technology transfer promotes the integration and consolidation of knowledge resources and the generation of technological innovation results. In terms of knowledge sources, externally transferred knowledge is more conducive to technological innovation performance enhancement than knowledge acquired from internal sources. The impact of technology transfer on technological innovation is more related to the relationship grid structure that enterprises focus on. Technology transfer among closely related enterprises tends to lead to high similarity of knowledge, which is not conducive to the enhancement of enterprises' technological innovation behavior. Only the transfer of complementary knowledge

can generate positive behavior towards enterprise technological innovation. Since technological innovation often involves multiple fields, individual enterprises will be unable to realize technological innovation due to the lack of innovation resources, so they need to obtain the knowledge resources required for enterprise technological innovation from the innovation knowledge grid structure through technology transfer and knowledge exchange, and then identify, integrate and utilize them to form new products, new processes and new methods, and finally form competitive advantages.

5.1.2 Insights

5.1.2.1 Theoretical insights

Taking technology-based entrepreneurial enterprise in industrial parks at all levels as research objects, which confirms that technical collaboration and technology transfer among enterprises in industrial parks have significant positive effects on entrepreneurial performance, extending previous studies related to technical collaboration within strategic alliances, technical collaboration within industrial clusters, and technical collaboration in enterprise grid structures. Previous studies have shown that strategic consortia, industrial clusters, and the innovation grid structure formed can promote the speed and quality of information dissemination, facilitate the dissemination and sharing of knowledge within the cluster, and improve the infrastructure to provide good external conditions for technology transfer. The empirical results of this paper show that the above relationship also exists among technology enterprises in industrial parks at all levels.

The findings show that enterprise technical collaboration can positively affect entrepreneurial performance through technology transfer. Technology transfer builds a connecting bridge between technical collaboration and entrepreneurial performance, and there is interaction between the two, and the effect size of each intermediary path is compared to validate an effective development model of technological innovation

for technology-based entrepreneurial enterprise in China. Technology transfer bridges the connection between technical collaboration and entrepreneurial performance, and there are interactions between them. This study compares the effect sizes of each intermediary pathway and validate an effective development model of technology innovation for technology-based entrepreneurial enterprise in China. When cooperating with partners, enterprises should not only quickly perceive market and industry changes, accurately evaluate the knowledge acquired from outside, and generate innovation performance by acquiring and identifying external knowledge, transforming and applying or partially modifying relevant knowledge, but also focus on breakthrough innovation when knowledge is accumulated to a certain extent, and appropriately develop internal technical ideas and sell part of the patents with partners in the form of export its own knowledge and share it with the outside, so as to enhance the innovation performance of the enterprise.

5.1.2.2 Practical insights

Enterprises should continuously optimize scientific and technical collaboration relationships with their own conditions to enhance the efficiency of heterogeneous scientific knowledge acquisition. Enterprises should attach importance to establishing connections with external organizations to broaden the channels for acquiring scientific knowledge, but also avoid departing from the existing knowledge base due to blind expansion of collaboration scale, which brings difficulties to knowledge absorption and effective integration. At the same time, in the process of external scientific research collaboration, enterprises should actively build cooperative consortia in relevant knowledge fields to discover scientific research knowledge boundaries earlier and focus on breakthroughs to achieve high-quality innovation. Finally, enterprises should coordinate the construction of internal and external research collaboration grid structure and build a good internal and external research collaboration synergy system. On the one hand, a sparse internal scientific research

grid structure with high cognitive openness can match a smaller scale of external scientific collaboration and induce the transfer of heterogeneous scientific knowledge to enterprises. With a larger external research collaboration scale, enterprises need to build a more dense internal technology research and development mechanism to improve the efficiency of external research knowledge screening and achieve effective accumulation of knowledge depth.

