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Statement

I affirm that this doctoral dissertation is an original work and has been composed solely by me.

I have properly acknowledged all sources of information utilized in this dissertation.

This doctoral dissertation has not been previously submitted for any academic degree at any university.

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Abstract

In the era of the digital economy, industries are shifting toward platform-based and ecological trends, with industrial parks similarly adopting digital and platform-based patterns. The systematic planning, functional layout, and service efficiency of science and technology industrial parks (sci-tech industrial parks for short) are designed to address emerging industries' spatial and organizational needs. This approach aims to create a system where digital transformation is employed as the mechanism and digital platforms empower entrepreneurial enterprises within these parks, fostering high-quality park development. However, despite efforts to build digital platforms for transforming into digital parks, many industrial parks have found their platform functions limited, failing to truly empower entrepreneurial enterprises with innovative capabilities. There is a need for in-depth research on the empowerment mechanisms of digital platforms.

Based on a literature review, this paper identifies that while the digital transformation of industrial parks is acknowledged as the future direction, the connotations, dimensions, mechanisms, and boundary conditions of the digital platform capability system have not been systematically explored. Thus, a pressing question emerges: How can sci-tech industrial parks develop digital platform capabilities that genuinely empower entrepreneurial enterprises and promote their sustainable development? To address this, the study focuses on the core question of "how to build digital platform capabilities for sci-tech

industrial parks to empower entrepreneurship of enterprises in the parks," and explores three specific sub-questions: (1) What digital platform capabilities should be developed for sci-tech industrial parks? (2) How can these digital platform capabilities empower entrepreneurial enterprises in the parks? (3) How do the basic standardized management systems impact the empowerment of digital platform capabilities on entrepreneurial enterprises in industrial parks?

To answer these questions, the study employs literature analysis, case studies, and empirical tests. Initially, it refines the connotation and dimensions of the digital platform capability system through literature analysis and case studies. It then examines the mechanisms by which digital platform capabilities influence entrepreneurship empowerment performance, proposing a preliminary analytical framework. Based on case studies, this study proposes, tests, and discusses a theoretical model exploring the relationship between digital platform capabilities, basic standardized systems, and entrepreneurship empowerment performance. The following four conclusions are drawn:

(1) Through a longitudinal single-case study, it is identified that sci-tech industrial parks' digital platform capabilities comprise platform complementarity capability and platform integration capability. Platform complementarity capability focuses on building a platform ecosystem from a "chain" perspective, while platform integration capability emphasizes integrating and establishing a total-factor service system from the platform owner management perspective. By reconstructing resources, these capabilities

provide entrepreneurial enterprises with dedicated industrial and platform services tailored to their needs.

(2) Case studies and empirical tests indicate that digital platform capabilities facilitate entrepreneurial enterprises in accessing complementary resources, offering them professional and platform services, thus enhancing both direct and indirect entrepreneurship empowerment performance. The integration and complementarity capabilities of digital platforms mutually reinforce each other, further boosting entrepreneurship empowerment performance.

(3) Empirical tests reveal that basic standardized management systems significantly enhance the empowerment of digital platform capabilities for entrepreneurial enterprises. These systems comprise a project-based operating system and a collaboration ecosystem. Building a professional and continuous project-based operating system will strengthen the connection between entrepreneurial enterprises and digital platforms. Meanwhile, building a collaboration ecosystem that spans across industries and regions will deepen and broaden the interaction between entrepreneurial enterprises and complementary parties. Therefore, digital platform capabilities show positive effects on entrepreneurial enterprises.

(4) Through comparative research and an overview, an empowerment performance evaluation system is constructed. The study proposes that entrepreneurship empowerment performance encompasses two dimensions:

direct entrepreneurship empowerment performance and indirect entrepreneurship empowerment performance. The former is reflected by traditional indicators such as growth, profitability, and innovation of entrepreneurial enterprises, while the latter focuses on the service efficiency of industrial parks during the entrepreneurial process. The evaluation system combines financial and non-financial indicators, as well as subjective and objective indicators, to provide a comprehensive assessment of entrepreneurship empowerment performance. It is expected to engage with the supervisor throughout the research process to further stimulate the efficiency of empowering entrepreneurship services and thus ensure the long-term sustainable development of industrial parks.

This study yields significant theoretical contributions and practical implications.

(1) Contribution to research on digital platform capabilities and digital industrial park platform capability: By integrating the theoretical foundations of digital platforms and digital industrial park capability systems, this study identifies the digital platform complementarity capability and platform integration capability as two dimensions of platform capability for sci-tech industrial parks from the perspectives of platform resource factors and platform enterprise management, leading to the construction of digital platform capability systems.

(2) Contribution to research on the empowerment of digital industrial

parks: The study highlights the use of digital platforms as the core medium for empowering entrepreneurial enterprises in industrial parks. It analyzes the mechanisms through which digital platform capabilities impact entrepreneurship empowerment performance, identifies and tests the basic standardized systems as a key moderating variable, and constructs a performance evaluation system that includes both direct and indirect entrepreneurship empowerment.

(3) Contribution to the paths and models for the transformation of sci-tech industrial parks: From an operational management perspective, this study suggests that digital empowerment platforms can significantly enhance the intelligent level of park management, providing managers with accurate and timely decision support. From a platform operation perspective, it is proposed that digital platforms should enable centralized resource management and efficient resource allocation, forming a robust industrial chain and ecosystem to attract outstanding enterprises to the park. From a park services perspective, digital platforms can offer efficient and precise data support, better insights into market dynamics, optimized decision-making processes, and support for innovative industry development. From a government support perspective, digital empowerment platforms can integrate information technology and data resources and enable real-time park monitoring, aiding governments in achieving refined and intelligent park management. These platforms can aggregate various production factors and resources, provide one-stop

government-oriented services, optimize resource allocation, and enhance service efficiency. They can also offer services such as technology transfer, financial support, and market promotion, provide support in all aspects, reduce entrepreneurial costs, stimulate innovation, and foster communication and cooperation among stakeholders, thus fostering a joint force to drive development.

Keywords: science and technology industrial park, digital platform capability, entrepreneurship empowerment, basic standardized system, empowerment performance

Content

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transformation and entrepreneurship empowerment of sci-tech industrial parks. I dedicate this dissertation to all who support, help, and care about me. I hope we can join hands to contribute more to the academic cause and social development.

1. Introduction

1.1 Development Background of Industrial Parks

Industrial parks serve as fundamental platforms and crucial growth poles for regional economic development. Since the 1990s, China has implemented pilot economic development zones, leading to the vigorous development of industrial parks nationwide over the past two decades. This underscores the significance of industrial parks. However, in the last decade, the rapid advancement of digital technology has highlighted the inefficiencies and functional limitations of traditional industrial parks. Integrating emerging digital technologies into these parks to achieve high-quality development has become a pivotal strategy for transforming economic development models across various regions. Consequently, leveraging emerging digital technologies to empower the transformation of industrial parks is increasingly prominent. In line with the national informatization development strategy and the deployment of the new infrastructure strategy, industrial parks are now driven by technological innovation and employ digital transformation, intelligent upgrading, and integrated innovation to build a park infrastructure system based on digital technology. This shift represents an inevitable trend toward the digital and ecological development of industrial parks. Therefore, this chapter systematically reviews the basic concepts, development history, types, and current status of industrial parks to provide a research background and practical basis for this study.

1.1.1 Concept and connotation of industrial parks

An industrial park is a specific area planned by national or regional governments through administrative means according to the inherent requirements of economic development. Within this area, leveraging special policies, industrial enterprises are clustered to capitalize on the moderate concentration of various production factors. This fosters distinctive industrial characteristics, significant cluster advantages, and a well-organized functional layout, thereby enhancing the development and competitiveness of regional industries.

China hosts various types of industrial parks, including export processing zones, free trade zones, industrial parks, science parks, technology parks, technology towns, economic and technological development zones, high-tech industrial development zones, eco-industrial parks, and creative industry parks. As significant forms of spatial agglomeration for regional economic development and industrial adjustment and upgrading, these parks undertake vital missions such as gathering innovative resources, cultivating new industries, and promoting urbanization. Industrial parks perform five key functions: resource gathering, technology penetration, enterprise incubation, demonstration and leading role, and peripheral influence. By offering one-stop services and an environment conducive to innovation for enterprises, these parks enable numerous small and medium-sized enterprises (SMEs) to specialize, scale up, and innovate, thereby driving local economic and social development.

Table 1.1 **Five Functions of Industrial Parks**

Function	Interpretation
Resource gathering	Gather human, material, financial, information, policy, and other resources to exert synergy and scale effect.
Technology penetration	Allow new technologies to penetrate into traditional industries, related industries, and other fields of society. For example, microelectronics technology promotes electronization and automation in the mechanical industry, and robotics technology and artificial intelligence (AI) technology are integrated with each other.
Enterprise incubation	Cultivate and incubate start-ups, technology-based SMEs, and innovative R&D technological achievements to help them grow steadily and gain market competitiveness.
Demonstration and leading role	Exert positive influence on enterprises and organizations outside industrial parks and promote technological advancement through innovations and breakthroughs in parks' organizational structure, products, and technologies.
Peripheral influence	Promote the development of local commerce, science and technology, education, transportation, and other aspects and create employment opportunities for local people.

1.1.2 Development history of industrial parks in China

Over more than 30 years, China's industrial parks have continuously evolved, forming distinctive patterns across different regions. Utilizing industrial park policies, regions have seen the transition from traditional industrial parks to manufacturing and modern industrial parks, along with diverse organizational modes and node functions being observed. Overall, the development of industrial parks in China can be divided into four stages (as shown in Table 1.2):

Stage 1.0: The factor agglomeration stage, where local governments demarcate specific geographic spaces to provide basic production factors and services for enterprises in the park featuring amenities such as water and electricity supplies, well-maintained roads and communication infrastructure, drainage systems, and leveled sites. Stage 2.0: Governments aim to guide the development of advantageous and leading industries through parks, forming a low-cost development pattern with concentrated industrial production factors. Stage 3.0: Recognizing that the low-cost, high-pollution, and low-added-value pattern is unsustainable, governments focus on developing science and technology industries by clustering enterprises with significant technological strength to build high-tech industrial clusters. The constantly emerging sci-tech parks during this stage promote industrial transformation and upgrading. Stage 4.0: Both national and local governments elevate sci-tech parks to new heights through large-scale new sci-tech towns and national high-tech development zones. Overall, the evolution of these stages indicates a shift from extensive to refined development, labor-intensive to technology-intensive industries, and single-function to multifunctional industrial parks closely integrated with urban development.

Table 1.2 Four Development Stages of Industrial Parks

	Park 1.0	Park 2.0	Park 3.0	Park 4.0
Comparison item	Factor clustering stage	Industry leading stage	Innovation and breakthrough stage	High-tech new town stage
Core drivers	Preferential government policies and low costs	Preferential government policies and enterprise competitiveness; oriented by industrial chain integration	Largely technologies; oriented by innovative technology development and high-end supporting services	Wealth; oriented by high-value brands, high-quality professionals, high R&D level, and high value-added capacity and rate of return
Park type	Industrial parks around gathering single enterprises or similar enterprises	Industrial parks around extending the industrial chain of core enterprises	Industrial communities around industrial cluster layout	Complexes around integrating industrial functions and urban functions
Dominant industries	Labor-intensive traditional industries with low added value	Capital-intensive industries, such as electronic communication equipment manufacturing and vehicle manufacturing	Technology-intensive and innovative industries, such as biotechnology, new energy, and information network industry	Sci-tech R&D, cultural creativity, high-end modern services, etc.
Park functions	Focus on manufacturing and processing of single products	Focus on product manufacturing	Composite functions of sci-tech R&D and product manufacturing	A gathering place of capital, industrial, and life activities, with modern comprehensive urban functions
Urban relations	Basically disengaged	Relatively disengaged	Pivotally influenced	Closely integrated
Representative parks	Industrial park	High-tech industrial development zone	Zhongguancun Science Park	Nanshan Science and Technology Park, Shenzhen

Data source: compiled and formed by referring to the LeadLeo Research Institute.[1]

[1]Zheng, M. (2019). Overview of China's industrial park industry. LeadLeo Research Institute.

1.1.3 Types of industrial parks

Industrial parks can be classified into two main types based on their establishment objectives: traditional industrial parks with a single economic growth orientation and modern industrial parks with diversified comprehensive development goals.[2]

(1) Traditional industrial parks

Traditional industrial parks are designed to facilitate the gathering and flow of conventional production factors such as raw materials, labor, and capital. They also promote the sharing of resources like land, transportation, and infrastructure to create an agglomeration effect. These parks can be further divided into export processing zones and industrial parks. Export processing zones are special areas established by a country or region to manufacture, process, and assemble export commodities. The goal is to utilize foreign capital to develop export-oriented industries and expand foreign trade, thereby expanding international markets and fostering an export-oriented economy. The majority or all of the products from these zones are destined for export. Industrial parks are areas where specific tracts of land are designated and pre-planned exclusively for industrial facilities. As a strategic means of industrial development, industrial parks reduce infrastructure costs, stimulate regional economic growth, and offer various benefits to local communities.

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[2]Wang, J. [Jici], & Zhu, K. (2018). Relevant theories of foreign industrial parks and their implications for China. *Urban Planning International.*

(2) Modern industrial parks

Modern industrial parks arise during an era marked by global energy crises and competition in both soft and hard power of sci-tech innovation worldwide. These parks have a problem-oriented focus and can be subdivided into sci-tech parks, eco-industrial parks, innovation parks, and other categories (as shown in Table 1.3).

Table 1.3 Types of Industrial Parks3

Type	Typical industry	Leadership	Main function	Management mode	Example
Export processing zones	Labor-intensive traditional industries	Government and its agents	Resource gathering	A management committee is established as an agency of the government, which is responsible for daily management affairs in the zone and cannot engage in commercial activities.	Hangzhou Export Processing Zone
Industrial parks	Labor-intensive traditional industries	Industry-leading enterprises	Resource gathering	A management committee is established as a public institution directly under the industrial park to organize, implement, and formulate various management systems and service regulations of the park, to create a good investment environment for the park.	Songmudao Chemical Industrial Park, Dalian
Sci-tech parks	Technology-intensive and innovative industries	A dedicated park operating company	Resource gathering Technology penetration Enterprise incubation	Co-established by governments and enterprises but operated by them separately; established by governments and operated by companies	Zhongguancun Science Park
Eco-industrial parks	High-tech and environmental protection industries	New park solution providers	Resource gathering Demonstration and leading role	Designed with efficient park management systems to implement efficient management of all aspects of parks and promote their sound operations	Qingdao Sino-German Ecopark
Innovation parks	Sci-tech R&D, cultural creativity, high-end modern services, etc.	A dedicated park operating company	Resource gathering Enterprise incubation Peripheral influence	"Park + market-oriented operation company." A management service center and a management company are established.	Binjiang Innovation Park

Source: prepared by the author

Sci-tech parks are comprehensive areas where high-tech industries cluster around innovation as the core. They include research institutions, institutions of higher learning, high-tech enterprises, and the necessary business and life service facilities and infrastructure such as municipal and transportation systems. These parks represent the most effective spatial organization for developing a knowledge economy. Eco-industrial parks form regional systems comprising industrial enterprises, agriculture, and residential areas. Enterprises within these parks share resources through close industrial relations. They contribute to reducing the environmental impact of production processes, strengthening waste recycling, lowering production costs, improving economic benefits, and achieving sustainable development. Innovation parks, focusing on innovation experiences, aim to attract employees to participate in and enjoy the process of sci-tech innovation, contributing to developing innovative and creative industries. Innovation parks primarily provide office spaces such as conference rooms and laboratories for innovation teams, coordinate industrial chains for project experiments, transform and apply valuable scientific research achievements of industrial chains, outsource service projects, and sell cultural and creative products.

To summarize, traditional industrial parks embody four main modes of operation and management: government and its agency organizations dominate; industry leaders dominate; professional park operating companies dominate; new solution providers for park operation dominate. Different operating entities and governance modes suit different types of industrial parks.

1.1.4 Development status of industrial parks

Currently, industrial parks in China are at a transformative juncture. On the one hand, numerous traditional industrial parks are transforming and upgrading in response to national industrial transformation. On the other hand, industrial parks dominated by emerging industries are quickly burgeoning, creating an overall prosperous landscape. The total number of various industrial parks exceeds 25,000.[3] However, the further development of industrial parks faces several challenges, which generally fall into three areas.

Insufficient digital planning for sci-tech parks. The long-established development path of industrial parks based on traditional models is no longer adequate for the digital age. This has led to insufficient overall digital planning and a lack of coordinated development for high-tech industrial parks. Consequently, there is a low-level repetition in digital transformation efforts, with high competition frequency but insufficient synergistic benefits. For example, in addition to focusing on commerce and trade industries, many parks set up technology and finance sectors, without distinguishing differentiated industrial characteristics. Internal park development often lacks systematic and forward-looking planning, focusing instead on fragmented functional development. This results in isolated functional subsystems that fail to meet the needs of current industrial ecological development.

Inefficient digital services in sci-tech parks. Most sci-tech parks still operate under GDP-centric management and governance models. While business owners in parks provide basic services such as energy, water, and sites, they often neglect issues like high energy consumption, pollution, and waste. The development of digital empowerment systems for innovation and

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[3]Wang, D. [Depei]. (2022, July 7). Driving economic growth by over 30%, facing serious overcapacity and eight barriers to park development. *Yicai*. Retrieved from https://m.yicai.com/news/101309151.html

entrepreneurship is significantly lacking. Digital and intelligent solutions pose significant challenges to the transformation of such industrial parks. Furthermore, traditional industrial parks suffer from outdated infrastructure, such as old network systems and weak power supplies, which fail to meet the needs of modern enterprises, especially those requiring digital platform development models.

Lack of support for innovation-driven entrepreneurship. Traditional industrial parks have historically attracted enterprises through location and tax policy advantages, providing basic, simple management services. However, with the current saturation of industrial parks, relying solely on tax, land, and energy price advantages is no longer effective for investment attraction. In the context of national strategies for innovation-driven and high-quality development, enterprises now prioritize services that promote effective innovation-driven entrepreneurship, such as environmental, technical, talent, financial, and information services. However, traditional industrial parks are relatively weak in these areas, necessitating urgent transformation and upgrading.

1.2 Digital Transformation of Industrial Parks

1.2.1 Evolution of digital park ecosystem

Digital transformation has become a strategic imperative to effectively address existing challenges in developing industrial parks. With the advent of the digital economy, industrial digitization and digital industrialization have set new trends for the transformation of industrial parks. In general, the development of China’s industrial parks has reached a critical period for transformation and upgrading. On the one hand, in the context of industrial digital transformation, many enterprises in traditional industrial parks have undergone transformation and upgrading, promoting the overall digital transformation of the parks. On the other hand, industrial parks dominated by emerging industries have rapidly emerged, creating a flourishing scene for industrial parks. The total number of various industrial parks now exceeds 25,000 (Wang Depei, 2022).

Different studies offer varied conclusions on the direction of industrial park transformation. K. Zhang et al. (2012) and Ai et al. (2016) suggested that future industrial parks will emphasize the coordinated development of production, life, and ecological activities, transforming into an ecological economic development model. Enterprises within these parks shift from traditional manufacturing to high and new technology, focusing more on technological innovation, increasing R&D investment, and gradually capturing high value-added links in the industrial chain. The management systems of industrial parks are evolving toward intelligence, humanization, and perfection to meet increasingly intricate social needs.

Z. Zhong et al. (2021) and G. Zhu (2021) argued that industrial parks develop in an ecological manner. Under the trend of digital development, the ecosystem of digital parks has become a product of the transformation and upgrading of traditional industrial parks. By adopting digital, platform-based, and intelligent technologies, industrial parks develop an ecological system that integrates people, machines, things, and materials through comprehensive perception and extensive connection, forming an organism and sustainable development space characterized by active service and intelligent evolution. Digital parks use information technologies such as cloud computing and the

Internet of Things (IoT) to perceive, monitor, analyze, control, and integrate all key links. They are intelligent parks based on digital foundations (H. Liu, 2016). Digital parks use technologies like IoT and cloud computing to monitor park dynamics at all times, improving operational efficiency and reducing operating costs (M. Ma, 2016). G. Zeng (2022) pointed out that the increasingly complex development of digital industrial parks is conducive to multi-park management, which requires discipline and organizational support from fields such as industrial planning, economic development, industrial technology, transportation systems, ecological balance, and scientific research.

Based on the above, we summarize the characteristics of the digital park ecosystem as follows: (1) Parks adopt IoT, digital, intelligent, and platform-based technologies to transform infrastructure digitally. This provides efficient and low-cost basic property services for enterprises and empowers innovation-driven entrepreneurship with various resources inside and outside parks. (2) Parks demonstrate the interactive and integrated development of production and life activities. Digital parks offer compound functions such as office space, R&D, production, enterprise display, residence, and commerce, providing comprehensive service support for enterprises and individuals in parks. (3) Parks serve as innovation and entrepreneurship empowerment platforms for settled enterprises. Historically, industrial parks provided low value-added and non-technology-oriented services, such as life services and production services. Now, facing the national innovation-driven development strategy, they are transforming from providing lifestyle services to delivering innovative entrepreneurship services, promoting the high-quality development of enterprises within the parks.

1.2.2 Development trend of industrial parks as digital platforms

With the ecological development trend of industrial parks, the management of sci-tech parks is also showing a trend toward ecological, platform-based, and systematic development. Relying on digital infrastructure, the interconnection and coordinated development between these parks and enterprises within them have been realized. The development of digital platforms reflects the following trends in organizational elements, inter-element relations, and organizational structures.