At the park level, a comprehensive service platform for technical collaboration and technology transfer should be established to enhance the scale, quality and efficiency of collaboration among enterprises. At present, technical collaboration and technology transfer of entrepreneurial enterprises still rely mainly on mutual collaboration among enterprises, and many studies have confirmed that technology service platforms are an important force to enhance the effectiveness of technical collaboration and technology transfer of enterprises. Science and technology service platforms are a new organizational model for providing various types of science and technology services. As an important part of the science and technology service system, technology transaction service is a bridge and link connecting technology and economy, and is the main intermediary for technological innovation and transformation of achievements. It can be borrowed from the service model of technology transfer and trading platform of various countries to provide high quality technology trading services for the entrepreneurial enterprise in the park. Due to the different needs of technology trading, each technology transfer and trading platform provides supporting services related to technology trading, which mainly involve four aspects. Firstly, intellectual property services, intellectual property information management and maintenance, patent search and analysis, intellectual property consulting, etc.; secondly, knowledge brokerage services, technology brokerage, industry analysis, market research, intellectual property assessment and evaluation; thirdly, technology business services, business investment, business incubation,

operational planning and consulting; fourthly, specialized professional services, such as lawyers, accountants, and patent agents. Knowledge platforms provide the above-mentioned services for startups, which can effectively improve the effectiveness of technical collaboration and technology transfer, and enable technology-based entrepreneurial enterprise to effectively improve their entrepreneurial efficiency.

At the government level, the park should play a leading role in policy to form a synergy of enterprises. National government agencies such as the regional and county governments need to promote collaboration among enterprises through certain incentive mechanisms and guidance measures to maximize the economic benefits of energy and resource recycling services, so as to ensure the establishment and maintenance of collaboration relationships among enterprises in the park. Through institutional and policy constraints, it can improve the responsibility of enterprises in the process of circular economy implementation, strengthen the training of talents, information communication, and technology sharing among individual enterprises, thus enabling them to eliminate the defenses and the risk wariness that collaboration may bring, and create conditions for the formation of collaboration as soon as possible.

In addition, the park should improve the formulation of policies to support the economic development of the park, consider the benefits that may be brought by the mutual collaboration of each enterprise, pay attention to the balance of resources and capabilities possessed by each enterprise, and form a policy system that supports the economic development of the park with reasonable levels, focus, complementarity and mutually supportiveness through the efforts of multiple parties. It should also pay attention to the long-term benefits that may be brought by mutual collaboration among enterprises in the park, adhere to the principle of benefit sharing, focus on long-term benefits, improve the long-term collaboration mechanism, improve the

enthusiasm of enterprises to cooperate in the park, and form a strong synergy of collaboration among enterprises in the park.

5.2 Limitations and prospects

This paper explores the unique role of technical collaboration on entrepreneurial performance, distills the characteristics of technology-based enterprise in industrial parks, constructs a model of industry-academia technical collaboration affecting entrepreneurial performance in the industrial park context, and explores the mediating role of technology transfer between industry-academia technical collaboration and entrepreneurial performance, aiming to reveal the intrinsic mechanism of industry-academia technical collaboration on entrepreneurial performance enhancement in industrial parks. However, this article still has some shortcomings such as: the sample data of different levels of industrial parks has not been further explored and researched, and further analysis and discussion are needed in the future.

The sample source for this study is taken from typical industrial parks in China that are formed under the role of government leadership or guidance. The data of this study do not involve other types of industrial parks, such as platform-type industrial parks built by large enterprises. The research findings lack a certain degree of generalizability and replicability and need to be further verified.

The data used in the empirical analysis of this study are cross-sectional data, which can only reflect the characteristics of the variables at a certain point in time, and it is difficult to reveal the dynamic changes of the relevant variables, such as the changes caused by unpredictable factors such as changes in government policies to a particular industry. There are still limitations in asking respondents about changes in technical collaboration over time. Based on this, future scholars need to explore the evolutionary mechanisms of the impact of technical collaboration on entrepreneurial

performance at different stages of enterprise development.

Research on the impact of industry-academia technical collaboration on entrepreneurial performance in industrial parks focuses on three aspects: technical collaboration, technology transfer, and entrepreneurial performance. This study focuses on the mediating effect of technology transfer to explore the impact of industry-academia technical collaboration on entrepreneurial performance, and research on the characteristics of cognitive and outcome aspects needs to be further explored. Future research needs to explore the effects of cognition and outcomes, technology diffusion, and absorption on entrepreneurial performance.

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Abstract

This study investigated the effects of technical collaboration on the financial performance of technology-based startup enterprises located in industrial parks in China. Enterprises within the same industrial park are geographically close and have a relatively free exchange of talent, allowing for the rapid spread of information. Industrial parks provide favorable conditions for technical collaboration and technology transfer between enterprises making them a suitable context for this study.