First, digital organization development of industrial parks. The digital organization development of industrial parks is foundational to achieving platform-based and ecological development. Parks' digital organization can be divided into three aspects: base system (digitization of infrastructure), digital process, and front-middle-back office collaboration. Regarding the base system development, industrial parks should use technologies like AI, blockchain, cloud computing, data analytics (ABCD) plus 5G to build a big data platform that integrates both government and business data. Government data includes services, spatiotemporal information, building information, and safety information, which aid in providing policy consulting services for enterprises in parks. Business data include customer, market, industry data, and industrial analysis, providing business support for enterprises in parks. Regarding digital process development, to ensure orderly data operations, parks need to establish a well-organized data process system with robust data standardization, processes, and normalization systems. This supports both service provision for enterprises and effective governance. It is also necessary to ensure sound organizational development of enterprises in parks. Front-middle-back office collaboration represents the development of organizational systems of park management institutions. It enables the back office to manage underlying data, the middle office to design functional systems based on different customer scenarios, and the front office to meet personalized needs.

Second, the organizational change for platform-based development of industrial parks. The platform-based development of industrial parks depends not only on digital technology but also on digital organizational change to create a collaborative system of digital platforms for the parks. Corresponding to digital technology, organizational change encompasses the organizational change of park management institutions and their interactions with enterprises within parks. Firstly, the park management institution should establish a "park brain." This concept is not technical but functional. It involves creating a collaborative command system using technological means and building various modules according to the park's service functions (such as comprehensive management, government services, economic analysis, innovation incubation, and precise investment attraction). It should enable human-computer interaction management, allowing for overall perception, real-time monitoring, full-line scheduling, and data-driven decision-making within the park. Secondly, there must be efficient interaction between the "park brain" and various terminals (enterprises in the park). The park management institutions should implement digital interactions with each node. In terms of organizational design, the most effective organizational modules should be selected according to forms like project teams, technical teams, and service teams, to ensure efficient connections with the "park brain."

Third, digital empowerment of industrial parks to entrepreneurial enterprises. Traditional industrial park management is often closed, with all services provided by operating institutions and designed by the management enterprises within the parks. This model is not conducive to large-scale, wide-ranging, and platform-based park operations. Supported by digital technology, future industrial parks should be platform-empowered. Firstly, parks should pursue open partnerships. Various park services can be provided by professional service organizations outside the park. Secondly, park services should be oriented toward innovation and entrepreneurship. Parks should be high-level suppliers of innovation and entrepreneurship elements rather than low-level service providers. They should design service technology structures, functional elements, main tasks, and implementation paths centered on their development goals to provide high-quality services for enterprise innovation and entrepreneurship. Thirdly, interaction and collaboration can be realized among enterprises in each node of the park. The park platform should offer specialized services such as collaborative R&D, production and manufacturing, enhancement technology, and efficiency technology. Enterprises within the park should act as synergistic entities, cooperating and empowering each other to continuously enhance the digital capability of the park, promote digital technology innovation, and create a digital organizational community.

1.3 Research Questions

The digital transformation of industrial parks has become a crucial strategic direction for their development, with building digital platforms as a key approach of great significance. However, there are challenges in creating digital platforms and achieving the transformation of industrial parks. For instance, current platform functions are mainly focused on information display, which hampers empowerment in innovation and entrepreneurship. The systems of digital platform capabilities and entrepreneurship empowerment evaluation have not been systematically constructed, and the pathway for digital platforms to empower entrepreneurial enterprises needs further exploration. In response, the study focuses on the core question of "how to build digital platform capabilities for sci-tech industrial parks to empower entrepreneurship of enterprises in the parks."

To answer this question, this study focuses on three sub-questions. First, what digital platform capabilities should be developed for sci-tech industrial parks? This study identifies and refines the connotations and dimensions of digital platform capabilities through case studies to build a capability system that can empower entrepreneurial enterprises.

Second, how can these digital platform capabilities empower entrepreneurial enterprises in the parks? Based on the proposed digital platform capability system, the study tests the mechanism and action process of digital platform capabilities on the entrepreneurship empowerment performance of entrepreneurial enterprises in parks using questionnaire data.

Third, how do the basic standardized management systems impact the empowerment of digital platform capabilities on entrepreneurial enterprises in industrial parks? The study proposes that the basic standardized management system acts as a boundary condition affecting the digital platform capabilities and the performance of empowerment over entrepreneurial enterprises in industrial parks. The moderating effect of this system is also tested using questionnaire data.

1.4 Research Significance

From the perspective of industry development, China's industrial park development remains largely traditional. There is an urgent need to address issues such as insufficient overall planning and coordination of digital parks, low efficiency of digital services, and inadequate support for innovation-driven entrepreneurship. From the perspective of digital transformation, currently, industrial parks are in the initial stages of digital transformation. Therefore, it is pressing to explore an ecological, platform-based, and systematic development path for industrial parks through the development of a digital park ecosystem. Specifically, theoretical breakthroughs and practical explorations can be made in three key areas: the digital organizational development of industrial parks; the organizational change in industrial parks' platform-based development; and the digital empowerment of industrial parks to entrepreneurial enterprises.

1.4.1. Theoretical significance

First, this study introduces the concept of digital platform capabilities and identifies its connotation and dimensions, providing a theoretical reference for the capacity building of industrial parks. The study explores the concept, connotation, and characteristics of digital platform capabilities, proposing two dimensions: digital platform complementarity capability and digital platform integration capability, based on resource elements and platform enterprise integration, aiming to establish a digital platform capability system for industrial parks.

Second, the study outlines the components and measurement methods of digital platform capabilities. It highlights that the practical value of digital platform capabilities lies in understanding the specific management systems for developing digital platforms of parks. It describes operational ideas such as platform complementarity capability and platform integration capability. Through case studies, it proposes standardized indicators and measurement methods for platform capabilities, along with a performance evaluation model for platform-empowered entrepreneurship in sci-tech industrial parks, providing a referential standardized base for digital platform development within parks.

Third, the study establishes the causal relationship between digital platform capabilities and entrepreneurship empowerment performance. It explores the mechanism and process through which digital platform capabilities impact the entrepreneurship empowerment performance of entrepreneurial enterprises in parks. Using parks' basic standardized management system as a moderating variable, this study reveals the positive effect of the interaction between digital platform capabilities and basic standardization capability on improving entrepreneurial empowerment in parks. These contributions can serve as a theoretical reference for the platform organization development of high-tech industrial parks in the digital age.

1.4.2 Practical significance

Given the development of digital technology and digital industries, it has become a significant practical challenge to build a digital capability system to empower enterprises and new entrepreneurs in industrial parks in combination with parks' positions. Considering the "gathering and interactive benefits" for subsequent digital platforms, this study proposes a conceptual framework of "digital platform capabilities," outlining the constituent elements, system functions, and mechanisms of action. The study's practical value includes the following aspects.

First, this study provides a realistic framework for developing digital platforms for management institutions and operating enterprises in industrial parks. The research results will offer guidance for the digital transformation of industrial parks and propose ideas about establishing a collaborative online-offline service system for parks to serve enterprises. Specifically, systematic thinking is provided for case enterprises to strategically develop the capability system of park development, and these enterprises are guided to explore mechanisms that more effectively serve enterprises in parks.

Second, the study offers a framework and strategic guidance for building a digital platform in Zhixin Zedi Science and Technology Industrial Park. By analyzing the basic elements of digital platform capacity development and basic standardized management system design, the study provides paths and implementation ideas for enterprises to build digital platforms and better empower enterprises in parks to achieve high-quality, efficient, and cost-effective entrepreneurship. It also offers strategic suggestions for the future development of Zhixin Zedi.

Third, the study provides policy suggestions for developing park service systems in various regions and industries across China, as well as suggestions for the construction of national entrepreneurial parks. It proposes an operational system for the digital transformation of future industrial parks from a system level, establishing basic standardized systems comprising a project-based operating system, team-based organizational system, and collaboration ecosystem. This aims to provide policy guidance for parks to better serve and empower enterprises' innovation and entrepreneurship.

1.5 Research Ideas and Content Framework

The study employs the following ideas:

First, the development of sci-tech industrial parks requires a thinking shift from traditional park service to entrepreneurship empowerment within an innovation ecosystem. Based on this logic, sci-tech industrial parks are seen as platform organizations for entrepreneurship empowerment, and their digital transformation involves establishing digital platform organizations.

Second, the internal foundation of a digital platform organization is its digital platform capabilities. A capability system is formed through online and offline collaboration, cooperation between companies and external partners, and collaboration between companies and entrepreneurial enterprises within the park. The core components of this system are the digital platform complementarity capability and the digital platform integration capability.

Third, to empower entrepreneurial enterprises in the park through digital platform capabilities, it is essential to establish basic standardized systems comprising a project-based operating system and collaboration ecosystem. This will solidify the base of AI industrial parks and continuously empower innovation and entrepreneurship for enterprises in parks.

Fourth, the overall theoretical model follows a causal logic of digital platform capabilities — entrepreneurial performance of enterprises in parks. Empowerment performance can be measured in two ways: direct performance (reduction of entrepreneurial costs and improvement of entrepreneurial efficiency) and indirect performance (it can be service effectiveness during the entrepreneurial process).

Based on the above ideas, this study introduces the concept of digital platform capabilities. This concept aims to integrate resources inside and outside parks and achieve platform-based management through digital technology and management systems. Digital platform capabilities include industrial focus, service professional capability, and platform integration capability.

The purpose of proposing digital platform capabilities is to build a foundational framework for future industrial parks. This framework includes a causal relationship model with basic standardized systems as the condition, digital platform integration capability as the core variable, and entrepreneurship empowerment performance as the result. The model involves three constructs: basic standardized systems, digital platform capabilities, and entrepreneurship empowerment performance. In this model, digital platform capabilities are independent variables, entrepreneurship empowerment performance denotes a dependent variable, and basic standardized systems are moderating variables.

Based on the above research ideas, the basic research framework includes the following five parts:

First, Introduction. This part reveals the current development trend of industrial parks and their demand for digital transformation by analyzing the industry background and case enterprises. It outlines the basic theoretical and practical problems to be solved, forming the research objectives and basic framework. The case method and empirical method are also explained in this part.

Second, Literature Review. This part starts with the platform-based transformation of industrial parks, sorting out the basic path of their digital transformation. It introduces the logic and capacity building of digital platforms and outlines the relationship between digital platform capabilities and innovation and entrepreneurship empowerment, providing a theoretical background for subsequent research.

Third, Case Studies. This part discusses exploratory research, aiming to construct the theoretical logic, basic framework, and empirical conceptual model. It systematically analyzes the platform organization, structure, and elements formed through the adoption of digital technology by sci-tech parks. This part reveals the underlying mechanism and important conditions for platform capabilities to empower entrepreneurial enterprises, forming a theoretical framework and proposing the causal logic between platform capabilities and entrepreneurial empowerment. The case study results serve as a basis for empirical testing in the next part.

Fourth, Research Hypotheses and Testing. This part tests the basic hypotheses using an empirical statistical model to measure the main effects and moderating variables. It reveals the correlation analysis among digital platform capabilities, basic standardized systems, and entrepreneurship empowerment performance. Relevant theories of digital transformation and platform capabilities are employed to discuss the research conclusions and analyze the theoretical logic and explanation mechanism of the empirical results.

Fifth, Conclusions and Outlook. This part summarizes the research conclusions and theoretical contributions, provides policy suggestions for improving the digital platform system of industrial parks in the context of digital transformation, and proposes the study’s shortcomings and future research prospects.

1.6 Research Methods

The study analyzes organizations including Zhixin Zedi, entrepreneurial enterprises, and service enterprises. Data is obtained through these enterprise units for statistical analysis and case studies. The research methods mainly include three aspects:

(1) Literature analysis. Digital platform capabilities represent a new construct. To improve construct validity, we review and summarize Chinese and international literature to propose the connotations and measures of digital capabilities, digital platform capabilities, and entrepreneurship empowerment performance. Corresponding theories are used to explain the interrelationship between these constructs.

(2) Case studies. Using Zhixin Zedi as a case study, we analyze its development process, current organizational structure, and business content to identify the components of digital platform capabilities. Additionally, we examine innovative and entrepreneurial enterprises within the park as another category of case study to analyze the platform elements and coordination mechanisms of Zhixin Zedi. From the perspective of these enterprises, we analyze the service content and satisfaction and explore the organization and effect of activities, resource needs, and resource allocation of the digital platform to examine the service performance of the platform for enterprises, thus proposing the underlying mechanism through which the digital platform empowers entrepreneurship.

(3) Statistical analysis. First-hand data are collected through questionnaires for statistical analysis to test the causal relationship among model constructs. Questionnaires are distributed to enterprises (samples) that

have used digital platforms in digital industrial parks. After the samples are collected, regression analysis is carried out to test the impact of the digital platform empowerment system on entrepreneurial enterprises' empowerment performance and to examine the moderating effect of the basic standardized systems.

Based on the above chapter relationships and research methods, the technology roadmap of this study is shown in Figure 1.1.

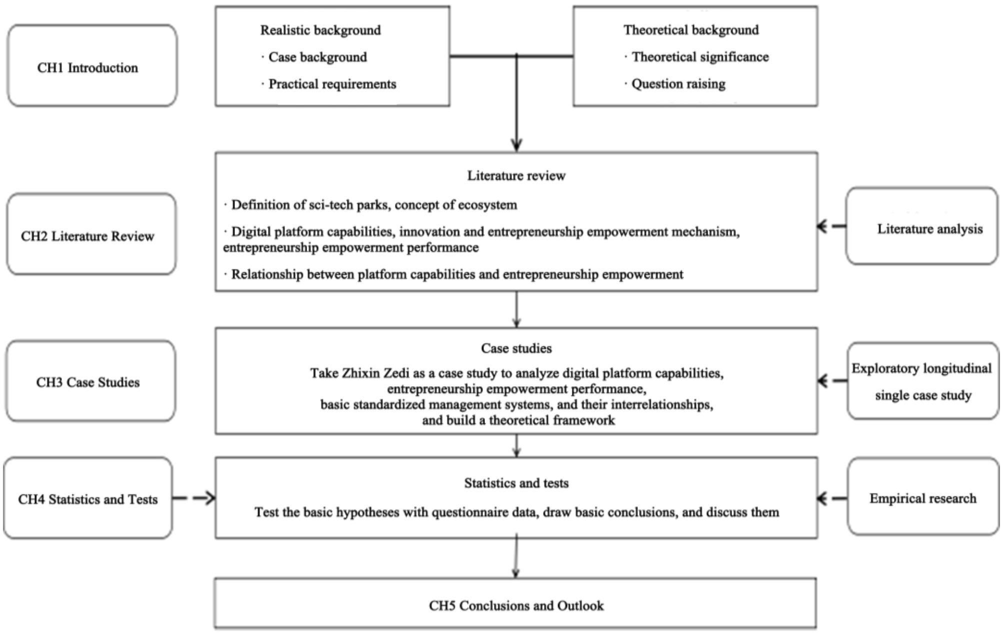

Figure 1.1 Technology Roadmap

2. Literature Review

2.1 Typical Construction Path of Digital Park Ecosystems

In response to the requirements of digital, platform-based, intelligent, and ecological development for enterprises, traditional industrial parks must build digital ecosystems, form an ecological system that empowers innovation-driven entrepreneurship, and serve the green and high-quality development of the regional economy. The digital park ecosystem is a product of the transformation and upgrading of traditional industrial parks. By adopting digital, platform-based, and intelligent technologies, it constructs an ecological system based on comprehensive perception and extensive connection, deeply integrating people, machines, events, and things. It is an organic life form and sustainable development space characterized by proactive service, intelligent evolution, and other features.

Currently, in China, the Bohai Rim, Yangtze River Delta, and Pearl River Delta regions have emerged as the three major agglomerations for the construction of digital parks, leveraging their extensive industrial park platforms. In the central regions along the Yangtze River, there is great potential for coordinated development among the cities along the river, leading to active efforts in digital park construction. The vast western regions are seizing the new opportunities presented by industrial transfer, combining their unique geographical features and existing industrial park foundations, to accelerate the planning and construction of digital engineering projects. Based on insights gained from leading digitization practices in existing parks, this paper summarizes four key paths for building digital park ecosystems.

2.1.1 Path 1: Transformation and upgrading of government-led traditional industrial parks

In government-led traditional industrial parks, local governments create relevant industry support policies and favorable tax conditions based on the needs of urban development and socioeconomic growth to attract external enterprises to settle in the parks, thereby facilitating industrial agglomeration. The government takes responsibility for the construction of park infrastructure but avoids excessive interference in the internal operations of the park. Instead, it establishes governing bodies within the park, typically in the form of a park management committee, to oversee and govern the park. During the transformation and upgrading of government-led traditional industrial parks into parks with digital ecosystems, the park management committee will **first** digitize the existing assets and services within the park. This digital transformation enables the flow and integration of resources driven by online information, enhancing the park's monitoring, early warning, prediction, and response capabilities. **Furthermore**, the park management committee invests in digital technology platforms to integrate and achieve synergy between online and offline resources, as well as within and outside the park. This enables the provision of convenient information services for the public in industrial parks, facilitates the construction of comfortable office environments, expands the scope of park services, and enhances service efficiency. **Lastly**, the park management committee strengthens the park's features, core capabilities, and access rules to attract and introduce high-quality complementary resources from outside the park. This is done to build an open digital park ecosystem, leverage the advantages of both the park's internal resources and complementary resources, and empower enterprises within the park with innovation-driven entrepreneurship.

Case of adopting this path: **Suzhou Lianfa Industrial Park's transformation and upgrading with a focus on financial services.** With a development history of 20 years, Lianfa Industrial Park had a small-scale tenant with a low added value, which fell far behind the pace of optimizing and adjusting the industrial structure of the park. In 2010, Suzhou Industrial Park established the first national-level large-scale RMB fund of funds (FOF), the "Guochuang Kaiyuan FOF" with a total size of RMB 60 billion. Over time, dozens of sub-funds have been established through investments. In 2020, an RMB 10 billion government industrial investment fund and an RMB 2 billion angel FOF were established to increase investment in strategic emerging industries. Leveraging the policy advantages of the China (Jiangsu) Pilot Free Trade Zone Suzhou Area, efforts are being accelerated to promote financial openness and innovation. The government departments have built an industrial park platform and formed an ecosystem for innovation and entrepreneurship by opening up park functions. Under the active guidance of the Jinji Lake CBD, Suzhou Lianfa Industrial Park has launched comprehensive renovation and upgrading efforts while simultaneously adjusting and upgrading business formats through iterative replacement of traditional industrial tenants. So far, the park has achieved a 70% carrier renewal rate, gradually attracting around 30 enterprises in industries such as electronic components, medical devices, and semiconductor equipment, forming a cross-industry digital park ecosystem. [4]

[4]Free imagination. (2022, June 24). Government-led city-industry integration model—Suzhou Industrial Park. QQ.com. Retrieved from https://new.qq.com/rain/a/20220624A08JJ100

2.1.2 Path 2: Transformation and upgrading of traditional industrial parks led by industry-leading enterprises

Traditional industrial parks led by industry-leading enterprises refer to industrial parks where these enterprises act as the main developers and operators. They are responsible for unified planning and design, infrastructure construction, investment attraction, operation services, and industrial incubation of the industrial park projects, driving the operation and development of the industrial park in a market-oriented manner. With their brand advantages and position in the industry chain, these leading enterprises attract upstream, downstream, and supporting enterprises to settle in the park, forming efficient collaboration and promoting regional industrial and economic development. Through digital transformation, the leading enterprises extend their presence beyond the existing industrial foundation. **First**, they utilize digital technologies such as AI and 5G to strengthen the digital infrastructure construction of traditional industrial parks, enhancing the provision of digital services within parks. **Second**, they open up multidimensional and multisource data generated by parks' internal operations, advancing the research and development of shared solutions within parks. **Last**, leveraging their technological and resource advantages, the leading enterprises build park ecosystems based on digital platforms and other means, enhancing the synergy of the industry chain within and outside parks and empowering enterprises within parks with innovation-driven entrepreneurship.

Case of adopting this path: **from Yutai Textile Park to Yutai Cultural and Creative Industrial Park.** Yanjiao High-tech Industrial Development Zone in Sanhe is the production site of Yutai Textile Printing and Dyeing

Machinery, a foreign-funded enterprise. In recent years, due to the requirements for industrial transformation and upgrading and urban spatial optimization, existing projects have faced shortcomings such as low technological content, low industrial added value, and a low industrial hierarchy. Most of the factories are either idle or subleased. In 2019, through the efforts of the Zone, Yutai Textile acquired the entire old factory area and, based on the "Two Exits and Two Optimizations" policy, revitalized the idle industrial land and transformed it into a pilot project for industrial transformation and upgrading, and established the Yutai Cultural and Creative Industrial Park, thereby realizing "second-time business starting." In supporting the transformation and upgrading of the park's ecosystem, the Sanhe Municipal People's Government boldly innovated and issued the *Management Measures for Industrial Enterprise Technological Transformation Projects* and the *Pilot Measures for Promoting the Redevelopment of Inefficient State-owned Construction Land in Urban Areas* to provide policy services for the park. During this period, Yanjiao High-tech Zone also introduced the *Implementation Measures for Industrial Project Transformation and Upgrading (Trial)* to further clarify the path and streamline the process for the reuse of existing industrial land. The Yutai Cultural and Creative Industrial Park is positioned based on the original textile machinery and clothing design, to achieve industrial upgrades and extensions. It focuses on three major industries: intelligent manufacturing, creative design, and modern services, actively develops headquarters functions, and creates a sci-tech innovation industrial park that gathers sci-tech innovative manufacturing and cultural and creative industries, thereby empowering enterprises within the park with innovation-driven entrepreneurship. [5]

2.1.3 Path 3: transformation and upgrading of traditional industrial parks led by professional park operators

The separation of ownership and operation rights in industrial parks has led to the emergence of professional industrial park operators. These operators engage in cooperation from the planning stage of the industrial park, ensuring the feasibility of project positioning and planning while gaining insights into the local conditions and amassing customer resources. Professional industrial park operators can provide more systematic and specialized services for the industrial park, including park planning, construction, investment attraction, operation, and enterprise entry and exit. During the process of transforming traditional industrial parks into parks with digital ecosystems, professional industrial park operators **first** need to digitize and upgrade their comprehensive service systems by introducing advanced digital technologies and management concepts. **Second**, they follow the renovation logic of "information technology + industrial park management" and integrate innovative technologies such as cloud computing, AI, big data, IoT, and mobile web. By relying on a unified platform, they establish an information-based and integrated management system that covers various aspects, including office collaboration, investment attraction, financial management, property management, industrial analysis, and project incubation for traditional industrial parks. **Last**, they open up park resources to attract external entities and provide

[5] Official Baijiahao account of *Xiaoxiang Morning Herald*. (2021, April 25). Fifteenth typical case of transformation in parks: Yutai Cultural and Creative Industrial Park "takes in the fresh while getting rid of the stale" to foster cultural and creative dynamism. *Xiaoxiang Morning Herald*.

more opportunities for innovation and entrepreneurship for enterprises within parks.