While a lot of literature on the topic of technical collaboration exists, few studies have adequately examined the actual effects of collaboration on performance. To do so, this paper asks: Does technical collaboration affect startup performance? What is the relationship between technical collaboration and technology transfer? How does technology transfer affect startup performance? What is the mediating effect of technology transfer on technical collaboration and startup performance?

To address these research problems, we analyzed the results of 501 questionnaires and formulated the following hypotheses.

1.Technical collaboration between technology-based startups has a positive impact on entrepreneurial performance.

2.Technical collaboration between technology-based startups has a positive impact on technology transfer.

3.Technology transfer between technology-based startups has a positive impact on entrepreneurial performance.

4.The technology transfer between technology-based startups has a mediating effect between technical collaboration and entrepreneurial performance.

Using the Bootstrap method with statistical analysis, correlation analysis, reliability and validity analysis, the results upheld all four hypotheses. The

conventional wisdom that technical collaboration between enterprises can drive innovation and that these external resources can be an important complement to the internal innovation processes of an enterprise was thus confirmed through empirical analysis.

Key words: technical collaboration, technology transfer, entrepreneurial performance, intermediary effect, industrial park

Appendix:Questionnaire on the impact of technology transfer and technical collaboration of technology-based entrepreneurial enterprises in the park on entrepreneurial performance

Dear Sir/Madam:

Thank you for taking the time out of your busy schedule to participate in this survey. This questionnaire is an empirical research part of academic research.

Under the background of China's transitional economy in the new era, at present, with the rapid development of technological innovation, the technology transfer of scientific and technological achievements with the knowledge economy as the main body has become an important support for the adjustment of industrial structure and economic transformation and upgrading. The diffusion, flow, sharing and application of scientific and technological achievements are indispensable links to enhance scientific and technological innovation capabilities, promote the industrialization of scientific and technological achievements, stimulate innovation and entrepreneurial vitality, realize the close connection of scientific and technological economy, and build a deep integration system of production, education and research. It is of great significance. At the same time, however, some uncertain factors have also caused the technology transfer rate of scientific and technological achievements to not increase significantly. Of course, it is impossible to find out all the reasons. The aim of the research is to understand the most important parts as

much as possible on the existing basis. Such as the technology transfer of technology-based entrepreneurial enterprises in the park, the relationship between technical collaboration and entrepreneurial performance. The intermediary effect between technology transfer and technical collaboration and entrepreneurial performance variables of technology-based entrepreneurial enterprises. Please help us to complete this questionnaire in your busy schedule. Your answers are very important to our research conclusions. Thank you very much for your enthusiastic help!

When filling out this questionnaire, I promise you:

This survey is anonymous, and there is no uniform standard answer to the questionnaire. The information obtained in the survey is used for basic management science research, and will never be disclosed individually or for other commercial purposes. Please rest assured to answer. Thank you for your cooperation and support!

Pukyong National University

(Email: chn.lp@foxmail.com)

May, 2021

Part 1: Formal Questionnaire

The following questionnaires are related to "technological entrepreneurial enterprises". Please choose among the numbers (①～⑤) according to your feelings and thoughts, and mark them with the symbol '○' or '√'. The meanings represented by each number are: ① meaning "strongly disagree"; ② meaning "disagree"; ③ meaning "neither disagree nor agree"; ④ meaning "agree"; ⑤ meaning "strongly agree".

1. The following items describe the "technical collaboration" situation, please mark the number you think is appropriate.

Question item	strongly disagree	disagree	neither disagree nor agree	agree	strongly agree
TC1：We have frequent communication with innovation partner organizations (enterprises /colleges) and often share technical knowledge with our partners via e-mail, Internet, etc.	①	②	③	④	⑤
TC2：In collaboration with innovation partner organizations (enterprises / colleges), we invest a lot of human, material and financial resources to provide our own corporate knowledge to share with our partners, so that we can receive tangible or intangible rewards.	①	②	③	④	⑤
TC3：We communicate with our innovation partner organizations (enterprises / colleges) on a wide range of production, technology and market information, and regularly compile and document our work related to collaborative technological innovation for a reference of other partners.	①	②	③	④	⑤