Case of adopting this path: **Liando Group invested in the establishment of Yuepu Technology to explore a new model of park operation.** Founded in 1991, Liando Group has a registered capital of RMB 620 million and oversees over 20 subsidiary companies. It is a conglomerate that integrates industrial parks, template steel structures, and investment business. Liando Group is one of the earliest enterprises in China engaged in industrial park development and operation. With its long history in the industry and years of development, Liando Group has established a unique development model, gaining a first-mover advantage and accumulating resources. In September 2020, Liando Group invested RMB 500 million to establish Shanghai Yuepu Technology Co., Ltd., a new company registered in Jiading District, Shanghai, with its office in the Hongqiao Business District. It also launched its new subsidiary brand, Yuepu Technology Industrial Development Group (hereinafter referred to as “Yuepu”). Yuepu marks the initiation of Liando’s second direction in the industrial park business, differentiating itself from traditional manufacturing parks. It primarily focuses on sci-tech parks, catering to the “hard-tech industry” and targeting cities of the first and second tiers. It has formed an innovative operational model of “investment + space + operation + scenario.” Regarding the creation of a digital park ecosystem, Yuepu first establishes a favorable ecological environment, embodying Liando Group’s concept of “ecology-based technology.” Second, it enhances the level of synergy and collaboration in the industry chain, achieving the “chain-based technology” of Liando Group. Furthermore, it promotes global collaboration, regional collaboration, and cross-industry collaboration, realizing the "technology collaboration" of Liando Group. It tightly integrates scenarios with technological applications to create the "scenario-based technology" of Liando Group. Lastly, it accelerates the upgrading and transformation of urban functions, focusing on "talent density" to achieve the "pinnacle-based technology" of Liando Group. Through the transformation of the "Five Transformations," Liando Group achieves comprehensive upgrading of the enterprise itself, constructing a high-energy ecosystem that empowers industrial parks for innovation-driven high-quality development.

2.1.4 Path 4: New solution providers build digital park ecosystem

The new solution providers for industrial parks refer to the large-scale park operators that leverage emerging digital technologies, platform technologies, and intelligent technologies to provide full lifecycle empowerment for the integration of investment, construction, operation, and maintenance of industrial parks. New solution providers view industrial parks as spatial complexes integrating the physical world, humanistic world, and digital world and strive to build a digital park ecosystem that encompasses sensing, connectivity, and intelligence for all. New solution providers lead the construction of digital industrial park ecosystems through two main paths: First, they respond to regional government needs for the development of emerging and strategic industries by spearheading the planning, design, development, and operation and maintenance of new industrial parks. They leverage their brand and government endorsements to attract top-notch partner enterprises and employ advanced concepts and technologies to create model new industrial parks. Second, they focus on projects that combine "new planning and construction" with the "renovation of old industrial parks," conducting second-time creation based on the original characteristics of the industrial parks. By leveraging their strong advantages in systematic, digital, and platform-based solutions, they take over and renovate old industrial parks, again using their brand and government endorsements to attract excellent participants and jointly building a new digital industrial park ecosystem.

Case of adopting this path: **Enjoy Town creates a digital park that empowers the full lifecycle.** Enjoy Town was established in 2014 with its headquarters in Hangzhou. As a practitioner of vibrant communities in future towns, Enjoy Town is a capital management operator of sci-tech innovation communities with development capabilities and a service provider of communities in the digital society. With the mission of "making community life more colorful with culture and technology," Enjoy Town integrates international resources to develop digital communities in the mode of "integrating investment, construction, operation, and maintenance." Guided by the development strategy of "empowering future communities with culture and technology and promoting consumption upgrades through the integration of culture and tourism," Enjoy Town focuses on future communities and culture-tourism integration business and has initially formed a complete industry chain encompassing investment, investment attraction, construction, and operation of future communities and culture-tourism integration projects. It has invested, constructed, and operated two main thematic products: innovative future community-neighborhood center cultural complex and creative culture-tourism integrated complex. As a comprehensive service provider for the digital society, Enjoy Town is driven by the dual engines of culture and technology. It plans a business architecture of

"One Headquarters, Two Groups," focusing on digital community operation projects in the three major urban clusters of Zhejiang Province and new towns across various regions. It exerts influence on the Yangtze River Delta region, providing local governments, enterprises, and developers with services throughout the full lifecycle of digital communities, including investment services, project services, ecosystem enterprise incubation services, digital empowerment services, and research and academic services.[6]

2.2 Capability System for Entrepreneurship Empowerment of Digital Parks

The digital park ecosystem needs to empower the park's enterprises with innovation-driven entrepreneurship, and the leader of the ecosystem must possess a certain capability base. Based on existing research findings (J. Liu, 2015; Z. Ma, 2020; Wang Dongyang, 2022; Wang Shuguang et al., 2022), the capability system of the leader in the digital park ecosystem should include capabilities to build the digital park ecosystem and integrate internal and external resources of the park to empower innovation-driven entrepreneurship. Specifically, it encompasses five core capabilities: infrastructure construction, core component development, boundary resource development, ecosystem values establishment, and ecosystem governance.

2.2.1 Infrastructure construction capacity

The infrastructure of an industrial park is a fundamental requirement for supporting the operation of a digital park ecosystem. The leader of the digital park ecosystem must possess strong infrastructure construction capability to

[6]Zhang, L., & Shen, G. (2020, March 22). Qicai Community in Guali Town, Xiaoshan District: The town's role in future communities. *Zhejiang Daily*.

ensure a solid foundation for the ecosystem. The infrastructure of the digital park ecosystem includes physical space infrastructure and network space infrastructure (M. Ma, 2016). On the one hand, the leader needs to invest in the spatial layout planning and construction of the industrial park, such as production and manufacturing systems, logistics systems, transportation systems, sewage systems, energy supply systems, environmental protection systems, and logistical support systems. On the other hand, the construction of network space infrastructure includes network transmission infrastructure, basic data collection for supporting the operation of the industrial park, intelligent devices and platforms for the park's basic production and daily life, basic data storage for the park, and basic data governance for the park, among others.

The construction of infrastructure in the digital park ecosystem is a process that relies on technological advancements and continuous improvement. The digital park ecosystem needs to respond to the requirements of economic development while complying with national and regional regulatory provisions. Therefore, the leader must continuously adopt new technologies to update and iterate the infrastructure of the ecosystem based on external environmental pressures and internal growth demands. This includes the application of platform-based and intelligent technologies to enhance the operational efficiency of the digital park ecosystem.

2.2.2 Core component development capability

According to the definition of an innovation ecosystem (Jacobides et al., 2018), the leader of a digital park ecosystem must invest in the development of core components. These core components define the competitive advantage of the ecosystem that distinguishes it from others and are crucial for attracting complementary parties to participate in the ecosystem.

The core components of a digital park ecosystem are determined based on the industry characteristics and the core competitive advantages of the leading enterprises within the ecosystem. For example, the core advantage of Suzhou Industrial Park lies in its industrial funds. Therefore, it is confirmed that its core component is the financial services module.[7] In Yutai Industrial Park, the foundation lies in the production and manufacturing of textile printing and dyeing machinery equipment. Its core components are based on existing textile machinery and clothing design, focusing on three major components: intelligent manufacturing, creative design, and modern services.[8] The development of core components in a digital park ecosystem requires the leader to form a professional team, gain deep insights into the practice of industry enterprises, and build universal functional components that can significantly enhance the operational efficiency of industry enterprises. These core components should be continuously updated and iterated upon.

The development of core components in a digital park ecosystem requires a high level of standardization and modularization. This is necessary for the core components to be utilized by other complementary parties within the ecosystem. Standardization of the core components helps to reduce the development and operational costs for the leader of the ecosystem, while modularization enables the customization of the core components to meet the

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[7]Free imagination. (2022, June 24). Government-led city-industry integration model—Suzhou Industrial Park. QQ.com. Retrieved from https://new.qq.com/rain/a/20220624A08JJ100

[8]Official Baijiahao account of *Xiaoxiang Morning Herald*. (2021, April 25). Fifteenth typical case of transformation in parks: Yutai Cultural and Creative Industrial Park “takes in the fresh while getting rid of the stale” to foster cultural and creative dynamism. *Xiaoxiang Morning Herald*. Retrieved from https://baijiahao.baidu.com/s? id=1697999611793620980

individual demands of different complementary parties. In summary, the core component development capability is one of the key capabilities of the leader in a digital park ecosystem.

2.2.3 Boundary resource development capability

Boundary resources refer to all the tools, methods, processes, rules, APIs, digital platforms, and more that enable complementary parties in an innovation ecosystem to access the ecosystem, use core components, and create complementary components (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). For example, Alibaba developed Alipay to facilitate efficient settlement between merchants and consumers on their e-commerce platform. It also developed AliWangWang to enable effective communication between merchants and consumers, building trust and improving transaction efficiency.

Boundary resource development capability is one of the core capabilities of the leader in a digital park ecosystem. It determines the possibility and efficiency of complementary parties accessing the core components of the ecosystem. A well-developed and efficient boundary resource system can incentivize complementary parties to actively adopt core components and create complementary components, enriching the diversity of ecosystem resources and providing more opportunities for ecosystem parties to innovate and start businesses.

In the process of developing boundary resources, the leader of a digital park ecosystem needs to continuously interact with complementary parties and understand their pain points and challenges in accessing and using the core components. Leveraging platform-based and intelligent technologies, the leader can provide targeted new boundary resource solutions or optimize existing boundary resources to ultimately improve the boundary resource development capability, enhancing the openness of the digital park ecosystem and attracting more complementary parties to participate in the ecosystem.

2.2.4 Ecosystem values establishment capacity

Competition also exists among digital park ecosystems. When the benefits of land and tax policies disappear, industrial parks need to identify new sources of competitive advantage (Yu et al., 2011). When complementary parties, consumers, and others engage in value co-creation within the ecosystem, the values upheld by the digital park ecosystem serve as one of the sources of its attractiveness. Complementary parties tend to choose ecosystems that align with their values to contribute their resources and capabilities, engaging in value co-creation and sharing with other complementary parties, consumers, and leaders within the ecosystems. Similarly, consumers prefer to be embedded in ecosystems that align with their values to contribute digitally and consume. The values of the digital park ecosystem remain crucial for gaining long-term support from complementary parties and consumers. When complementary parties and consumers find themselves unable to identify with the values of the ecosystem, they may reduce their involvement or even withdraw from the ecosystem.

The leader of a digital park ecosystem should adhere to institutional regulations, social norms, and public awareness in establishing ecosystem values. The leader should also draw strength from national and social development trends, demands of industry enterprises, public expectations, and the essence of traditional cultures. By doing so, the leader can build ecosystem values that are recognized by key stakeholders, ensuring the support of complementary parties, consumers, and others for driving the digital park ecosystem.

2.2.5 Ecosystem governance capacity

The ecosystem governance capability of a digital park is one of the core capabilities of its leader and is crucial for the sustainable development of the ecosystem. The ecosystem governance of a digital park involves the construction, implementation, evaluation, and optimization of a series of ecosystem rules. Ecosystem governance primarily deals with three types of relationships: the relationship between the ecosystem and the environment, the relationship between participants and the ecosystem, and the relationship among participants (Sun, 2021).

In terms of governance regarding the relationship between the ecosystem and the environment, the digital park ecosystem must draw energy from external environments, including information, policies, and funding. Therefore, its leader needs to plan and design the digital park ecosystem to ensure it aligns with the requirements of national development strategies. This alignment will enable the ecosystem to leverage national and regional policies, providing support for national and regional economic development. **In terms of the governance of the relationship between participants and the ecosystem**, the leader must first establish appropriate entry rules for participants to enter the ecosystem. The leader should selectively choose high-quality complementary parties to join the ecosystem and provide consumers with high-quality products and services. Furthermore, it is important to impose sanctions on behaviors that harm the interests of the digital park ecosystem and other participants, such as providing counterfeit or substandard products or deceiving consumers. Simultaneously, incentives should be provided for behaviors that benefit the digital park ecosystem and other participants, fostering a positive culture of collective participation and sharing within the ecosystem. Lastly, the digital park ecosystem should operate voluntarily, allowing participants to voluntarily exit the ecosystem. The ecosystem should rely on the attractiveness of its services, brands, and core components rather than enforcing rules to retain participants. **In terms of the governance of the relationship among participants**, the leader should uphold a fair and just stance and establish mechanisms for value creation contribution and sharing that are fair and equitable within the ecosystem, ensuring that participants' contributions receive commensurate rewards. This can include implementing appropriate mechanisms for intellectual property protection, dispute resolution, and cooperation with judicial enforcement.

When constructing the governance capability of a digital park ecosystem, the leader needs to adopt advanced governance concepts and tools and leverage the power of intelligent technology, digital technology, and platform technology to enhance governance effectiveness. Additionally, in the process of designing specific governance rules, it is essential to consider the interests of multiple stakeholders within the ecosystem. Therefore, the leader needs to maintain sufficient openness and actively engage the government, consumers, complementary parties, and the public in co-creating the governance rules of the ecosystem. This ensures that these rules can achieve a certain balance and stability in the context of multiple stakeholders' interests, thereby ensuring the long-term sustainability of the digital park ecosystem. In reality, the governance experience of existing ecosystem leaders has shown that they should not abuse their dominant position to arbitrarily harm the interests of ecosystem participants and the public. A wise leader aims to earn limited profits while allowing the ecosystem to become an infinite game.

2.3 Entrepreneurship Empowerment Mechanism of Digital Park Ecosystem

The digital park ecosystem aims to surpass traditional industrial parks in terms of efficiency and functionality and provide services beyond basic property management for settled enterprises. The operator of the industrial park can not only rely on its own resources to serve settled enterprises but also connect with external resources to provide them with services and enhance their innovation-driven entrepreneurial efficiency. Based on existing research (Chang et al., 2021; H. Wang, 2022) and observations of leading parks, this report summarizes the services that the digital park ecosystem can provide to park enterprises. In addition to basic property services, the digital park ecosystem can offer incubation services, financial and insurance services, logistics services, policy services, information services, supply chain services, and other value-added services, as shown in Table 2.2.

Table 2.1 Services of Digital Park Ecosystem

Service item	Interpretation of services
Property service	Basic property management, vehicle operations, and warehouse management, as well as fire and theft prevention, security services, and cleaning and sanitation, with property facilities available for repair anytime and anywhere.
Incubation service	Set functions such as house leasing, industrial and commercial registration, project evaluation and declaration, sci-tech funds, loan financing, and entrepreneurship and employment training.
Financial and insurance service	Introduce professional financial services companies to provide financing, guarantees, insurance, and warehouse receipt pledges for settled enterprises.
Logistics service	Offer freight forwarding, cargo transshipment, and logistics outsourcing services for settled enterprises, using a logistics service platform to reduce logistics costs, integrate information resources, and achieve efficient allocation of social resources.
Policy service	Provide policy services for settled enterprises, ensuring that they receive appropriate policy support at every stage of their development. This includes rent subsidies, warehouse repair and renovation subsidies, water and electricity subsidies, preferential tax policies, talent introduction policies, and project subsidies.
Information service	Offer information services for settled enterprises, including vehicle management systems, warehousing and distribution management systems, customer management systems, financial management and settlement systems, and decision support systems.
Supply chain service	Deeply involved in the supply chain management of settled enterprises, providing integrated supply chain management services from procurement and supply to the online and offline of components and parts and semi-finished products during the production process, as well as the sales and distribution of finished products.
Value-added service	Provide comprehensive innovation and entrepreneurship services based on the needs of settled enterprises, such as warehousing management, transportation and distribution, information services, financial services, talent outsourcing, and other value-added services (leasing, office services, etc.), to achieve multi-format revenue.

This study, from the perspective of the innovation-driven entrepreneurial lifecycle, distinguishes the process of empowering park enterprises' innovation-driven entrepreneurship by the digital park ecosystem into three stages: identification of innovation-driven entrepreneurial opportunities, implementation of innovation-driven entrepreneurial activities, and transformation of innovation-driven entrepreneurial achievements. Based on this, it explores the empowering mechanism.

2.3.1 Identification of entrepreneurship opportunities empowered by digital park ecosystem

The core components provided by the digital park ecosystem offer complementary parties opportunities for innovation-driven entrepreneurship. Complementary parties within the ecosystem can leverage the core components provided by the leader to engage in complementary innovation-driven entrepreneurship (Autio et al., 2018). For example, a logistics entrepreneurial enterprise can utilize the logistics interface provided by the digital park ecosystem to establish a logistics fleet and undertake logistics operations within the park, enabling entrepreneurial activities. Similarly, a pallet manufacturing enterprise can also join the digital park ecosystem to provide shared pallets, facilitating entrepreneurial endeavors.

The digital park ecosystem also integrates a vast array of resources, allowing participating enterprises to interact with resource owners. This interaction fosters the emergence of entrepreneurial ideas (Autio & Levie, 2017). For example, a financial service institution can provide financial services for upstream and downstream enterprises in the supply chain within the digital park ecosystem. By innovating the model of supply chain finance, it can help these enterprises address issues such as loans for advance payment. Similarly, a talent service institution can identify opportunities for tailored professional talent development programs based on the common talent needs of enterprises within the ecosystem.

The digital park ecosystem, leveraging digital platforms and network information technology, aggregates a vast amount of consumer data, thereby providing opportunities for participating enterprises to conduct data mining, identification of new demands, and demand-driven innovation-driven entrepreneurship. For example, the leader of the digital park innovation ecosystem can analyze customer and consumer evaluation data from downstream of the park to identify numerous opportunities for innovation-driven entrepreneurship. Subsequently, they can invite both internal and external enterprises within the ecosystem that possess the corresponding capabilities to provide suitable solutions and realize innovation-driven entrepreneurship.

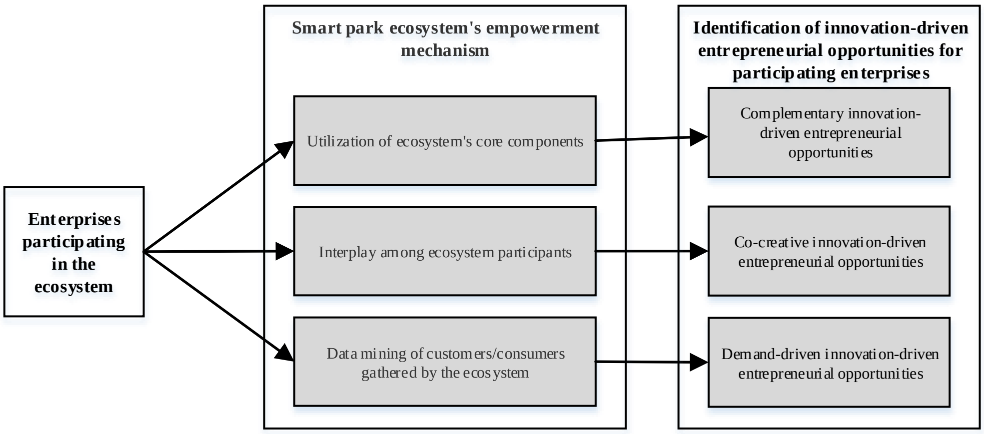

Figure 2.1 Mechanism of Digital Park Ecosystem Empowering the Identification of Innovation-driven Entrepreneurship Opportunities

2.3.2 Implementation of entrepreneurial activities empowered by digital park ecosystem

The digital park ecosystem brings together a multitude of tangible and intangible resources from both internal and external sources, helping innovation-driven entrepreneurial enterprises materialize their innovation-driven entrepreneurial ideas and rapidly transform entrepreneurial opportunities into innovative products or services. Participating enterprises often lack sufficient resources for innovation-driven entrepreneurship, with these resources dispersed across different entities (Nambisan et al., 2018). The digital park ecosystem, by connecting, accessing, and integrating a diverse range of internal and external participants with heterogeneity, can assist participating enterprises in quickly searching for, negotiating, and transacting the resources required for innovation-driven entrepreneurship. Moreover, through value co-creation, it can even overcome integration barriers caused by resource exclusivity, enabling the rapid realization of innovation-driven entrepreneurial ideas.

Even if the digital park ecosystem itself is not directly connected to or integrated with the innovation-driven entrepreneurial resources required by participating enterprises, it can still provide strong legitimacy endorsement for these enterprises due to its significant economic and brand influence. This helps them efficiently integrate innovation and entrepreneurship resources that may not be accessible within the ecosystem itself (Autio & Levie, 2017). For example, an enterprise from Haier's Food Network can leverage the endorsement of Haier to directly engage with senior executives from SF Express, quickly establishing a partnership for the exclusive delivery of roast duck ingredients. This enables the rapid implementation of their creative project for home-cooked roast duck.

The digital park ecosystem not only empowers participating enterprises in their search for resources and access to resources for innovation-driven entrepreneurship but also provides tools, methods, and technological empowerment for integrating and utilizing these resources in the process of innovation-driven entrepreneurship. This helps improve the efficiency of resource integration and utilization, accelerating the realization of innovation-driven entrepreneurship (Acs et al., 2014). For example, participating enterprises can leverage the legal services provided by the digital park ecosystem to swiftly establish transactions or cooperative agreements with resource providers required for innovation-driven entrepreneurship, thereby enhancing the efficiency of innovation-driven entrepreneurial activities.

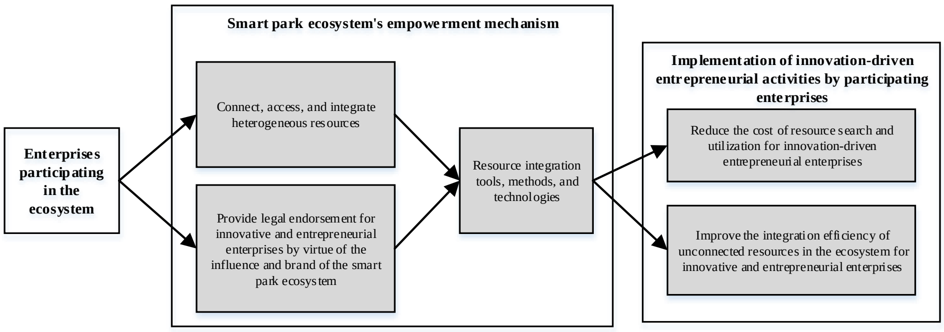

Figure 2.2 Mechanism of Digital Park Ecosystem Empowering the Implementation of Innovation-driven Entrepreneurial Activities

2.3.3 Transformation of entrepreneurial achievements empowered by digital park ecosystem

The digital park ecosystem, by integrating a large number of industry chain enterprises, consumers, venture capital institutions, and incubators, empowers the transformation of innovation-driven entrepreneurial achievements, enabling them to quickly realize economic value (Elia et al., 2016). There are three specific scenarios in which it promotes the transformation of achievements and advances entrepreneurship:

Scenario 1: When the innovation-driven entrepreneurial achievements of participating enterprises bring value to industry chain enterprises, the vast number of industry chain enterprises, collected by the digital park ecosystem, can serve as the initial users of these achievements. This helps expedite the innovation trial period, allowing for quicker refinement of innovation-driven entrepreneurial products and services. Ultimately, this brings a rapid entry into the open market and the success of innovation-driven entrepreneurship.

Scenario 2: When the innovation-driven entrepreneurial achievements of participating enterprises bring value to consumers, the digital park ecosystem can leverage its online and offline information resources, media resources, and traffic resources for these achievements. This assistance helps participating enterprises swiftly monetize their innovation-driven entrepreneurial achievements (Rippa & Secundo, 2019), mitigating the risk of failure in innovation-driven entrepreneurship due to a lack of a viable business model.

Scenario 3: In cases where the innovation-driven entrepreneurial achievements of participating enterprises cannot be rapidly monetized within the digital park ecosystem, they can still be empowered by venture capital institutions and incubators connected with the ecosystem. This support helps them better secure funding for innovation-driven entrepreneurship and receive incubation services, thereby accelerating the progression of their innovation-driven entrepreneurship outcomes toward mature markets.

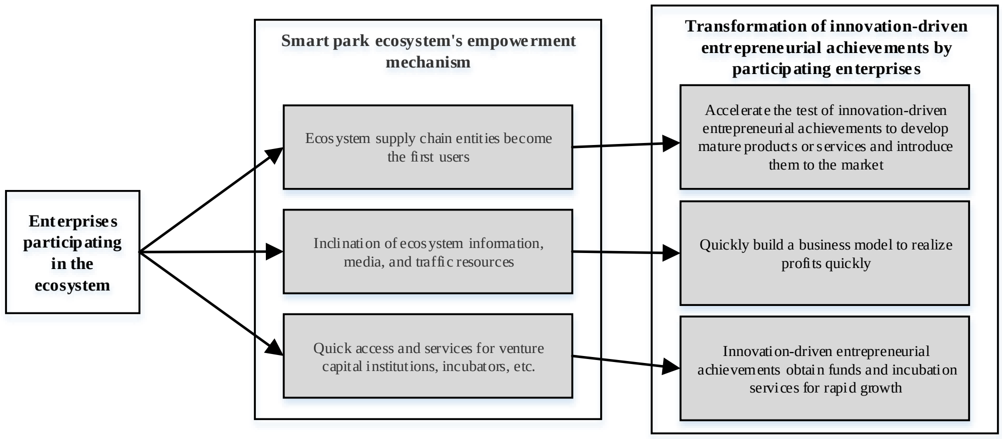

Figure 2.3 Mechanism of Digital Park Ecosystem Empowering the Transformation of Innovation-driven Entrepreneurial Achievements

Given the lack of an overview of research on how industrial parks empower innovation-driven entrepreneurship, this study first employs a literature analysis method to clarify the definition and connotation of industrial parks. Based on the economic growth goals and diversified development objectives of industrial park construction, this study distinguishes between five basic types of traditional and modern industrial parks: export processing parks, industrial parks, sci-tech parks, ecological industrial parks, and innovation parks. Additionally, the concept of a digital park ecosystem is proposed based on the trend of intelligent and ecological development in industrial parks. Next, from the perspectives of innovation ecosystems and service innovation systems, this study examines the core capabilities system of the digital park ecosystem in empowering innovation-driven entrepreneurship. These capabilities include the leader's infrastructure construction capacity, core component development capability, boundary resource development capability, ecosystem values establishment capacity, and ecosystem governance capacity. Finally, from the perspective of the innovation-driven entrepreneurship process, this study elucidates the mechanisms through which the digital park ecosystem empowers the identification of innovation-driven entrepreneurial opportunities, the implementation of innovation-driven entrepreneurial activities, and the transformation of innovation-driven entrepreneurial achievements. This study addresses the lack of a comprehensive overview of existing studies on industrial parks empowering innovation-driven entrepreneurship, offering insights into the intelligent and ecological development of industrial parks and the empowerment of innovation-driven entrepreneurship. It provides government departments with strategies for promoting the transformation and upgrading of industrial parks and serving the national innovation-driven development strategy.

2.4 Evaluation System for Entrepreneurship Empowerment of Digital Park Ecosystem

Previous studies have discussed the evaluation system for entrepreneurship empowerment of the digital park ecosystem. They have examined the performance of the digital park ecosystem in empowering innovation-driven entrepreneurship from three dimensions: the output of innovation-driven entrepreneurial enterprises in the park, the output of intermediary service agencies, and the social impact of innovation-driven entrepreneurship in the digital park. Furthermore, they have evaluated entrepreneurship empowerment performance from multiple perspectives, including innovation output, entrepreneurial output, technology transfer, financial services, talent services, enterprise incubation, and economic contribution. The details are presented in Table 2.2.

Table 2.2 Entrepreneurship Empowerment Evaluation of Digital Park Ecosystem

Dimension	Index type	Specific index	Definition of index
Output of innovative and entrepreneurial enterprises	**Innovation output**	**Number of scientific research output of enterprises in the park**	Number of patents and papers published by enterprises in the park
		Number of innovative brands of enterprises in the park	Number of innovative brands of all enterprises in the park
	Entrepreneurial output	Net growth rate of enterprises in the park	Proportion of the net increase in the number of enterprises in the park to that at the end of the previous year
		Growth rate of high-tech enterprises in the park	Proportion of the number of certified high-tech enterprises in the park to the total number of enterprises at the end of the previous year
Output of intermediary service agencies	**Technology transfer**	**Number of technology transfers in the park**	Average annual transaction volume of technology contract conclusions in the park
		Technology transfer efficiency of the park	Average annual transaction amount of technology contract conclusions in the park
	Financial services	**Coverage of financial intermediary services in the park**	Number of enterprises served by financial service institutions in the park
		Average financing amount of enterprises in the park	Ratio of financing received by enterprises in the park to the number of enterprises
	Talent services	**Number of talents introduced in the park**	Annual number of talents attracted by the park
		Talent retention rate of the park	Ratio of the number of talents retained in the park to the total number of talents attracted
	Enterprise incubation	**Number of incubated enterprises in the park**	Total number of incubated enterprises in the park
		Annual "graduation" rate of incubated enterprises in the park	Proportion of the annual number of graduated enterprises in the park to that under incubation
Social impact	**Economic contribution**	**Economic contribution rate of the park**	Proportion of park GDP in urban GDP
		Contribution rate of tax payment of the park	Proportion of park tax payment to urban tax revenue
	Energy consumption contribution	**Energy consumption per unit of output value in the park**	**Average energy consumption per RMB 10,000 added value of enterprises in the park**
		Labor productivity of the park	Industrial added value of unit labor force in the park
		Contribution rate of green GDP in the park	Proportion of green GDP of the park in urban GDP

Table 2.2 Evaluation Index System for Entrepreneurship Empowerment of Digital Park Ecosystem (Continued)

Dimension	Primary index	Secondary index	Definition of index
	Employment contribution	Contribution rate of employment of the park	Proportion of employed people in parks to urban employment
	Talent contribution	**Number of people educated and trained in the park**	Annual number of visitors and trainees in the park
		Number of interns accepted by the park	Annual number of college interns received by the park
		Number of on-the-job talents trained in the park	Number of talents who have obtained vocational skill certification above the provincial level annually in the park
		Talent spillover level of the park	Ratio of population outflow to inflow in the park

Note: The growth of park enterprises does not solely come from park incubation but also includes enterprises formed through investment attraction, natural-person investment and establishment, and other non-incubation means.

In addition, to effectively evaluate the digital park ecosystem's entrepreneurship empowerment performance, the Zhejiang Province's sci-tech departments take the lead in organizing an annual performance evaluation of digital park ecosystems across the province. Based on annual statistical data, the qualitative evaluation is carried out based on the assessment and evaluation index system through methods such as listening to reports, reviewing documents, on-site visits, and interviews with enterprises in parks. It takes into account factors such as innovation output, entrepreneurial output, output of intermediary service agencies, and the overall social impact of innovation-driven entrepreneurship within the digital park ecosystem. The evaluation results are categorized into four levels: excellent, good, qualified, and not qualified. Government departments can utilize these results to formulate governance policies, optimize policies, and provide incentives and rewards for the digital park ecosystem, thereby promoting continuous improvement and enhancement of the digital park ecosystem and better serving the national innovation-driven development strategy.

2.5 Literature Review

Based on the definition and construction path of the digital park ecosystem, as well as the literature review on the capability system, empowerment mechanisms, and empowerment achievements, it is evident that the study of building digital platform capabilities and entrepreneurship empowerment performance of sci-tech industrial parks holds theoretical significance. Existing research provides a theoretical foundation for further exploration in this study. However, as research on digital transformation and digital platform capabilities of sci-tech industrial parks is still in its infancy, the understanding of key factors such as the composition, mechanisms, and boundary conditions of digital platform capabilities is not yet thorough. Therefore, there are still theoretical gaps in the following three aspects:

(1) The dimensions and composition of digital platform capabilities are not yet clear. In terms of the capability system for entrepreneurship empowerment of sci-tech industrial parks, existing research has provided theoretical frameworks like the five-capability system. However, there is a lack of identification and discussion regarding the key dimensions within it. As digital platforms serve as the core enabler for sci-tech industrial parks, the composition and dimensions of the digital platform capabilities are crucial for in-depth research into the empowerment mechanisms and conditions of sci-tech

industrial parks. Therefore, it is necessary to consider digital platform capabilities as the core construct of this study and conduct an in-depth exploration of the dimensions and composition.

(2) The mechanisms and boundary conditions for sci-tech industrial parks to achieve entrepreneurship empowerment through digital platform capabilities are not yet clear. In terms of the mechanisms for entrepreneurship empowerment in sci-tech industrial parks, existing research has explored the service types, empowerment paths, and achievements that sci-tech industrial parks can provide. However, without a clear definition and analysis of digital platform capabilities, there has been insufficient exploration of the mechanisms through which digital platform capabilities empower entrepreneurial enterprises. Furthermore, there is a lack of discussion on the organizational foundations required to integrate digital platform capabilities, which prevents addressing the question of "under what conditions can digital platform capabilities achieve entrepreneurship empowerment." Therefore, this study will build upon the existing theoretical foundation to further explore the mechanisms and boundary conditions of digital platform capabilities influencing entrepreneurship empowerment.

(3) There is a lack of a comprehensive and systematic evaluation system for entrepreneurship empowerment performance. Existing research often evaluates empowerment performance from individual or multiple dimensions (such as achievement output, efficiency improvement, etc.), but lacks a comprehensive and systematic performance evaluation system. Therefore, based on existing theories and practical experiences, this paper will measure entrepreneurship empowerment performance and preliminarily

construct a comprehensive and systematic evaluation system for entrepreneurship empowerment performance.

3. Digital Platform Capabilities Empower Entrepreneurial Enterprises: Longitudinal Case Study

According to the literature review in Chapter 2, the construction of digital platforms and entrepreneurship empowerment of sci-tech industrial parks hold theoretical significance. However, research on digital platform capabilities of sci-tech industrial parks is still in its early stages, and there is a lack of thorough understanding regarding the composition, mechanisms, and boundary conditions of digital platform capabilities. There is also a need for further exploration of the mechanisms through which digital platform capabilities empower entrepreneurship enterprises. To address these issues, this chapter will focus on the development process of the Zhixin Zedi Artificial Intelligence Industrial Park as a focal case. Adopting a longitudinal exploratory single-case research method, this chapter will clarify the dimensions and connotations of the digital platform capability system, analyze the mechanisms and enabling conditions for entrepreneurship empowerment at different stages of digital platform capabilities, and propose a theoretical framework for digital platform capabilities' empowerment for entrepreneurial enterprises.

3.1 Research Method

3.1.1 Method selection

This study adopts a longitudinal single-case research method. First, the research topic of this study involves exploring the detailed processes of "how," and case studies are suitable for answering questions including "how" and "why" (Eisenhardt, 1989). Compared to multiple cases, a single-case study allows for a comprehensive presentation of case data and its inherent significance, facilitating focused analysis and discussion (Siggelkow, 2002). Second, a longitudinal case study can demonstrate the process of change in phenomena over time (Huber & Vande Ven, 1990). This study analyzes the dynamic evolution of enterprise digital platform capabilities and their empowerment mechanisms. Conducting a longitudinal study on this topic will contribute to a deeper understanding of differences in digital platform capability empowerment at different stages, as well as the achievements brought by the empowering effects.

3.1.2 Case selection

This study follows the principle of theoretical sampling (Eisenhardt, 1989) and selects the Zhixin Zedi Artificial Intelligence Industrial Park as the case study object. The selected case enterprise meets the following criteria: (1) Actively constructing platforms and developing corresponding digital platform capabilities, (2) Dedicated to empowering entrepreneurial enterprises, and (3) Able to provide real-time and retrospective firsthand and secondhand data at the organizational and functional levels (Pettigrew, 1990). The Zhixin Zedi Artificial Intelligence Industrial Park was established in 2017 and is guided by technological innovation, all-factor development, and digital platform capability empowerment. By providing a digital ecosystem for regional AI industry innovation and entrepreneurship, the park supports the sci-tech innovation and entrepreneurship of enterprises within the park in the field of AI. The park adequately showcases the required digital platform capabilities and empowerment mechanisms at different stages, making it a typical sample for this study.

3.1.3 Data source

This study utilizes multiple data sources, including in-depth interviews, archival documents, and media reports, to complement and cross-validate each other, ensuring the reliability and validity of the research information and data.

(1) In-depth interviews. The research team has been conducting longitudinal case study work on the Zhixin Zedi Artificial Intelligence Industrial Park since January 2024. They have closely followed the process of the case enterprise empowering entrepreneurial enterprises through digital platform capabilities. Face-to-face in-depth interviews were conducted with various levels of managers within Zhixin Zedi, including senior executives, technology department managers, and marketing department managers. The interviews primarily focused on topics such as enterprise digital development, platform construction, digital platform capabilities, and entrepreneurial enterprises. Each interview lasted approximately 120 to 180 minutes and was recorded. The interview content was transcribed and organized promptly.

(2) Archival documents. Internal publications, such as publications documenting key events within the Zhixin Zedi Artificial Intelligence Industrial Park, were examined.

(3) Media reports. News reports related to the case enterprise and the latest industry trends were collected through the case enterprise’s official website, industry association websites, and search engines like Baidu and Bing.

3.1.4 Data analysis

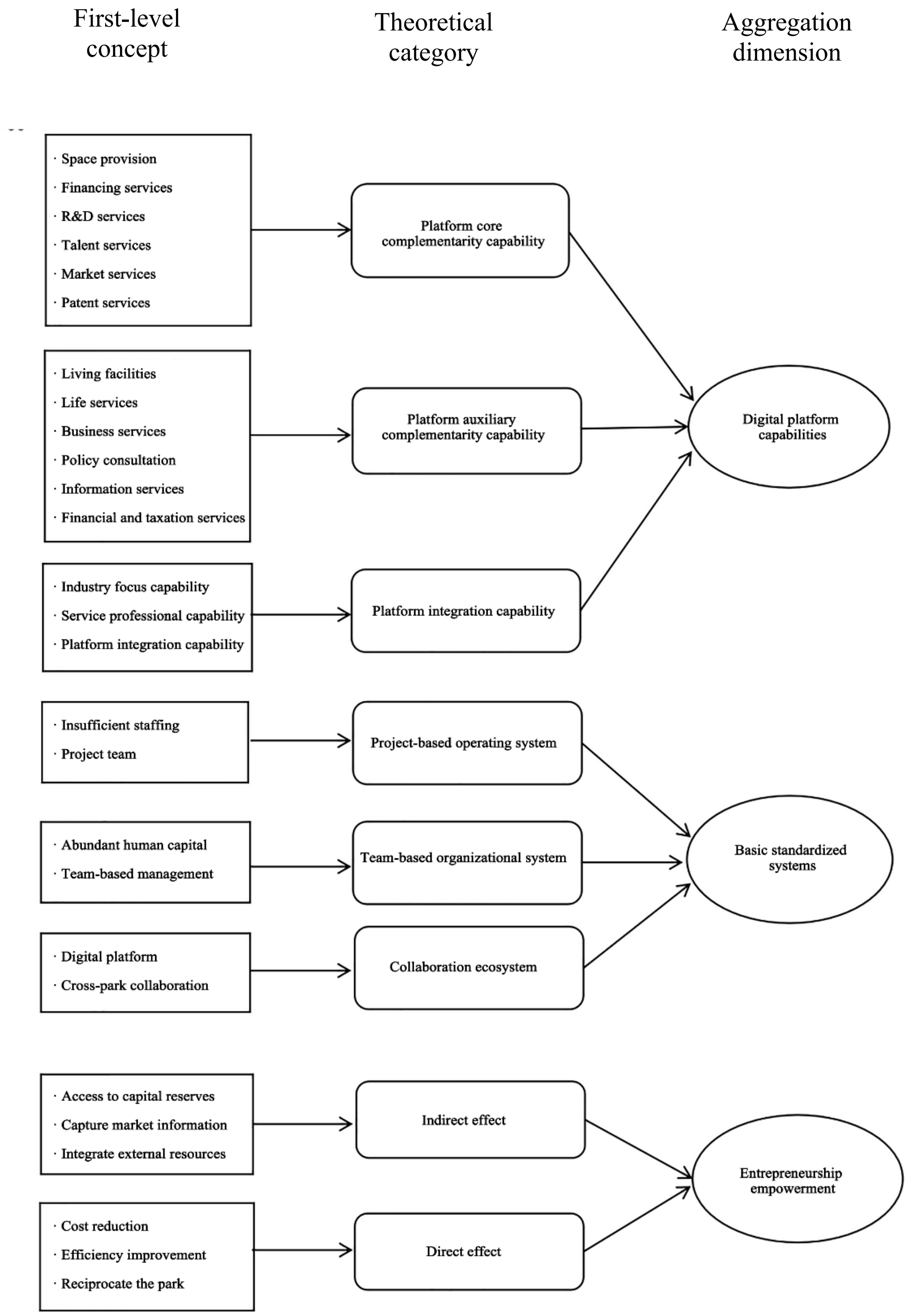

Figure 3.1 Coding Structure of This Study

3.2 Background Introduction of Case Enterprise

Zhejiang Zhixin Zedi Science and Technology Development Co., Ltd. (hereinafter referred to as “Zhixin Zedi”) was established in 2010. It is a specialized park operator and innovation and entrepreneurship service provider with a core focus on "sci-tech industrial park construction and operation." Zhixin Zedi's mission is to create a favorable environment for entrepreneurship and innovation, provide comprehensive entrepreneurship and innovation services, and foster the growth of thousands of sci-tech enterprises. It is dedicated to building an innovation and entrepreneurship community that integrates entrepreneurship with industrial elements to provide all-factor development services for the rapid growth of SMEs. Building a platform-based digital ecosystem is a strategic focus for Zhixin Zedi. Following the strategy of digital transformation and development, it has structured the development of industrial parks into a platform-based approach and has successively established sci-tech industrial parks in Zhejiang, Shandong, Anhui, Sichuan, and other regions. **The strategic blueprint of Zhixin Zedi** is to adhere to the development concept of "integrated innovation, open integration, and win-win cooperation," position the park as an "entrepreneurial platform provider, entrepreneurial resource organizer, and entrepreneurial service provider" and strive to build itself into a service-oriented enterprise for sci-tech innovation and entrepreneurship.

Zhixin Zedi, relying on technologies such as the Internet, AI, and big data, has gradually explored the path of digital transformation for the sci-tech industrial park operators. Among them, one representative park is the Artificial Intelligence Industrial Park established in the Binjiang National High-tech Industrial Park. The goal is to provide a digital ecosystem for the innovation and entrepreneurship of the regional AI industry, supporting the sci-tech innovation and entrepreneurship of enterprises within the park in the field of AI. In the future, Zhixin Zedi will be rooted in Zhejiang and expand its influence nationwide. It aspires to become a catalyst for the high-quality development of small and medium-sized sci-tech enterprises, a leader in industry innovation and development, and an enabler for regional industrial and economic transformation.