2. The following items describe the "technology transfer" situation, please mark the number you think is appropriate.

Question item		strongly disagree	disagree	neither disagree nor agree	agree	strongly agree
Cog niti on	TT1：Members, including researchers, actively collaborate and participate in internal (external) technical briefings of	①	②	③	④	⑤

	the institution (enterprises / institutes) or consulting project meetings of researchers, etc.					
	TT2：Members, including researchers, are actively involved in educational programs related to intellectual property application and management, technology transfer, and new technology entrepreneurship offered by the institution (enterprises / institutes).	①	②	③	④	⑤
	TT3：Members, including researchers, actively develop some new technologies to start new technology entrepreneurship (or secondary entrepreneurship within the organization), such as new technology entrepreneurship using technologies like laboratory start-ups.	①	②	③	④	⑤
	TT4：For commercialization of technology transfer, members, including researchers, are actively using commercialization support institutions (external investment institutions and technology trading institutions, etc.) or government policies to	①	②	③	④	⑤

	support commercialization of technology transfer and technological achievements.					
Question item		strongly disagree	disagree	neither disagree nor agree	agree	strongly agree
Achievements	TT5：Acquire much of the knowledge necessary for basic technology and application technology development from partner institutions (enterprises/ colleges).	①	②	③	④	⑤
	TT6：Acquire a lot of knowledge on new product design and development from partner institutions (enterprises/ colleges).	①	②	③	④	⑤
	TT7：Acquire a lot of knowledge about new production processes and management from partner institutions (enterprises / colleges).	①	②	③	④	⑤

3. The "entrepreneurial performance" is described in each item, please mark the number you think is appropriate.

Question item	strongly disagree	disagree	neither disagree nor agree	agree	strongly agree
EP1：Your enterprise has a higher market share growth rate compared to your competitors in the industry.	①	②	③	④	⑤
EP2：Your enterprise has a higher sales growth rate compared to your competitors in the industry.	①	②	③	④	⑤

EP3：Your enterprise has a higher profit growth rate compared to your competitors in the industry.	①	②	③	④	⑤
EP4：Your enterprise has a higher return on assets compared to competitors in your industry.	①	②	③	④	⑤
EP5：Your enterprise has a higher return on investment compared to competitors in your industry.	①	②	③	④	⑤

Part 2: Basic Information

The following are some basic information questions about the respondent. Please read the questions in the left column and select them in the right column and mark them with the symbol '○' or '√'.

1.Gender:	A.Male	B.Female	
2.Age:	A.Below 30 (30 included)	B.31~40	C.41~50
	D.Above 51(51 included)		
3.Education level:	A.High school and below	B.College	C.Undergraduate
	D.Master	E.Doctor	
4.Personnel size of your enterprise:	A.Less than 50	B.51-100	
	C.101-200	D.More than 201	
5.Region where the enterprise is located:	A.Northeast China (Heilongjiang, Jilin, Liaoning) B.North China (Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia) C.Central China (Henan, Hubei, Hunan) D.East China (Shandong, Jiangsu, Anhui, Shanghai, Zhejiang, Jiangxi, Fujian, Taiwan) E.South China (Guangdong, Guangxi, Hainan, Hong Kong, Macao) F.Northwest China (Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang) G.Southwest China (Sichuan, Guizhou, Yunnan, Chongqing, Tibet)		
6.Industry that the enterprise	A.Agriculture, forestry, animal husbandry and fishery		

belongs to	B.Mining C.Manufacturing D.Electricity, heat, gas and water production and supply E.Construction F.Wholesale and retail G.Transportation, storage and postal services H.Accommodation and catering I.Information transmission, software, and information technology services J.Finance K.Real estate L.Leasing and business services M.Scientific research and technology services N.Water conservancy, environmental and public facilities management O.Residential services, repair, and other services P.Education Q.Health and social work R.Culture, sports and entertainment S.Public administration, social security, and social organizations T.International organization				
7. Work experience (except the current work):	A.Without work experience			B.One period	
	C.Two periods			D.Three periods and above	
8.Years from the establishment	A.Less than 1 year	B.1 year	C.2years	D.3 years	E.4 years
	F.5 years	G.6 years	H.7years	I.8 years or more	
9.Registration type of the enterprise:	A.Domestic funded enterprises (state-owned enterprises, collective-owned enterprises, joint stock cooperative enterprises, associated enterprises, limited liability companies, joint stock limited companies, private enterprises) B.Hong Kong, Macao and Taiwan invested enterprises C.Foreign-invested enterprises D.Others				
9.The technical source of your enterprise is (multiple choices):	A.Enterprise owned technology B.Purchase technology from universities and scientific research units C.Joint research and development with universities and scientific research units in the province (city) D.Joint research and development with enterprises in the province (city) E.Joint research and development with universities and research units outside province (city) and research F.Joint research and development with enterprises outside				