Zhixin Zedi's service system construction: Based on the current understanding of industrial park development, the construction of the park's service system, and the practical needs arising from customer interactions, Zhixin Zedi, over the past more than a decade, has built a service system that empowers entrepreneurship for enterprises within the park. This system is based on 12 service elements: talent, facilities, space, patents, enterprises, information, culture, law, capital, finance and taxation, air traffic control, and policy. In the context of the rapid development of the digital economy, leveraging the role of the park's digital platform to achieve digital transformation is the core task for the company's next phase of development.

However, the company is also acutely aware that due to the lack of clarity in Zhixin Zedi's digital transformation strategic path and the insufficiency of its digital resources and capabilities, there are a series of challenges in the depth of the company's digital transformation and development and in empowering innovation and entrepreneurship for enterprises within the park:

(1) The construction of the digital platform within the industrial park is still in the early stages of exploration and has not yet formed a relatively mature system and structure. Currently, Zhixin Zedi operates parks of different types, with diverse industries within each park. It is necessary to analyze the

characteristics of different parks and industries and explore organizational and operational models that have their own unique features.

(2) The platform-based functionality of the industrial parks is also continuously improved. The transition of sci-tech parks from traditional park management to digital innovation and entrepreneurship empowerment requires the establishment of a platform-based system organized by various functional modules. These modules may include sci-tech empowerment, entrepreneurship empowerment, market empowerment, park service empowerment, sci-tech finance empowerment, and talent empowerment. To achieve this, it is necessary to explore the platform-based and ecological organizational systems of sci-tech parks, enabling effective collaboration and integration of various functionalities.

(3) The empowerment mechanism of the digital platform for entrepreneurial enterprises within the industrial park is still to be explored. Zhixin Zedi has explicitly stated that its future core function is to empower entrepreneurial enterprises within the park. However, a well-established and effective empowerment mechanism has yet to be developed. Currently, its main revenue and profits still come from the "middleman" profit model. To generate profits through the aggregation and empowerment of innovative and entrepreneurial elements, it is essential to further explore effective paths.

(4) Evaluating the effectiveness of platform-based empowerment within sci-tech industrial parks is challenging. For entrepreneurial enterprises, what they most need is to directly and indirectly access the value of empowerment. How can sci-tech industrial parks give play to the core complementary party role of entrepreneurial enterprises and achieve tightly coupled growth with park enterprises? If this question can be addressed, the

platform of sci-tech industrial parks can realize value co-creation and shared distribution with entrepreneurial enterprises.

3.3 Case Discovery

3.3.1 Start-up stage: 2017-2018

In 2017, with the vigorous development of the digital economy, the rapid advancement of digital technology has become a new engine for enterprise growth. To accelerate the breakthrough of intelligent industrial carrier management, the application of new-generation information technologies such as big data, cloud computing, and AI has become an important means to enhance carrier services and management levels. At the same time, the shortcomings of traditional industrial parks in terms of efficiency and functionality have gradually become apparent. The use of emerging digital technologies to empower park transformation and upgrading has become increasingly prominent. In alignment with the national informatization development strategy and the deployment of new infrastructure initiatives, industrial parks are now adopting a model driven by technological innovation. They are focusing on digital transformation, intelligent upgrading, and integrated innovation to build a digital technology park infrastructure system. This evolution represents an inevitable trend toward the digital and ecological development of industrial parks. Therefore, Zhixin Zedi, by dialectically perceiving threats and opportunities, has officially launched the construction of the Artificial Intelligence Industrial Park. It is dedicated to building a specialized platform for the development and innovation of the AI industry, aiming to become a demonstrative platform for the industrialization of AI technology R&D and application.

3.3.1.1 Basic standardized systems

The basic standardized systems of the Artificial Intelligence Industrial Park comprise a project-based operating system, a team-based organizational system, and a collaboration ecosystem. The project-based operating system involves temporary staffing for each project to address relevant issues. The team-based organizational system, a higher level of the project-based operating system, involves professional teams dedicated to providing solutions for each project. The collaboration ecosystem represents the highest level, bringing together entities such as third-party institutions, entrepreneurial enterprises, and the Artificial Intelligence Industrial Park to achieve synergy.

In the start-up stage, Zhixin Zedi Artificial Intelligence Industrial Park faced a staffing shortage and adopted the project-based operating system, temporarily assigning employees to specific projects. For example, when providing financing services for entrepreneurial enterprises in the park, managers may mobilize personnel from various functional departments to set up a temporary project team. Upon completion of the project, these personnel return to their original positions.

3.3.1.2 Digital platform capabilities

At this stage, the digital platform capabilities of the Artificial Intelligence Industrial Park encompass platform core complementarity capability, platform auxiliary complementarity capability, and platform integration capability. However, these capabilities have not yet reached full maturity. In the start-up stage, the core complementarity capability is mainly similar to that of traditional industrial parks, with a focus on addressing the initial needs of entrepreneurial enterprises by providing physical space and funds, along with offering relevant R&D services regarding AI technology. Building upon the core complementarity capability, the platform auxiliary complementarity capability offers essential life services for entrepreneurial enterprises within the parks. The purpose of establishing the Artificial Intelligence Industrial Park is to distinguish it from the diversified development trend of traditional parks and build a park dedicated exclusively to a specific industry. As a result, the platform integration capability at this stage is reflected in industry concentration.

(1) Platform core complementarity capability

The platform core complementarity capability in the start-up stage comprises space provision, financing services, and R&D services. An industrial park is a specific area planned by national or regional governments through administrative means according to the inherent requirements of economic development. Within this area, industrial enterprises take advantage of the park's special policies and the moderate concentration of various production factors to foster the development of advantageous and leading industries, forming a cost-efficient development model characterized by relatively concentrated industrial production factors. Therefore, physical space is one of the core elements of a park. Zhixin Zedi Artificial Intelligence Industrial Park, located in Hangzhou High-Tech Zone, comprises buildings A, B, C, and D, with a total construction area of over 80,000 square meters. The park serves multiple functions such as office, production, enterprise exhibition, residence, and commerce, providing sufficient foundational physical space support for entrepreneurial enterprises to engage in entrepreneurial activities.

Restricted by their development capabilities and external environmental factors, entrepreneurial enterprises have continually faced capital constraints throughout their development. Problems such as high rent, difficult financing, heavy tax burdens, and insufficient effective asset mortgages have also become persistent issues that plague enterprises. To solve the financing difficulties faced by entrepreneurial enterprises and further support their growth, the Artificial Intelligence Industrial Park has cooperated with Zhejiang Venture Capital Association to establish the "Zhejiang Artificial Intelligence Industry Investment Fund Alliance," which is jointly established by dozens of renowned investment institutions in the province, including Tisiwi, Zheshang Venture Capital O2O Consumer Fund, and Ginkgo Data Fund. This professional investment and financing platform is established to provide capital support, incubation, and nurturing for high-quality enterprises or projects settled in the park and leverage the leading role of capital in driving the growth and development of AI enterprises.

Entrepreneurial enterprises often struggle with low R&D levels, high R&D risks, and delayed returns on R&D investments, all of which aggravate their risks of failure. Moreover, entrepreneurial enterprises in the park lack knowledge and insights related to core AI technologies, resulting in significant technical bottlenecks. To this end, the Artificial Intelligence Industrial Park has jointly built an "AI Public Technology Service Platform" with Hangzhou Innovation Institute of Beihang University and Zhejiang Provincial Intelligent Research Institute. This platform covers five centers: the AI Research and Development Center, the High-performance Computing and Big Data Center, the Digital Certification Service Center, the AI Industry Chain Collaborative Innovation Center, and the AI Industry Technological Achievements Trading

Center. It provides AI entrepreneurial enterprises within the park with a range of services focused on high-tech AI-related R&D, such as chip integration, industrial IoT, intelligent robots, network security, big data processing, and material testing.

(2) Platform auxiliary complementarity capability

The platform auxiliary complementarity capability in the start-up stage includes supporting living facilities, life services, and business services. In addition to core elements such as space, capital, and R&D, entrepreneurial enterprises within the park also need one-stop and efficient basic services related to business and life. The Artificial Intelligence Industrial Park provides diversified and all-round facilities including canteens, gyms, and conference rooms tailored for entrepreneurial enterprises. It sets up three functional zones: the incubation area, the public service area, and the supporting business area to meet the development needs of enterprises. Additionally, the park has also established five centers. The operation center provides perfect services to support the settlement of entrepreneurial enterprises. The life center provides facilities such as supermarkets and sunshine leisure bars to enrich employees' spiritual needs. The conference center features large, medium, and small public meeting rooms. The activity center offers leisure places including book bars, coffee bars, and small gardens. The social center sets up an entrepreneurship club to hold various entrepreneurial activities to foster the rapid growth of entrepreneurial enterprises.

By leveraging the auxiliary complementarity capability provided, the Artificial Intelligence Industrial Park has achieved: ① Low-cost openness. It is open to all entrepreneurial enterprises by offering some free services while charging fees for others, or by adopting a membership service system to provide entrepreneurs with a relatively low-cost growth environment; ② Mutual assistance and synergy. Activities such as salons, training camps, training, and entrepreneurship competitions foster effective communication among entrepreneurs and the establishment of communities. A shared working environment enables entrepreneurs to assist and inspire one another, share resources, and achieve the goal of collaborative progress. This "aggregation" leads to a synergistic "fusion." ③ Facilitation. The park offers venue space and hosts related activities, enabling entrepreneurs to display products, share ideas, and conduct project roadshows. ④ "All-factor" innovation. The park provides "all-factor" innovation and entrepreneurship services such as materials, equipment, facilities, creativity, and innovation and entrepreneurship plans tailored for entrepreneurial activities.

(3) Platform integration capability

Platform integration capability in the start-up stage refers to industry concentration. Leveraging AI technology, Zhixin Zedi AI Industrial Park distinguishes itself from traditional sci-tech industrial parks by fostering an innovation and entrepreneurship community that integrates entrepreneurship and industrial elements, providing all-factor development services for the rapid growth of SMEs. The Artificial Intelligence Industrial Park brings together AI entrepreneurial enterprises, creating distinct advantages with distinctive industrial characteristics, remarkable cluster advantages, and a perfect function design. The park nurtures numerous entrepreneurial enterprises, facilitating their professional development, business expansion, and innovation. This, in turn, enhances the overall development and competitiveness of regional industries.

Relying on industry concentration, the Artificial Intelligence Industrial Park cooperates with scientific research institutions such as the AI Innovation Alliance, AI Laboratory, and the Institute of Artificial Intelligence, Zhejiang University, to build a professional production and service platform centered on the development of the AI industry, forming the pattern of "one main body, three transformations, and five platforms." This initiative fosters the growth of the AI industry. The Artificial Intelligence Industrial Park aims to drive achievements in AI technology and facilitate its industrialization and capitalization. To support this vision, five sub-platforms, namely AI Industry-University-Research Cooperation Platform, Industrial Technology Achievement Promotion Platform, Industrial Public Service Platform, Entrepreneur Exchange Platform, and Industrial Investment Development Platform will be established to support the entrepreneurship and growth of AI enterprises and boost the innovation-based development of the regional AI industry.

3.3.1.3 Entrepreneurship empowerment

At this stage, the Artificial Intelligence Industrial Park has just been established. Significant human, material, and financial resources are necessary in the early stage to develop the essential digital platform capabilities and empower entrepreneurial enterprises with services. As a result, the direct effects (cost reduction and efficiency improvement) brought by entrepreneurial empowerment are not obvious. Conversely, the Artificial Intelligence Industrial Park leverages the agglomeration effect of resources to maximize service efficiency in the entrepreneurial process. The indirect effects of empowerment are notably significant, particularly in the enhancement of capital, material, and life services.

Based on the platform core complementarity capability, platform auxiliary complementarity capability, and platform integration capability, the park can offer more external resources to entrepreneurial enterprises. The diversification of resource types facilitates the transformation of enterprises' various advantages into indirect entrepreneurial performance (Hannah & Eisenhardt, 2018). For example, financial resources can supply sufficient capital reserves for the R&D and market investment of new products and services in entrepreneurial enterprises. By providing financing services, the Artificial Intelligence Industrial Park enables entrepreneurial enterprises within the park to secure financing of RMB 2 billion. Hangzhou Lingxin Microelectronics settled in the park in 2018. Through the matchmaking of the park, the company has successively secured the first round of financing of RMB 4 million from Jianyu Taicang Tianda Investment and a technology loan of RMB 3 million from the Bank of Hangzhou. Material resources constitute the infrastructure (including life and business services) that entrepreneurs rely on to carry out entrepreneurial activities. These resources play a crucial role in the daily management and operation decisions of entrepreneurial enterprises (Xie et al., 2020). The core and auxiliary complementarity capabilities of the platform can facilitate the rational allocation and utilization of heterogeneous resources. This helps entrepreneurial organizations timely capture market information and seize fleeting opportunities, thus enhancing their indirect performance.

Table 3.1 Typical Examples and Coding Results in the Start-up Stage

Citation of typical examples in the start-up stage	Theoretical category	Aggregation dimension
"Entrepreneurial enterprises need capital the most in the early stage, but they often face challenges such as financing difficulties at this stage. Therefore, parks must introduce professional financial service companies to provide financial and insurance services such as financing, guarantee, insurance, and warehouse receipt pledges for settled enterprises, helping them solve pain points in financing." (Zheng)	Platform core complementarity capability	Digital platform capabilities
"The park offers an excellent green environment and complete supporting facilities, and it responds quickly to any questions we may have." (An enterprise in the park)	Platform auxiliary complementarity capability	
"Currently, digital technology is continually advancing, and the country has been promoting this development as well. From the very beginning, we aimed to create an industrial park focused on AI." (Zheng)	Platform integration capability	
"When providing various services for entrepreneurial enterprises in the park, we may mobilize personnel from various functional departments and set up a temporary project team. Upon completion of the project, these personnel return to their original positions." (Human Resources Director)	Project-based operating system	Basic standardized systems
"By providing financing services, the Artificial Intelligence Industrial Park enables entrepreneurial enterprises within the park to secure financing of RMB 2 billion." (Chief Financial Officer)	Indirect effect	Entrepreneurship empowerment

3.3.2 Development stage: 2019-2021

In 2019, the market size of AI expanded significantly, with its core industry reaching nearly RMB 57 billion, profoundly changing the production methods, lifestyles, and economic structure of human society. Park platforms play a crucial role in cultivating the AI industry. Hangzhou has been designated as a national pilot zone for new-generation AI innovation and development, with the Artificial Intelligence Industrial Park serving as a key platform for its growth and development. During this stage, Zhixin Zedi relied on the platform of Hangzhou Artificial Intelligence Industrial Park to enhance the cultivation and development of the AI industry and build a multi-level and diverse entrepreneurship and innovation service system, fostering an AI industry ecosystem that integrates incubators, multipliers, and accelerators. This initiative has created an excellent innovation and entrepreneurship environment for the high-quality development of AI enterprises. In 2021, the Zhixin Zedi Artificial Intelligence Industrial Park was recognized as a national incubator for sci-tech enterprises. As a key driver for industrial development, the park continuously fosters the cultivation of AI and other industrial projects and enterprise development. It has become a vital engine propelling industrial growth.

3.3.2.1 Basic standardized systems

In the development stage, the continuous improvement of infrastructure and gradual enrichment of human capital in the Zhixin Zedi Artificial Intelligence Industrial Park have led to the establishment of basic standardized systems, forming a park management system combining the team-based organizational system and project-based operating system. That is to say, the park organized internal management and backbone according to the project-based system and managed projects according to the team-based organizational system. Managing the management and backbone in a project-based organizational structure can help the Artificial Intelligence Industrial Park optimize the utilization of resources, especially key human, material, and financial resources. This approach can strengthen the core cohesion of managers and backbones, foster mutual trust, cooperation, and assistance, and improve the efficiency and flexibility of critical project management. It also clarifies organizational objectives, enabling unified command and rapid decision-making when confronting major projects. Implementing the team-based organizational system for each service project—for instance, creating human resources teams dedicated to specific HR service projects—enables the park to provide professional, personalized, and precise service plans tailored to the diverse needs of enterprises within the park.

3.3.2.2 Digital platform capabilities

In the development stage, the mismatch between the annual increase in the number of enterprises incubated in the park and the park's limited service capabilities drove the park to further enhance and improve its digital platform capabilities including platform core and auxiliary complementarity capabilities and platform integration capability. The park has enhanced its core complementarity capability by strengthening space provision, financial services, and R&D support. Additionally, it has placed a strong emphasis on talent, patent, and market services. The park has further developed its auxiliary complementarity capability by improving supporting living facilities, life services, and business services, offering related basic services such as policy consulting services, information services, and finance and taxation services. The professional service capability has emerged as a new form of platform core capabilities, enabling the park to provide all-around and all-factor services for SMEs. The further improvement of the three capabilities has laid a solid service foundation for the high-quality development of enterprises settled in the park.

(1) Platform core complementarity capability

The core complementarity capability in the development stage includes space provision, financing services, R&D services, talent services, patent services, and market services. The first three complementarity capabilities in the start-up stage have been further improved and supplemented. For example, building upon its continually improved service offerings, the Zhixin Zedi Artificial Intelligence Industrial Park has further strengthened strategic cooperation with banks to provide a variety of financing services for settled enterprises. During this stage, talent, patent, and market services were initially developed. It is essential for entrepreneurial enterprises in the AI field to have access to top-notch AI talent and cultivate continuous talent acquisition capabilities. However, start-ups face heavy pressure in acquiring professional talent. To alleviate the dilemma of talent shortage faced by enterprises in the park, the Artificial Intelligence Industrial Park provided talent service support for these enterprises. This included access to AI expert consultant teams, one-on-one guidance from entrepreneurship mentors, and enterprise-university-scientific research institution cooperation. By leveraging the resources and expertise of these mentors, the park assists these enterprises in knowing themselves and provides them with scientific and technological resource support.

Patent application by enterprises has far-reaching significance. For start-ups, especially technology enterprises in the AI field, it is not enough to focus solely on R&D, marketable products, excellent quality, and market development. Effectively managing patent issues and high-level application patent tools are essential capabilities for these innovative enterprises. To assist enterprises in the park in deploying and carrying out patent-related work, the Zhixin Zedi Artificial Intelligence Industrial Park has provided specialized intellectual property services. It has established a learning and exchange platform and regularly carried out knowledge-sharing and training activities in service fields such as project application, intellectual property rights, and legal affairs according to the actual needs of these enterprises. As of 2021, enterprises incubated within the park have achieved fruitful results in the AI field, amassing over 710 scientific and technological achievements including invention patents, software copyrights, utility models, appearance designs, and trademarks. Notably, 51.4% of these incubated enterprises hold valid intellectual property rights.

In addition, technological advances and innovations have driven the emergence of new markets. With the continuous development and applications of AI technology, the AI market size continues to expand and is projected to maintain a high growth rate in the next few years. AI enterprises must think about how to seize market opportunities in the AI era. To help enterprises seize market opportunities and expand their development potential, the park has actively established cooperative relations with the Zhejiang Equity Exchange, Zhejiang Property & Stock Exchange, and Zhejiang Venture Capital Association. The park has actively assisted incubated enterprises in listing technological achievements for trading at the exchange centers, opening up capital channels, fostering the matchmaking between achievement promotion and investment and financing, and realizing the capitalization of achievements and enterprises. Additionally, leveraging media and WeChat official accounts at various levels, the park has comprehensively showcased incubator news and development information of these incubated enterprises, actively helping them promote their brands, increase their popularity, and secure market opportunities. For example, the park actively collaborated with Binjiang District’s initiative to recommend quality incubation carrier enterprises. It recommended UFintech as a distinguished enterprise within the park, leading to a special report.

(2) Platform auxiliary complementarity capability

In the development stage, the park has further developed its auxiliary complementarity capability by improving supporting living facilities, life services, and business services, offering related basic services such as policy consulting services, information services, and finance and taxation services. The development of the AI industry cannot be separated from the support of relevant policies and systems. Government-issued innovation policies, intellectual property protection policies, and other related policies will substantially influence the innovation results of AI entrepreneurial enterprises. Understanding and navigating these policies effectively is a crucial challenge that entrepreneurial enterprises must overcome to succeed. During this stage, the Zhixin Zedi Artificial Intelligence Industrial Park cooperated with multiple forces to irregularly organize various policy interpretation and service activities, creating a mutually beneficial interactive exchange platform for the government, the park, and enterprises. These initiatives contributed significantly to the development and growth of the enterprises involved. For example, it held a training session on the application of scientific and technological talent projects in 2021 to effectively help project applicants better grasp relevant talent policies and key application points.

Additionally, in the information age, decision-making, schemes, or plans are closely intertwined with information. Providing effective information services allows enterprises to timely and efficiently utilize information resources, addressing the issue of information islands. To this end, the park has actively established an information exchange platform and regularly organized entrepreneurship and innovation activities such as annual meetings of entrepreneurs, entrepreneur salons, and industrial cooperation and exchange meetings in the park. Such initiatives have fostered knowledge and information sharing, bringing together various enterprises and assisting them in accessing a broader array of information sources. Moreover, these initiatives have bridged the digital divide, eliminated information or resource asymmetry, and promoted coordinated development among various enterprises.

In addition, finance and taxation services are essential for micro-, small-, and medium-sized enterprises to start a business and conduct business operations. However, as many enterprises expand their business scale, they often fall behind in accounting and financial management. Their financial practices tend to be inconsistent, inefficient, and unclear. To assist enterprises in overcoming fiscal and taxation problems and focusing on business operations and development strategies, the park has actively cooperated with government agencies to hold regular themed salons and training activities centered on their fiscal and taxation issues and combined with their actual needs. These initiatives have enhanced enterprise managers' financial expertise, fostered their financial mindset, and promoted standardized and professional development of enterprises.

(3) Platform integration capability

Platform integration capability in the development stage refers to professional service capability. Zhixin Zedi Artificial Intelligence Industrial Park, recognized as a national incubator for sci-tech enterprises, has established a complete enterprise incubation system and created the “Entrepreneurship Code” for the innovation and entrepreneurship service platform. By offering one-stop integrated services, the park provides enterprises with “12-factor services," namely space carrier services, finance and taxation industrial and commercial services, capital services, legal consulting services, human resources services, cultural services, information management services, technological innovation services, enterprise management services, policy guidance services, intellectual property rights services, and basic supporting services. By integrating various service factors, the park has provided all-around and all-factor services for SMEs, establishing a robust service system that empowers enterprises in the park to start a business. At this stage, the park served as a service provider, builder, and organizer, effectively becoming an all-factor service provider. However, due to the short history of the digital platform and the inadequate facilities available at that time, the park still faced the critical challenge of "efficiently and cost-effectively integrating various service factors to build a replicable service system." This still requires ongoing investments and efforts from the park.

3.3.2.3 Entrepreneurship empowerment

In the development stage, the Zhixin Zedi Artificial Intelligence Industrial Park leveraged the cutting-edge AI industry platform to continuously optimize core and auxiliary complementarity capabilities and platform integration capability. The park has actively fostered a favorable innovation and entrepreneurship environment for enterprises within the park and provided all-factor entrepreneurial growth services to enhance their internal driving force and constantly empower them to accelerate resource acquisition, integration, and reconstruction. This, in turn, has accelerated the development and performance enhancement of the AI industry.

On the one hand, the digital platform acts as a two-sided market and can connect a variety of external resources using digital platform capabilities. The Artificial Intelligence Industrial Park leveraged the cutting-edge AI industry platform to maximize the key role of digital platform capabilities, offering services such as information services, consulting services, and talent services to settled enterprises in various forms of activities. This enabled enterprises within the park to search for and obtain high-quality external information resources at a low cost and through multiple channels and frequencies, thereby mitigating their resource disadvantages. Additionally, it has fostered a strategic symbiosis between park-based and platform enterprises under a framework of "dependent upgrading" (W. Chen & Wang Jiexiang, 2021), assisting enterprises within the park in reducing matching costs and accelerating their common growth. For example, the park has successively provided technology matchmaking, consultation, and services for more than 10 AI enterprises within the park. Annually, it hosts over 100 training activities on policies and talent development and provides entrepreneurship services for more than 200 enterprises, attracting a total of over 3,000 participants.

On the other hand, digital platform capabilities serve as resource integration and reconfiguration capabilities that can integrate platform information and resources. The Artificial Intelligence Industrial Park has integrated 12 preferential service factors tailored to the needs of SMEs throughout the whole entrepreneurial process. The park has provided all-around support for the entrepreneurial growth of incubated enterprises, helping them effectively match and integrate internal and external resources, forming a unique resource combination. As a result, these enterprises could quickly respond to market demands and enhance their performance. For example, the innovation and entrepreneurship service platform "Entrepreneurship Code" developed by the Zhixin Zedi Artificial Intelligence Industrial Park has effectively improved the integration efficiency of settled enterprises on platform resources, fostering their new product development or new value creation.

Table 3.2 Typical Examples and Coding Results of the Development Stage

Citation of typical examples in the development stage	Theoretical category	Aggregation dimension
"We provide entrepreneurial enterprises with a range of services such as house leasing, industrial and commercial registration, project evaluation and declaration, sci-tech funds, loan financing, and entrepreneurship and employment training." (Gan)	Platform core complementarity capability	Digital platform capabilities
"The government provides a range of supportive policies for entrepreneurial enterprises, such as water and electricity subsidies and preferential tax policies. However, many of these enterprises remain unaware of these policies. Therefore, the park offers policy services to settled enterprises, ensuring that they get appropriate policy support at each stage of their development. These services include rent subsidies, warehouse repair and renovation subsidies, water and electricity subsidies, preferential tax policies, talent introduction policies, and project subsidies." (Director of Marketing Department)	Platform auxiliary complementarity capability	
"We provide services beyond basic property management for settled enterprises. In addition to leveraging our own resources, we also tap into external resources to provide them with services and enhance their innovation-driven entrepreneurial efficiency." (Zheng)	Platform integration capability	
"The park organizes and manages internal management and backbone in a project-based organizational structure. This approach fosters clear organizational objectives, facilitates unified command, and enables rapid decision-making." (Human Resources Director)	Project-based operating system	Basic standardized systems
"Implementing the team-based organizational system for various service projects—for instance, creating human resources teams dedicated to specific HR service projects—enables the park to enhance efficiency, increase adaptability, and provide professional, personalized, and precise services for settled enterprises." (Human Resources Director)	Team-based organizational system	
"We have successively provided technology matchmaking, consultation, and services for more than 10 AI enterprises within the park. Annually, it hosts over 100 training activities on policies and talent and provides entrepreneurship services for more than 200 enterprises, attracting a total of over 3,000 participants." (Zheng)	Indirect effect	Entrepreneurship empowerment
"The park helps settled enterprises search for and obtain high-quality external information resources at a low cost and through multiple channels and frequencies, fostering their new product development or new value creation while assisting them in reducing matching costs and accelerating their common growth." (Chief Financial Officer)	Direct effect	

3.3.3 Maturity stage: 2022-now

Since 2022, the Artificial Intelligence Industrial Park has been officially on the right track, with various services and support systems gradually maturing and improving. By providing high-quality office space and building an efficient resource matchmaking platform, the park has met the basic daily operation needs of enterprises. Moreover, it has offered comprehensive support in key areas such as financing, R&D, and marketing. Additionally, the park has actively fostered a conducive environment for innovation and vigorously promoted exchanges and cooperation among enterprises, fostering a benign development ecosystem. It can be said that the park on the right track has created an ideal stage for many enterprises to grow and thrive. In March 2023, the park was approved as a “National Incubator for Sci-tech Enterprises.” In May of the same year, it was recognized as one of the “Top 10 Low-carbon Application Scenarios in Hangzhou,” consistently contributing to low-carbon energy-saving digital intelligence park management as well as innovation and entrepreneurship services. During this stage, the park’s three key capabilities have been continuously upgraded to support the growth of enterprises.

3.3.3.1 Basic standardized systems

With the increasing maturity of the construction of digital platforms within the park, the assistance system has undergone significant changes and enhancements. The park management system integrating the project-based operating system and the team-based organizational system developed in the development stage has been further upgraded into an assistance mechanism comprising the “project-based operating system + team-based organizational system + collaboration ecosystem.” This upgrade has enhanced the park’s core competitiveness and offered unprecedented development opportunities to the incubated enterprises. Specifically, all organizations within the park, including incubated enterprises, park assistance project teams, external investment teams, and information service providers can realize smooth communication with each other through digital platforms and achieve efficient ecological synergy.

The enhancement of financing services is a vivid example. In the past, the park provided many start-ups with financial service support through the project-based system during their incubation stage, especially in the early stages. This means that after the incubation stage ends, these enterprises face the significant challenge of lacking continuous and professional financing guidance and resource matchmaking. This abrupt halt in service provision often leaves enterprises confused during the subsequent financing process, making it difficult for them to effectively navigate the complex capital market. However, with the continuous improvement of the park's support mechanisms, the current situation has improved significantly.

To address the aforementioned service pain points, the park extends its support beyond short-term assistance services during the incubation stage to cover various stages of the enterprise life cycle. Specifically, enterprises can leverage the digital platform built by the park to reconnect with project teams they have previously engaged with. They can resolve new challenges by communicating in real-time with the project teams on the digital platform. The project teams faced challenges in maintaining detailed information records of each enterprise due to the large number of enterprises they served. This long-standing problem has been completely solved with the introduction of the digital platform. The platform allows them to easily access relevant information from previous assistance stages, ensuring continuity and efficiency in their services. The establishment of this long-term service mechanism not only enhances the financing success rate of enterprises but also strengthens the connection between the park and enterprises, ensuring that enterprises receive continuous and stable financing service support at different stages of their development.

Moreover, the park has also thoughtfully established a complete information database, enabling enterprises to access various financing channels and successful cases to understand market trends and the latest policies.

3.3.3.2 Digital platform capabilities

Faced with the delay in information processing and other persistent problems of platform outsourcing teams during the start-up and development stages, the park has come to understand that these problems must be fundamentally solved to truly enhance the operational efficiency and service quality of the platform. Therefore, the park decided to establish its own digital platform construction team. Through the self-established team, the park has achieved faster and more accurate information processing and business response while better grasping the core technology and key information of the digital platform.

After the park masters the digital platform construction capability, its three platform capabilities can better demonstrate their value. Relying on the main framework of the digital platform, the core complementarity capability plays a vital role in data processing, information analysis, and business support, providing users with stable and efficient services. Specifically, the core complementarity capability of the platform provides support for incubated enterprises in terms of core technologies, resource integration, and business models, thus providing strong support for their core businesses. The platform auxiliary complementarity capability focuses on providing a range of auxiliary services that optimize user experience and boost operational efficiency, ensuring seamless overall operations of the platform. Both provide a continuous flow of development support for the incubated enterprises, from internal to external resources.

(1) Platform core complementarity capability

After five years of official operation, the park's development smoothly transitioned into a mature stage, and the platform core complementarity capability reached a new height. The core capabilities such as financing, R&D, talent, markets, patents, and space services support each other to form a strong complementary effect. To foster the continuous growth of the platform core complementarity capability, the park formulated a perfect enterprise incubation management system, internal management system, and AI professional technical service platform management measures. These initiatives aimed to enhance the park's incubation capacity and management efficiency. According to the latest policies and regulations, the park has developed a systematic enterprise incubation mechanism and established comprehensive management measures. It has also set standards for enterprises' entry into incubation, "graduation" standards, enterprise assessment methods, and incubation fund management methods. These initiatives have effectively implemented a strategy of "supporting and assisting some enterprises while phasing out others," creating a better development environment for the growth of incubated enterprises.

In addition to providing services for enterprises relying on its resources, the park has also actively connected with external resources and successfully established close cooperative relations with organizations such as investment industry associations, prominent domestic investment institutions, financial service institutions, and investment and financing service organizations to provide comprehensive professional capital services such as direct investment and investment introduction for incubated enterprises. The park's investment and financing team boasts years of experience in the science and technology industry, financial consultancy, and industrial investment. They can assist enterprises in opening up capital channels and promoting the rapid development of the AI industry as well as innovative and entrepreneurial enterprises. The team is dedicated to ensuring that enterprises in the incubator navigate the downturn smoothly, boosting the confidence and vitality of market entities, and minimizing the adverse impact of the external environment on their economic development.

(2) Platform auxiliary complementarity capability

The park has always been at the forefront in terms of platform auxiliary complementarity capability. The park stands out in offering a four-in-one mentor service system. To address the diverse needs of settled enterprises, the park has set up a four-in-one service system consisting of liaison officers, instructors, entrepreneurship mentors, and expert consultants. It assigns at least one mentor and one liaison officer to every 10 incubated enterprises. Staff members with rich work experience and strong coordination capabilities serve as liaison officers. Their primary responsibilities include addressing enterprises' consultations promptly and understanding and assisting in solving their service needs. Instructors' primary responsibilities include visiting enterprises, declaring enterprise policies, recommending government activities and competitions, tracking follow-up services, and assisting entrepreneurship mentors in providing one-to-one guidance services for enterprises. Entrepreneurship mentors offer services through entrepreneurship lecture salons and one-on-one guidance for enterprises. Expert consultants provide services through technology R&D matchmaking meetings and one-to-one guidance. In 2022, the mentors communicated with enterprises over 25 times.

The construction of digital platforms has significantly improved the previous platform auxiliary complementarity capability. Nowadays, with more convenient and efficient supporting living facilities and business services, enterprises can easily access necessary services through digital platforms anytime and anywhere. Compared with the tedious offline application process previously required before the construction of digital platforms, enterprises now only need to apply for meeting venues, accommodation, and other matters online, which greatly reduces the approval process and waiting time. In addition, the park has also launched a park code feature. After successful application, enterprises only need to scan the park code for confirmation, which simplifies the process while improving work efficiency. This digital transformation not only reduces the time costs of enterprises but also enhances the service quality and response speed of the park, further boosting its attractiveness and competitiveness. Simultaneously, the construction of digital platforms enhances park management by providing greater convenience, enabling the park to understand the needs of enterprises more accurately, optimize resource allocation, and promote its sustainable development. On the digital platform, employees can even access detailed information such as the number of queues in restaurants, helping enterprises better arrange and plan their time.

(3) Platform integration capability

After the park developed into a mature stage, its platform integration capability has been further enhanced and refined. The park focused on simply integrating various service resources and building a one-stop service platform at its inception. It has now evolved to include more professional and efficient third-party institutions within the platform. These third-party institutions cover various fields such as legal consultation, financial audit, marketing, and human resources, providing more comprehensive and professional service support for incubated enterprises. The engagement of these third-party organizations not only enriches the services offered by the park but also significantly expands the business scope of incubated enterprises. Enterprises can access external resources more easily and establish closer ties with partners, thus accelerating their growth and development. Additionally, the professional services offered by these third-party organizations alleviate many concerns for enterprises, enabling them to focus more on their core business.

Up to now, the park has established strategic cooperation with various institutions such as Zhejiang Public Service Platform for SMEs, Hangzhou SME Service Center, and Zhejiang Jingxin Smart City Planning & Research Institute to jointly establish an AI industry public service platform, offering various services such as information, technology, talent, policies, and industrial resources to the enterprises incubated within the park. Moreover, the park has also established cooperation with institutions such as Zhejiang Equity Exchange, Zhejiang Property & Stock Exchange, Zhejiang Venture Capital Association, and Zhejiang Jingxin Smart City Planning & Research Institute. They aim to actively help high-quality incubated enterprises apply for listing on the innovation board at Zhejiang Equity Exchange and list and trade their technological achievements at Zhejiang Property & Stock Exchange. They are also committed to opening up capital channels as well as promoting achievements and facilitating investment-financing matchmaking, thereby realizing the capitalization of these achievements and enterprises. The establishment of the aforementioned multi-level and multi-entity platforms not only significantly expands the park's original boundaries, making it offer more extensive services, but also provides more diversified and higher-quality development opportunities for incubated enterprises.

3.3.3.3 Entrepreneurship empowerment

In the mature stage of park development, by building and improving digital platforms, the park integrated core technologies, resources, services, and other capabilities to offer comprehensive and multi-level entrepreneurial empowerment support to incubated enterprises. This empowerment not only reduced the entrepreneurial costs of enterprises and improved their operational efficiency, but also promoted their technological innovation and market expansion, injecting strong impetus into their rapid growth and sustainable development.

Entrepreneurship empowerment is primarily reflected in three aspects. The first involves technology and resource support: The park provides advanced technical support and resource integration services for entrepreneurs through digital platforms. This support includes the applications of cutting-edge technologies such as cloud computing, big data, and AI, as well as the integration of resources such as funds, talents, and market channels. This support helps address the difficulties entrepreneurs encounter in technology development and marketing, thus reducing the barriers and risks associated with starting a business. The second focuses on operational optimization and efficiency enhancement: The park offers a range of fine management and optimization services through digital platforms, such as the interpretation of cutting-edge policies and evaluation of fiscal and taxation schemes, to help entrepreneurs boost operational efficiency and market competitiveness. These services help entrepreneurs manage businesses more efficiently and achieve rapid growth. The third lies in industrial matchmaking and cooperation expansion: The park actively organizes various industrial matchmaking activities, providing a platform for entrepreneurs to exchange and cooperate with peers, as well as with scientific research institutions and investment institutions. These activities help incubated enterprises expand business cooperation and gain more market opportunities and resource support.

Take Hangzhou Shunyuan Microelectronics Co., Ltd. within the park as an example. The park actively conducted thorough communication and interviews with this enterprise during its incubation stage to understand its current difficulties. These difficulties primarily included: The enterprise needed to apply for the qualification as an innovative small/medium-sized enterprise as part of its operation and development plan and required professional organizations to review and guide its relevant application materials; it had investment and financing needs, with a desire to connect with multiple financial institutions; it hoped to participate in more industrial resource matchmaking activities. The park promptly provided support leveraging existing resources and previous successful cases. First, it arranged entrepreneurship mentors to offer one-to-one project application guidance through digital platforms; second, the park assigned these mentors to analyze the enterprise's capital needs and facilitated its thorough communication with Hangzhou United Bank and Tailong Bank; finally, the park actively invited the enterprise to participate in industry-related activities to meet its needs for resource matchmaking.

The rapid improvement and development of platform integration capability in the maturity stage facilitate the smooth development of industry concentration and professional service capabilities, thus bringing significant indirect effects to entrepreneurship empowerment. The development of platform integration capability signifies that the platforms can effectively integrate various resources, services, and functions to form an efficient and collaborative entrepreneurial ecosystem. This integration not only enhances the platforms' operational efficiency and service quality but also creates favorable conditions for increased industry concentration and professional service capabilities. In terms of industry concentration, the development of platform integration capability allows the platforms to more accurately understand the needs and development trends of specific industries. By integrating industry resources, expert insights, and market information, the platforms offer entrepreneurs more in-depth and professional industry analysis and guidance. This precise guidance helps entrepreneurs better understand the current situation and future development directions of the industry, allowing them to make more informed decisions and plans. In terms of professional service capability, the development of platform integration capability has enriched service content and enhanced service quality. By integrating various service providers and partners, the platforms can provide one-stop and all-around service support for entrepreneurs. Additionally, the platforms can also leverage advanced information technology and data analysis tools to continuously optimize and improve the service process and enhance service efficiency and user experience.

Take the Artificial Intelligence Industry Investment and Development Platform built by the park as an example. The park has cooperated with the Zhejiang Venture Capital Association to establish the "Zhejiang Artificial Intelligence Industry Investment Fund Alliance" to build a professional investment and financing platform. This platform has brought together dozens of renowned investment institutions in the province, providing capital support, incubation, and nurturing for high-quality enterprises or projects settled in the park and fully leveraging the leading role of capital in driving the growth and development of AI enterprises. Currently, the incubator has signed a contract with Tailong Bank to jointly set up a debt financing credit of RMB 200 million. Additionally, it has cooperated closely with the Bank of Nanjing, Agricultural Bank of China Hangzhou Branch, Hangzhou United Bank Science and Technology Sub-branch, Hangzhou United Bank Cultural and Creative Sub-branch, and China Construction Bank to assist enterprises in securing "leasing loans" and "operating loans." These collaborations have facilitated enterprises' utilization of capital recovery points and enhanced the strength of the incubator. Moreover, enterprises can pay housing funds in installments. These initiatives have solved enterprises' capital chain issues in the start-up stage, allowing them to optimize the use of existing funds and providing broad space for their rapid and convenient growth.

In addition, the park also regularly holds financing matchmaking meetings and training activities to build a bridge for exchanges and cooperation between enterprises and investors, helping enterprises solve their financing difficulties. The park has successfully helped Hangzhou Lingxin Microelectronics apply for Eyas Enterprise and National High-tech Enterprise qualifications, as well as with the announcement of two inventions and the authorization of two. As a result, the company has secured the first round of financing of RMB 4 million from Jianyu Taicang Tianda Investment and a technology loan of RMB 3 million from the Bank of Hangzhou. In addition to financing, the park also places a strong emphasis on other platform capabilities. It is deeply committed to improving service quality and mechanisms and constantly innovates upon its original foundation, striving to provide more sustainable and comprehensive services for enterprises.

With the continuous growth and meticulous nurturing of the park's three major capabilities, a benign ecosystem has emerged where enterprises and the park nourish each other and grow together. While utilizing the park's resources and services, these enterprises also actively participated in various park activities, significantly contributing to the park's cultural development and brand promotion. More importantly, some successful enterprises began to give back their advantageous resources and services to the park and provide guidance and help for other start-ups, creating a positive experience-passing effect. The interaction and cooperation between enterprises and the park not only foster the rapid growth of enterprises but also drive the continuous innovation and development of the park. By integrating various resources and services, the park fosters an optimal growth environment for enterprises. In return, these enterprises inject new opportunities and vitality into the park through their efforts and development. This model of mutual support and shared development has laid a solid foundation for the park's enduring prosperity.

Enhancing the three aforementioned capabilities not only enhances the park's overall competitiveness but also creates a broader development space with more opportunities for the enterprises incubated within it. In the future, with ongoing innovation and improvement of the park, we believe that more excellent enterprises will settle and flourish in the park to achieve their entrepreneurial dreams.