	the province (city) G.Purchase other business technology
10.The level of the park the enterprise is in:	A.National level industrial parks B.Parks at the level of municipalities directly under the central government, provinces, autonomous regions and special administrative regions C.Prefecture level cities, autonomous prefectures and league level parks D.County and district level parks E.Township and town level parks F.Others

At the end of this questionnaire, please confirm again that there are no missing questions! And thank you once again for your participation and help!

Acknowledgement

At the end of the thesis, I couldn't calm down for a long time. This thesis was completed under the careful guidance of two tutors, 천동필 and 남은영. In the writing and revision of the thesis, the two mentors devoted a great deal of effort to guiding me, helping me to open up my mind, and elaborating meticulously. The meticulous style, rigorous and practical attitude of the two mentors, and the down-to-earth spirit have benefited my life. I would like to express my deep gratitude to the two mentors.

I would like to thank all the professors of the school for their concern and guidance in my studies and scientific research. The valuable opinions and suggestions put forward by the professors in my daily study and the ardent care in life have moved me deeply. Thanks to the thesis defense members who provided valuable comments and suggestions for this thesis during the defense stage. These valuable comments and suggestions are my valuable assets for continuous improvement of professional knowledge, improvement of scientific research level and successful completion of the thesis!

Thanks to Director Zhao Futao and leaders of Zhejiang University Technology Transfer Center for providing me with a valuable internship platform, which allowed me to combine theory with practice during the half-year internship period, and deepened my understanding of Chinese universities and enterprises' technology transfer, as well as the technology transfer industry.

Thanks to my roommate Qi Ning and my senior schoolmates for their guidance and supervision. They brought me into a good atmosphere of academic study and a positive living environment. Without their tireless tutoring and help, and selflessly researching and discussing research methods and improvement methods, I would not

have finished the final completion of my thesis. Here, I would like to express my most heartfelt thanks to my roommate and my senior schoolmates who have counseled and helped me. Thanks to my classmates Lv Xiaojing, Shi Hanyong, Wang Xiaolong, and Zhao Bingqian for continuously helping me in my daily study and life. Thanks to Han Lei, Huang Junli, Li Mei, Meng Xincheng, Pu Xiaochuan, Song Changsong, Ran Yan, and Wang Xiaoyang for their company all the way. They brought me endless fun in life and study and accompanied me through an unforgettable PhD career!

Thanks to my parents, parents-in-law, relatives, friends and all those who care about and support me, thank you for the most selfless care you have given me. You have always been the inexhaustible driving force for my life. I want to thank my fiancee Ling Ruining, and thank her for supporting me behind my back and giving me spiritual strength during the last and most difficult period of my Ph.D. Thank her for sharing most of her filial piety to both parents and trivial matters in life. Thanks for her acceptance and support of my decision to go to a foreign country to finish my studies as soon as we got together. I am deeply guilty of this. Fortunately, now that I have finished my work, I also gave this article to her as a gift.

Finally, I would like to thank the great motherland for responding quickly in the face of the epidemic and providing free help to our overseas students and compatriots by sending them "epidemic prevention and health kits". Thanks to the motherland. No matter where we are, the motherland sends love to us. It is extremely warm, we are all proud of the motherland, and makes me feel proud of being a Chinese. As I am about to graduate and return to China, I would also like to thank those workers who have been fighting on the front line of epidemic prevention. Thank them for building the Great Wall of Epidemic Prevention and pulling up the line of love. Let our overseas returnees not worry about the risk of the epidemic after returning, and feel the warmth of the motherland. Thousands of words cannot express our gratitude to our

motherland. I only have to work hard after returning home and work hard to serve the motherland for the realization of the Chinese dream.