Table 3.3 Typical Examples and Coding Results of the Maturity Stage

Citation of typical examples of the maturity stage	Theoretical category	Aggregation dimension
"Core abilities such as financing, R&D, talent, markets, patents, and space services support each other to form a strong complementary effect. The aim is to promote the continuous growth of the platform's core complementarity capability." (Gan)	Platform core complementarity capability	Digital platform capabilities
"According to the diversified needs of settled enterprises, the park is equipped with a four-in-one service system consisting of liaison officers, instructors, entrepreneurship mentors, and expert-level consultants to meet enterprises' needs." (Zheng)	Platform auxiliary complementarity capability	
"The park has established strategic cooperation with various third-party institutions such as Zhejiang Public Service Platform for SMEs, Hangzhou SME Service Center, and Zhejiang Economic and Information Smart City Research Institute to realize the expansion and integration of resources. Not only does this significantly expand the park's original boundaries, making its services more extensive, but it also provides more diversified and higher-quality development opportunities for enterprises in it." (Marketing Department Director)	Platform integration capability	
"Settled enterprises can use the digital platform built by the park to connect with project teams they have previously engaged with. They can resolve new challenges by communicating in real time with the project teams on the digital platform." (Human Resources Director)	Project-based operating system	Basic standardized systems
"Building on the digital platform, we are further advancing the construction of a team-based organizational system to ensure the continuity and efficiency of our services." (Human Resources Director)	Team-based organizational system	
"Entrepreneurial enterprises can access more new resources. By building a digital platform, we can empower them with resource search and access, tools, methods, and technology empowerment." (CTO)	Collaboration ecosystem	Entrepreneurship empowerment
"We have established a complete information database where enterprises can access various financing channels and successful cases to understand market trends and the latest policies. Additionally, the park regularly organizes financing matchmaking events and training activities to provide a platform for communication and cooperation between enterprises and investors, helping companies address financing challenges." (Marketing Department Director)	Indirect effect	
"The park now presents a benign ecology in which enterprises and the park nourish each other and grow together. Some successful enterprises have begun to give back their advantageous resources and services to the park, providing guidance and help for other start-ups, creating a positive long-running effect." (Chief Financial Officer)	Direct effect	

Therefore, this study obtains the following case study-based theoretical analytical framework:

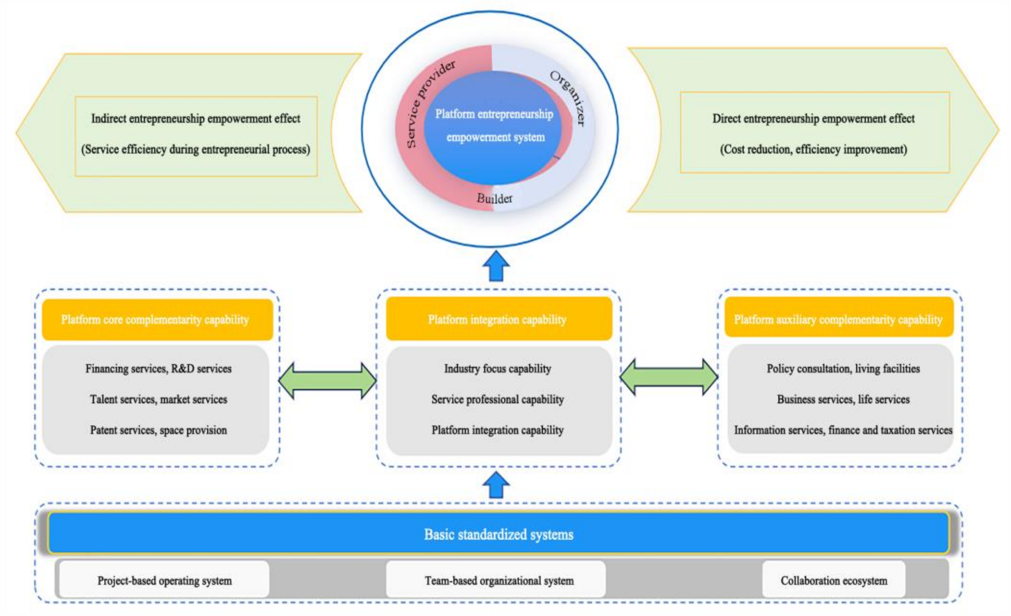

Figure 3.2 Theoretical Analytical Framework

3.4 Case Discussion

3.4.1 Digital platform capability system: Construction process and connotation dimensions

From the case material, it is evident that the development of Zhixin Zedi's digital platform capabilities features three stages: the start-up stage, the development stage, and the maturity stage. In these three stages, digital platform capabilities comprise three major capabilities: the platform's core complementarity capability, the platform's auxiliary complementarity capability, and the platform integration capability. With the continuous improvement of the Zhixin Zedi Digital Park, digital platform capabilities have gradually transformed from immaturity to maturity. The connotation of capabilities has become richer, the level of capabilities has enhanced, and the empowerment performance has significantly increased.

During the start-up stage, these three types of capabilities were not yet mature and had relatively simplistic connotations. Platform's core complementarity capability mainly focuses on providing physical space, funding, and R&D services to meet the primary needs of entrepreneurial enterprises. Based on the core complementarity capability, platform's auxiliary complementarity capability provides basic living services for entrepreneurial enterprises in the park. Platform integration capability contributes to the development of the industrial park by providing focus ability.

During the development stage, the connotations of the three capabilities have all been enriched. Regarding the platform's core complementarity capability, not only space provision, financing services, and R&D services have been further strengthened, but also talent services, patent services, and market services have been introduced. In terms of platform auxiliary complementarity capability, on the foundation of improving living facilities, life services, and business services, further development has been achieved in related services such as policy consultation services, information services, and financial and tax services. Platform integration capability sees the emergence of a new form, the professional service capability, enabling the park to provide comprehensive all-element services for SMEs.

During the maturity stage, the three capabilities not only further expand their connotations, forming mutual support, but also, supported by digital technology, their capability levels are significantly enhanced. Platform's core complementarity capability not only provides comprehensive support such as incubation space, funding, R&D, and talent for entrepreneurial enterprises but also relies on strong data processing, information analysis, and business support abilities to underpin the core operations of these enterprises. Meanwhile, while providing a series of auxiliary services, the platform's auxiliary complementarity capability also continuously optimizes user experience and enhances operational efficiency through digital technology. The platform integration capability has been further solidified, integrating more professional and efficient third-party organizations, and providing industry-specific and platform-specific services based on a precise understanding of the needs of entrepreneurial enterprises.

Finally, in analyzing the digital platform capability building process of Zhixin Zedi, it is found that the platform's auxiliary complementarity capability and the platform's core complementarity capability exhibit logical consistency, both focusing on platform connection resources and elements. The platform integration capability emphasizes platform enterprises, reflected in Zhixin Zedi's integration of platform elements and the provision of professional services for entrepreneurial enterprises. Therefore, based on the analysis of the case data, this study combines the platform's core complementarity capability with its auxiliary complementary capability to establish the digital platform complementarity capability. As a result, the digital platform capability framework comprises two dimensions: platform complementarity capability and platform integration capability. Digital platform capabilities are deconstructed from the perspectives of platform resource elements and the integration of platform enterprises.

3.4.2 Digital platform capabilities and enterprise entrepreneurship empowerment

The empowerment of entrepreneurial enterprises by digital platform capabilities is reflected in two aspects: direct entrepreneurship empowerment and indirect entrepreneurship empowerment. In terms of direct entrepreneurship empowerment, digital platform capabilities assist entrepreneurial enterprises by providing the resources needed for entrepreneurial activities, helping them overcome challenges in technology development and market promotion, thus reducing entrepreneurial costs and risks. These capabilities enhance the enterprises' operational efficiency and market competitiveness by offering a range of refined management and optimization services through digital platforms. By continuously providing entrepreneurial enterprises with professional services in the field of AI and expanding collaboration networks, they facilitate technological innovation and market expansion for enterprises. Therefore, digital platform capabilities can enhance the growth, profitability, and innovation of entrepreneurial enterprises, effectively improving their performance.

In terms of indirect entrepreneurship empowerment, as digital platform capabilities continue to evolve and improve, advancements have been seen not only in service professionalism but also in the ongoing optimization and enhancement of service processes. This allows for the provision of continuous, precise services to entrepreneurial enterprises, enhancing service efficiency and user experience. The continuous development of digital platforms has enabled the evolving ecosystem of industrial parks, attracting the involvement of more third-party service providers and thus creating a better entrepreneurial environment and commercial atmosphere for entrepreneurial enterprises. A virtuous development cycle is fostered between digital industrial parks and entrepreneurial enterprises. The park supports the growth of entrepreneurial enterprises through digital platforms, while entrepreneurial enterprises, in turn, reciprocate the park with their advantageous resources and services, thereby driving continuous innovation and development within the park. In this process, entrepreneurial enterprises can consistently enjoy better service experiences within a positive entrepreneurial ecosystem with long-term and sustainable development.

3.4.3 Basic standardized systems and digital platform empowerment

Based on the case material, it is apparent that basic standardized systems are a critical organizational guarantee for achieving digital platform empowerment. Specifically, the basic standardized systems comprise three aspects: the project-based operating system, the team-based organizational system, and the collaboration ecosystem. The project-based operating system refers to establishing project teams to address issues related to enterprises within the park. The team-based organizational system involves a professional team providing solutions for projects. The collaboration ecosystem focuses on the seamless communication achieved between incubated enterprises, park assistance project teams, external investment teams, and information service providers through digital platforms. It aims at facilitating efficient ecological synergy among these entities. Based on these three aspects, the park can continuously provide entrepreneurial enterprises with sustained, professional, and precise services, thus ensuring the effectiveness of digital platform empowerment.

Further analysis of the basic standardized systems reveals the project-based operating system and the team-based organizational system are logically consistent, both achieving park project operations through teamwork and discussing organizational systems at the level of individual park projects. The collaboration ecosystem transcends the boundaries of projects and parks, encompassing various parks, complementary enterprises, and entrepreneurial enterprises, embodying a systemic concept of the ecosystem. Thus, leveraging case data analysis, this study merges the project-based operating system with the team-based organizational system. With this approach, basic standardized systems consist of two dimensions: the project-based operating system and the collaboration ecosystem, deconstructing the management system of the park from both the project level and the ecosystem level.

Based on the analysis results from the cases above, this study presents the theoretical model as shown in Figure 3.3.

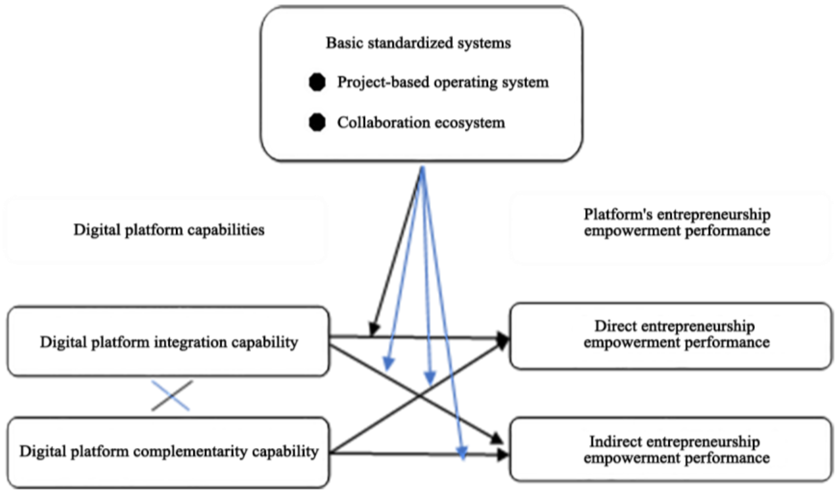

Figure 3.3 Theoretical Model of the Study

4. Digital Platform Capabilities and Their Entrepreneurship Empowerment Performance: Hypotheses and Testing

Through the exploratory case analysis of the Zhixin Zedi Industrial Park in Chapter 3, this study initially establishes the digital platform capability system of the park. It identifies two key dimensions—platform integration capability and platform complementarity capability—and constructs a theoretical framework model of "digital platform capabilities-entrepreneurship empowerment performance." Additionally, the sub-study identifies basic standardized systems as a key boundary condition influencing the role of digital platform capabilities, pointing out that its implementation significantly affects the effectiveness of digital platform capabilities. Building upon the previous research, this chapter further examines the conclusions obtained from the case studies. Through theoretical deduction and standardized large-sample empirical analysis, it tests the relationships among digital platform capabilities, basic standardized systems, and entrepreneurship empowerment performance within the industrial park. The results are then discussed.

4.1 Hypothesis Deduction

4.1.1 Research on digital platform capabilities and entrepreneurship empowerment performance

4.1.1.1 Platform complementarity capability and entrepreneurship empowerment performance

As the digital development of industrial parks advances, many digital industry park management enterprises are trying to connect internal and external resources by building digital platforms to empower entrepreneurial enterprises. Digital platforms leverage digital infrastructure to enable users to quickly digitize, store, and share large amounts of diverse information, facilitating rapid access and connection to information and resources. This allows for online interaction of information and knowledge with partners (Zhu et al., 2015). Therefore, digital platform capabilities are defined as the technological ability of park management enterprises to support and empower entrepreneurial enterprises through digital platforms, enabling them to exchange information with partners, engage in electronic interconnection, and collaborate online (Rai & Tang, 2010; Zhu et al., 2015).

Furthermore, existing studies categorize the digital platform capabilities into various dimensions such as platform integration, platform complementarity, and platform restructuring (Wang Dongyang, 2022; Wang Shuguang et al., 2022). Building upon existing theories and case study results, this study further subdivides digital platform capabilities into digital platform complementarity capability and digital platform integration capability. In this context, digital platform complementarity capability, viewed from the perspective of platform resource elements, emphasizes the platform's connection to core complementary resources and auxiliary complementary resources. This fosters information exchange and resource complementarity between entrepreneurial enterprises within the park and service enterprises on the platform. Digital platform integration capability, seen from the viewpoint of platform leaders, highlights how park management enterprises integrate and restructure internal and external resources based on digital platforms to provide professional industries and platform services for entrepreneurial enterprises (Grant, 1996; Li Zhenhua et al., 2019).

Platform complementarity capability is a critical dimension of capabilities that empowers entrepreneurship within industrial parks. Specifically, this complementarity can be observed from two perspectives: core complementarity and auxiliary complementarity. The concept of core complementarity originates from Teece (1986), who introduced the idea of complementary assets, highlighting that unique complementary assets are crucial in helping enterprises achieve technological innovation. Furthermore, in the literature on platforms and innovation ecosystems, core complementarity is considered the indispensable information, technologies, and resources for innovation that platform participants provide for platform enterprises (Jacobides et al., 2018; Wang Jiexiang et al., 2021; Wei & L. Xu, 2014). In digital industrial parks, entrepreneurial enterprises can gain the necessary information, technology, and resources needed during the entrepreneurial process by establishing connections with platform participants who are linked to digital platforms and possess core complementary resources, thus enhancing their entrepreneurial performance. On the one hand, entrepreneurial enterprises in the early stages of development typically face shortages of various resources such as financial resources, spatial resources, and market resources. In the later stages of innovation and entrepreneurship activities, they also encounter the absence of key resources like talent resources, R&D resources, and patent resources. Entrepreneurial costs and risks remain at high levels. Additionally, due to the liability of newness, entrepreneurial enterprises often struggle with a lack of legitimacy and find it challenging to easily acquire the aforementioned critical resources from the market (Shi & Shi, 2020; J. Su et al., 2017). The platform's core complementarity capability of digital industrial parks not only connects entrepreneurial enterprises with numerous complementary parties with key and core resources but also provides reputation endorsements, significantly reducing the difficulty for enterprises to acquire essential resources for development. This enhances these enterprises' efficiency in acquiring necessary resources and boosts the survival rate of entrepreneurial enterprises (Z. Su et al., 2023). On the other hand, entrepreneurial enterprises typically operate in niche markets and have higher organizational fragility. The platform's core complementarity capability of digital industrial parks can assist entrepreneurial enterprises in acquiring a large amount of heterogeneous key resources, enabling them to introduce new knowledge and technologies and establish unique competitive advantages (Yam et al., 2011). Therefore, the core complementarity capabilities of digital platforms undoubtedly enhance the direct entrepreneurial performance of entrepreneurial enterprises.

Auxiliary complementarity derives from Teece's (1986) definition of complementary assets, which emphasizes that although generic complementary assets may be relatively easily obtained, they play a crucial role in helping enterprises more efficiently achieve the commercialization of products, serving as important resources for enterprise development. Furthermore, in the literature related to platforms and innovation ecosystems, auxiliary complementarity is considered as the information, technology, and resources provided by platform participants to platform enterprises. It is not essential for enterprise development but can enhance enterprise efficiency (Jacobides et al., 2018). In digital industrial parks, entrepreneurial enterprises can enrich their information channels, further decrease entrepreneurial risks, and enhance the efficiency of their entrepreneurial activities by establishing connections with platform participants that are connected to digital platforms and hold auxiliary complementary resources. On the one hand, while important information such as policies and taxes may not directly impact the survival of entrepreneurial enterprises, they can influence their acquisition of funds and the conduct of business, providing support for entrepreneurial enterprises. However, many entrepreneurial enterprises lack the experience and channels to obtain relevant information and may even lack essential professionals in finance, business services, and other areas. As a result, they fail to timely access such information, thus facing increased entrepreneurial costs and risks. Platform's auxiliary complementarity capability of digital industrial parks can assist entrepreneurial enterprises in acquiring important information related to policies, finance, taxes, and others. It can also connect relevant complementary parties to provide government services, business services, tax services, and more for entrepreneurial enterprises, thereby enhancing the success rate of these enterprises (Du et al., 2020; Stam, 2015). On the other hand, robust infrastructure is equally crucial in enhancing the performance of entrepreneurial enterprises. High-quality infrastructure, living facilities, and life services not only enhance the daily operational efficiency of entrepreneurial enterprises but also increase communication and collaboration efficiency between these enterprises and other counterparts, assuring attracting more platform participants (Cumming et al., 2019). Hence, the auxiliary complementarity capability of digital platforms can also enhance the direct entrepreneurial performance of entrepreneurial enterprises.

In conclusion, this study puts forward Hypothesis 1a:

Hypothesis 1a: Digital platform complementarity capability positively promotes direct entrepreneurship empowerment performance.

Digital platform complementarity capability not only directly enhances the performance of entrepreneurial enterprises but also improves the efficiency of the entrepreneurial process services provided by digital parks for these enterprises. From the perspective of the platform's core complementarity capability, by collaborating with platform participants that provide complementary resources critical to innovative and entrepreneurial activities on the platform, entrepreneurial enterprises realize the increment of value and attract more entrepreneurial enterprises from related fields to join the platform. Furthermore, more entrepreneurial enterprises attract more companies with vital complementary resources for innovative and entrepreneurial activities to become platform complementary parties. Therefore, digital platforms in industrial parks establish a multilateral network effect, continuously attracting innovative complementary parties and entrepreneurial enterprises from various domains. This further enhances the attractiveness of digital platforms for entrepreneurial enterprises, enabling these enterprises to access more necessary resources on the platform and leading to increased satisfaction with the entrepreneurial process.

From the perspective of the platform's auxiliary complementarity capability, by providing services such as policies, financial and tax information, business services, and other supporting services for entrepreneurial enterprises, digital industrial parks create a favorable business environment and nurture a conducive commercial atmosphere for enterprises. Entrepreneurial enterprises cannot merely access pertinent information from external organizations linked to digital platforms but can also engage in organizational learning by communicating with other entrepreneurial enterprises within the industrial park.

This allows them to accumulate experience in entrepreneurial activities, thereby continuously advancing the virtuous cycle of entrepreneurial activities in the industrial park (Li Zhenhua & F. Li, 2018). Simultaneously, a favorable living environment and infrastructure assure information exchange and office life for entrepreneurial enterprises, stimulating their enthusiasm and satisfaction for innovation and entrepreneurship (Cumming et al., 2019).

To sum up, this study proposes Hypothesis 1b:

Hypothesis 1b: Digital platform complementarity capability positively promotes indirect entrepreneurship empowerment performance.

4.1.1.2 Research on platform integration capability and entrepreneurship empowerment performance

Building on the core complementarity resources and auxiliary complementarity resources provided by platform complementary parties linked to digital platforms to entrepreneurial enterprises, platform enterprises (i.e., park management enterprises) further integrate internal and external resources to enhance the matching of resources for both internal and external participants and provide industry-specific and service-specific services, thus empowering entrepreneurial enterprises.

Firstly, platform enterprises with platform integration capability integrate internal and external resources linked to digital platforms. Research on entrepreneurial ecosystems indicates that the resources needed by entrepreneurial enterprises exhibit distinct heterogeneous characteristics, placing demands on the resource allocation capabilities of leaders within the entrepreneurial ecosystem. Platform enterprises with platform integration capability can effectively organize internal and external resources, thereby helping entrepreneurial enterprises identify and connect the needed resources based on a comprehensive understanding of the needs of entrepreneurial enterprises. This helps enhance resource allocation efficiency (Helfat & Raubitschek, 2018; Teece, 2018). In rapidly changing market environments, platform enterprises can continuously monitor changes in the external market based on the scalability of digital platforms. They can connect and integrate changing partner networks according to the needs of entrepreneurial enterprises, enabling enterprises to address challenges from the external environment (Baldwin, 2012; Marion et al., 2015; Weill & Ross, 2009). Furthermore, platform integration capability can enhance communication among the platform's internal and external participants and promote the alignment of resources, capabilities, activities, and goals by designing integrated architectures effectively, enabling entrepreneurial enterprises to collaborate smoothly with complementary parties through sufficient communication (Gonzalez et al., 2018; Wareham et al., 2014).

Moreover, based on resource integration, platform enterprises with platform integration capability organize and restructure platform resources to provide the resources necessary for the industrial development of entrepreneurial enterprises. On the one hand, the complementary resources provided by digital platform complementary parties may not meet the actual needs of entrepreneurial enterprises. This is because these participants are often third-party service organizations serving the entire industry, and they may have a limited understanding of specific industries. In contrast, platform enterprises on digital platforms of industrial parks can leverage their in-depth understanding of entrepreneurial enterprises and their accumulated industry-specific knowledge and expertise from prolonged engagement in industry-specific entrepreneurial incubation activities. They can integrate and restructure platform resources, thereby providing industrial resources that are better aligned with the specific needs of entrepreneurial enterprises. This provides a smooth channel for the conversion and application of external knowledge resources, enhancing the efficiency of resource utilization for entrepreneurial enterprises (Rai & Tang, 2010). Also, in a rapidly evolving business environment, the complementary resources provided by participants in digital platforms require real-time adjustments and supplements. This calls for platform enterprises to be able to promptly identify opportunities and threats in industry development, proactively bring in platform participants that better meet requirements by adjusting platform architecture and rules, and coordinate relationships among new participants (Boudreau, 2017; Helfat & Raubitschek, 2018). By following this approach, digital platforms can consistently offer entrepreneurial enterprises complementary resources that align with the current industry development needs, ultimately elevating the long-term competitive edge of these enterprises (W. Liu et al., 2024; Wilden et al., 2016).

Lastly, platform enterprises with platform integration capability continuously optimize platform architecture and governance models to provide professional services for entrepreneurial enterprises. Digital platforms provide enterprises with a shared space, enabling them to integrate new knowledge and ideas with partners at low cost and high efficiency, unrestricted by time and space. However, this requires robust digital infrastructure, suitable digital platform architecture, and an effective governance model as support. Platform enterprises with high integration capability can effectively manage these elements (Jacobides et al., 2018; Tiwana, 2010). In terms of digital infrastructure and platform architecture, platform enterprises with high integration capability can adjust platform modules and interfaces promptly based on the needs of entrepreneurial enterprises, thereby enhancing the efficiency of information acquisition and business operations for the enterprises on platforms. Regarding platform governance models, platform enterprises with high integration capability can establish authoritative transaction rules and behavioral patterns tailored to platform business operations. They can also offer guidelines for potential conflicts among internal and external participants, thereby providing environmental protection and institutional support for cooperation between entrepreneurial enterprises and platform participants, ultimately increasing the likelihood of collaboration success (Cenamor et al., 2017).

In conclusion, this study proposes hypothesis 2a:

Hypothesis 2a: Digital platform integration capability positively promotes direct entrepreneurship empowerment performance.

As digital platform complementarity capability enhances direct entrepreneurial enterprise empowerment performance, it also improves the effectiveness of entrepreneurial process services provided by digital parks for entrepreneurial enterprises. Firstly, by integrating and coordinating complementary resources from platforms, entrepreneurial enterprises can quickly and accurately identify, acquire, and apply the resources needed for their innovative and entrepreneurial activities. This reduces the expenditure for enterprises in terms of resource searching and costs, as well as the trial-and-error costs for enterprises. This allows entrepreneurial enterprises to focus on their core operations, enhancing the overall experience of enterprises in entrepreneurial activities and hence improving platform service efficiency (Wu et al., 2014).

Furthermore, through the restructuring of complementary resources on platforms, entrepreneurial enterprises can perceive opportunities and threats that may exist in entrepreneurial activities. This helps enterprises obtain market information related to customer needs and competitive intelligence, stimulating entrepreneurial enterprises to create new knowledge and generate new ideas. This not only reduces risks in conducting entrepreneurial activities for enterprises but also enhances the ability and likelihood of entrepreneurial enterprises seizing opportunities. It boosts the innovative vitality and entrepreneurial enthusiasm of entrepreneurial enterprises (Agarwal & Selen, 2009; Mikalef & Pateli, 2017).

Furthermore, by offering professional services, entrepreneurial enterprises engaging in innovative and entrepreneurial activities can integrate new knowledge and ideas with partners without being constrained by time and space. This integration can be achieved at low cost and high efficiency. Entrepreneurial enterprises are no longer confined to tedious daily operational tasks. This enhances enterprises' operational efficiency and increases the sense of happiness for entrepreneurial enterprises in the entrepreneurial process.

Lastly, digital platform integration capability can also generate stronger positive cross-side network effects within digital platforms. After the gap between entrepreneurial enterprises and platform participants with complementary resources is bridged, transaction costs on platforms are significantly reduced. This means that entrepreneurial enterprises can engage in transactions with a greater number of complementary resource providers. This enables platforms to attract a greater quantity and a more comprehensive variety of platform participants, continuously expanding complementary resources and services to broaden the platforms' scope. Consequently, they can provide entrepreneurial enterprises with more comprehensive and attractive resources and services (Helfat & Raubitschek, 2018). Therefore, platform enterprises with better platform integration capability can enhance platforms' overall value creation and create a positive cycle by strengthening positive network effects. This will continuously improve the attractiveness of digital platforms to entrepreneurial enterprises and the satisfaction of these enterprises.

In conclusion, this study proposes hypothesis 2b:

Hypothesis 2b: Digital platform integration capability positively promotes indirect entrepreneurship empowerment performance.

4.1.1.3 Research on platform complementarity capability, platform integration capability, and entrepreneurship empowerment performance

Platform complementarity capability enables platform enterprises to leverage their resource integration capability more effectively, offering entrepreneurial enterprises more efficient, industry-aligned, and professional entrepreneurial services. This enhances the resource utilization efficiency of entrepreneurial enterprises and, ultimately, improves entrepreneurship empowerment performance. On the one hand, with the gradual enhancement of platform complementarity capability, the connection depth and breadth of platform enterprises with core complementary parties and auxiliary complementary parties continue to increase. This allows platform enterprises to continuously acquire core market knowledge and technical expertise through organizational learning based on ongoing connections. Moreover, they continually accumulate capabilities in business and other auxiliary services (Fu et al., 2024). This enables platform enterprises to further understand complementary enterprise resource and service content as well as the needs of entrepreneurial enterprises. With a more targeted approach to coordinating and integrating needs and resources, platform enterprises can offer specialized industry services based on the industrial needs of entrepreneurial enterprises. This ultimately enhances the efficiency and precision of resource allocation (Beltagui et al., 2020; Nambisan & Sawhney, 2011).

On the other hand, with the gradual enhancement of platform complementarity capability, platform enterprises accumulate extensive experience and abilities in communicating with platform participants. This allows them to identify potential conflicts and risks in cooperation between platform complementary parties and entrepreneurial enterprises, and to prevent them through effective platform system design. Platform enterprises thus can provide professional services such as demand matching and industrial resource supply more efficiently and ensure cooperation between entrepreneurial enterprises and complementary parties (Brahm & Tarzijan, 2016). At the same time, while linking complementary resources, platform enterprises can generate economic returns and continually invest in platform infrastructure development. This empowers platforms to deliver a more user-friendly and boundary-based platform interface, as well as more efficient key facilities like data storage, processing, and cloud services, hence smoother and more convenient communication between complementary parties and entrepreneurial enterprises (Clarysse et al., 2014). Therefore, the professional service level of platform enterprises is further enhanced. This not only improves the cooperation efficiency of entrepreneurial enterprises but also enhances the overall user experience of entrepreneurial enterprises using platform services.

The platform integration capability can stimulate platforms to acquire more complementary resources and expand and enhance the range and quality of resources available to entrepreneurial enterprises, thereby providing support and assurance for the sustainable development of the entrepreneurial ecosystem. On the one hand, platform enterprises with better platform integration capability can enhance the alignment between platform complementary parties' resources and entrepreneurial enterprises' needs, coordinate the collaborative process, and reduce cooperation friction, thus facilitating more partnerships (Baldwin & Clark, 2000; Wareham et al., 2014). This encourages more enterprises with complementary resources to join digital platforms and establish cooperative relationships with entrepreneurial enterprises. The depth and breadth of the relationships between entrepreneurial enterprises and platform complementary parties are significantly enhanced as a result. This injects new elements into the innovative and entrepreneurial activities of entrepreneurial enterprises, inspiring entrepreneurial enterprises to generate new ideas and solutions. It significantly enhances the efficiency of these enterprises' innovative and entrepreneurial activities.

On the other hand, platform enterprises with better platform integration capability can leverage their industry expertise and service professionalism to build a strong reputation, making digital platforms an effective resource aggregation and information communication medium, thus attracting more complementary resource providers and entrepreneurial enterprises. This further stimulates the network effects of digital platforms, continuously expanding their scale and supporting the long-term sustainable growth of digital platforms. As a result, entrepreneurial enterprises not only benefit from deeper and stronger complementary relationships but also profit from the endorsement effect brought by the reputation overflow of digital platforms. This ensures continuous support from digital platforms throughout long-term development (Cennamo & Santalo, 2019).

In conclusion, this study proposes hypothesis 3a and hypothesis 3b.

Hypothesis 3a: The interaction between platform integration capability and complementary capability significantly promotes direct entrepreneurship empowerment performance.

Hypothesis 3b: The interaction between platform integration capability and complementary capability significantly promotes indirect entrepreneurship empowerment performance.

4.1.2 Research on digital platform capabilities, basic standardized systems, and entrepreneurship empowerment performance

4.1.2.1 Platform complementarity capability, project-based operating system, and entrepreneurship empowerment performance

Basic standardized systems refer to standardized management systems of industrial parks. Specifically, basic standardized systems include a project-based operating system and a collaboration ecosystem. The project-based operating system involves the professional management of each industrial park conducted by project teams possessing strong professional expertise and service quality. These teams provide continuous, long-term, and professional services centered around project themes. The collaboration ecosystem emphasizes cross-industry and cross-domain collaboration, where platform enterprises, platform participants with complementary resources, entrepreneurial enterprises, and other entities form an entrepreneurial ecosystem to achieve synergistic interaction. It can be seen that the project-based operating system and the collaboration ecosystem respectively represent management systems at the project level and ecosystem level.

The project-based operating system divides project teams based on industrial boundaries, with specialized operational teams being responsible for each project team. Members of the operational teams often possess industry-specific knowledge and skills in business and information services. They serve as facilitators, promoting the communication of platform owners with platform-based complementary enterprises and entrepreneurial enterprises. On the one hand, project teams can leverage their expertise and skills to establish an understanding of platform-linked complementary resources, assisting in the transfer and diffusion of resources and technologies (Fichter & Beucker, 2012). This enables the platform to effectively allocate resources after linking complementary resources so that complementary resources can effectively serve the needs of entrepreneurial enterprises.

On the other hand, the project-based operating system allows industrial parks to present a unified front in external communications, engaging with platform complementary parties in a project format. This approach enhances both the platform's efficiency and experience of entrepreneurship empowerment from two perspectives. Firstly, industrial parks serve as an endorsement for project teams, allowing platform complementary parties to perceive themselves as serving the entire industrial park rather than individual entrepreneurial enterprises. This reduces the negative impact of uncertainties brought by the liability of newness of individual entrepreneurial enterprises for platform complementary parties. It mitigates the concerns of platform complementary parties, making them more willing to serve entrepreneurial enterprises (Nooteboom, 2013; Sun & Wei, 2019). Secondly, project teams reduce the friction that may arise when platform complementary parties communicate one-on-one with entrepreneurial enterprises, avoiding the inefficiency issues caused by platform complementary parties coordinating the personalized demands of entrepreneurial enterprises. This not only makes collaboration easier to achieve and improves collaboration efficiency but also enhances the perception of entrepreneurial enterprises in using platform complementary parties' resources and services (Howells, 2006).

In conclusion, this study proposes hypotheses 4a and 4b:

Hypothesis 4a: The project-based operating system promotes a positive correlation between platform complementarity capability and direct entrepreneurship empowerment performance.

Hypothesis 4b: The project-based operating system promotes a positive correlation between platform complementarity capability and indirect entrepreneurship empowerment performance.

4.1.2.2 Platform integration capability, project-based standardized systems, and entrepreneurship empowerment performance

The project-based operating system not only fosters connections between entrepreneurial enterprises and platform complementary parties on digital platforms but also deepens the platform owner's comprehension of both parties. This ensures that the industry-specific services and platform-specific services provided by digital platforms to entrepreneurial enterprises are more tailored to the actual needs of these enterprises. On the one hand, project teams, through long-term dedication to the development of specific industrial parks, have accumulated rich industry-specific knowledge and skills. They have a comprehensive understanding of the positions of park enterprises within the industry chains and their developmental needs. This enables them to develop core service capabilities tailored to specific industries, making resource matching and connections more efficient. The industry services provided by platforms are more professional, thereby improving the direct empowerment of platform integration capability to entrepreneurial enterprises (Hlefat & Raubitschek, 2018).

Moreover, the project-based operating system ensures the provision of long-term, sustainable services to entrepreneurial enterprises, thus elevating the indirect empowerment of platform integration capability to entrepreneurial enterprises. By maintaining contact with entrepreneurial enterprises through meetings and other channels, responding promptly to their needs, establishing archives for entrepreneurial enterprises, and offering full-lifecycle services, project teams can establish a continuous service flow for entrepreneurial enterprises. This ensures that services are delivered professionally and efficiently. In the long-term and continuous service process, the increasingly close relationship between project teams and entrepreneurial enterprises allows for a deep understanding of the enterprises. This enables the platforms to consistently provide the most appropriate resources and services for these entrepreneurial enterprises, thereby significantly enhancing the service efficiency of digital platforms.

In conclusion, this study proposes hypotheses 5a and 5b:

Hypothesis 5a: The project-based operating system promotes a positive correlation between platform integration capability and direct entrepreneurship empowerment performance.

Hypothesis 5b: The project-based operating system promotes a positive correlation between platform integration capability and indirect entrepreneurship empowerment performance.

4.1.2.3 Platform complementarity capability, collaboration ecosystem, and entrepreneurship empowerment performance

The collaboration ecosystem emphasizes cross-industry and cross-domain collaboration to address the diverse, all-element, and whole-process needs of entrepreneurial enterprises. Platform enterprises, platform participants with complementary resources, entrepreneurial enterprises, and other entities collaborate to form an ecosystem of elements (points), links (lines), and platforms (planes), meeting the growth and development requirements of enterprises. On the one hand, the collaboration ecosystem can form a resource pool that sparks resource synergy effects. Especially in dynamic and uncertain environments, the aggregation of resources from different industries and domains provides entrepreneurial enterprises with new information and creativity. This assistance enables the expansion of entrepreneurial enterprises' existing business scope, thereby enhancing their resilience to risks (Attour & Barbaroux, 2015). Hence, the cross-domain overlay of platform complementary resources generates a "1+1>2" effect, promoting the role of platform complementarity capability in enterprises' entrepreneurship empowerment performance.

On the other hand, the collaboration ecosystem can also increase the overall value of digital platforms by aggregating platform complementary parties from different industries and regions to attract a wider range of participants. With the continuous increase in the types and numbers of platform complementary parties and the expansion of the ecosystem, the reputation of digital platforms also rises. This further promotes the formation of a good cooperative relationship between entrepreneurial enterprises and platform complementary parties, reducing concerns of platform complementary parties about various factors such as business scale regarding newly built enterprises. In this way, the willingness of platform complementary parties to invest resources and participate is enhanced. Simultaneously, with the continuous and healthy development of the ecosystem, entrepreneurial enterprises can cultivate a conducive business environment where the efficiency of entrepreneurial process services and entrepreneurial activities is further enhanced (Cennamo & Santalo, 2019).

In conclusion, the study proposes hypothesis 6a and hypothesis 6b.

Hypothesis 6a: The collaboration ecosystem promotes a positive correlation between platform complementarity capability and direct entrepreneurship empowerment performance.

Hypothesis 6b: The collaboration ecosystem promotes a positive correlation between platform complementarity capability and indirect entrepreneurship empowerment performance.

4.1.2.4 Platform integration capability, collaboration ecosystem, and entrepreneurship empowerment performance

By establishing a cross-industry and cross-regional collaboration ecosystem, platform enterprises have enhanced their ability to provide industry-specific services and platform-based professional services for entrepreneurial enterprises. By integrating core complementary resources from different industries, platform enterprises can establish their knowledge base and methodology, enabling them to help entrepreneurial enterprises find, link, and reconstruct resources more quickly and effectively. Moreover, by integrating auxiliary complementary resources from different domains and areas, platform enterprises can accumulate a wide range of experience in business, support, and information services, providing entrepreneurial enterprises with higher-quality entrepreneurial services (Isenberg et al., 2011; Oh et al., 2016). Therefore, the collaboration ecosystem can enhance platform enterprises' experience, knowledge, and service levels, thereby improving the role of platform integration capability in direct entrepreneurship empowerment performance.

By creating a collaboration ecosystem that connects platform enterprises, platform complementary parties, and entrepreneurial enterprises, all parties gain a deeper understanding of each other's needs and challenges. This helps platform enterprises establish beneficial cooperative relationships between platform complementary parties and entrepreneurial enterprises more effectively, ultimately enhancing the overall value of the platforms. This also allows all participants on the platform to have a better service experience through platform collaboration (Jacobides et al., 2018). Therefore, the collaboration ecosystem can promote the formation of beneficial cooperative relationships and enhance the role of platform integration capability in promoting indirect entrepreneurship empowerment performance.

Therefore, this study proposes hypotheses 7a and 7b:

Hypothesis 7a: The collaboration ecosystem promotes a positive correlation between platform integration capability and direct entrepreneurship empowerment performance.

Hypothesis 7b: The collaboration ecosystem promotes a positive correlation between platform integration capability and indirect entrepreneurship empowerment performance.

4.2 Research Design

4.2.1 Questionnaire design

In this study, the research hypotheses involve constructs that cannot be directly observed, so questionnaires were used to measure the aforementioned constructs. The questionnaire was designed according to the suggestions of Dunn and Steaker (1994) as follows:

(1) Formation of the first questionnaire draft. Based on the results of case studies and existing theoretical literature, this study proposed a theoretical model. Since the independent, moderating, and dependent variables in this study are based on the results of the case studies and exhibit similarities and differences with existing constructs, questionnaire items were designed by integrating existing scales with the results of the case studies.

(2) Modification of the questionnaire. After drafting the initial version, I sought feedback from scholars in the field of entrepreneurial ecosystem research and digital platform research at Zhejiang University. Additionally, input was gathered from MBA students with entrepreneurial ecosystem work experience, as well as the management team of the Zhixin Zedi Industrial Park and enterprises within the park. The former provided theoretical assurance for the reliability and validity of the questionnaire, while the latter ensured that

questionnaire respondents could quickly and fully understand the questionnaire items in practice. After feedback was obtained, the questionnaire measure items and statements were adjusted to further enhance the reliability and validity of the questionnaire.

(3) Finalization of the questionnaire. After the questionnaire was modified, a small-scale trial questionnaire filling activity was conducted at the Zhixin Zedi Industrial Park, and then some measure items were removed based on the reliability and validity test results from the small sample, thereby finalizing the questionnaire.

(4) Avoidance of common method bias. This study took the following measures. Firstly, in the questionnaire design, antonymous items and sequential changes were employed to adjust the order of questionnaire items, resulting in five different versions of the questionnaire. These versions were randomly distributed to different respondents to reduce their habitual thinking. Secondly, in this study, the industrial park management team sent out emails to recruit questionnaire respondents. The study utilized anonymous surveys and informed participants that there were no right or wrong answers in the questionnaire results. The data would be used solely for academic research purposes, and the research team would ensure the confidentiality of all information provided. This approach aimed to eliminate concerns about information leakage from respondents and enhance the quality of questionnaire responses. Finally, this study employed cross-validation of subjective and objective data. For instance, when measuring entrepreneurship empowerment performance, participants were asked to respond to subjective items ("The efficiency of starting and running the company has improved," etc.) along with objective data (such as

compound growth rate over the past three years, number of patent applications, etc.). This approach aimed to further enhance the quality of the data.

4.2.2 Measure of variables

The variables in this study include independent variables (platform complementarity capability and platform integration capability), moderating variables (project-based operating system and collaboration ecosystem), dependent variables (direct entrepreneurship empowerment performance and indirect entrepreneurship empowerment performance), and control variables (industry type, enterprise size, enterprise age, government subsidies, number of patents, enterprise revenue, and annual revenue growth rate). In this study, the 5-Point Likert Scale was utilized to measure each item in the questionnaire. The scale ranges from 1 to 5, with “1” for “Completely Inconsistent,” “2” for “Relatively Inconsistent,” “3” for “Neutral,” “4” for “Relatively Consistent,” and “5” for “Completely Consistent.”

4.2.2.1 Measure of independent variables

The independent variables in this study consist of two constructs: platform complementarity capability and platform integration capability. Platform complementarity capability refers to digital platforms connecting complementary parties with core complementary resources and auxiliary complementary resources, providing complementary resources for entrepreneurial enterprises. The existing literature provides references and inspiration for the design of this questionnaire item on the types of resources in the entrepreneurial ecosystem (Isenberg et al., 2011; Spigel, 2017). This study, in conjunction with the results of case studies, measures platform complementarity capability through the following five items.

Table 4.1 Items for Measuring Platform Complementarity Capability

Code	Item	References
HBNL1	The digital platforms of sci-tech industrial parks provide us with space services.	Results of case studies; Isenberg, 2011; Spigel, 2017
HBNL2	The digital platforms of sci-tech industrial parks provide us with resources and services needed for R&D (such as technical resources, talent resources, and patent services).	
HBNL3	The digital platforms of sci-tech industrial parks provide us with resources and services needed for market development (such as market resources and financing services).	
HBNL4	The digital platforms of sci-tech industrial parks provide us with information services (such as policy consulting, finance, and taxation services).	
HBNL5	The digital platforms of sci-tech industrial parks provide us with supporting services (such as life-supporting services, business services, and information services).	

Platform integration capability refers to the ability of platform enterprises to integrate and restructure internal and external resources within the platform, providing entrepreneurial enterprises with industry-specific and service-specialized services. Based on the existing literature frameworks on resource integration (Grant, 1996; Li Zhenhua et al., 2019) and discussions on platform integration capabilities (Cenamor et al., 2019), this study, combining with the results from case studies, measures platform integration capability through the following five items.

Table 4.2 Measure Items for Platform Integration Capability

Code	Item	References
ZHNL1	The digital platforms of sci-tech industrial parks integrate resources and service information both within and outside the parks, enabling us to identify/understand the resources and services available for use.	Case study results; Cenamor et al., 2019; Grant,1996; Li Zhenhua et al., 2019;
ZHNL2	The digital platforms of sci-tech industrial parks can link resources and services inside and outside the parks, enabling us to obtain needed resources and services.	
ZHNL3	The digital platforms of sci-tech industrial parks can reconstruct the resources and services integrated by the platforms, providing us with resources and services that meet our needs.	
ZHNL4	The digital platforms of sci-tech industrial parks can provide us with industry-related resources and services based on the platforms-integrated resources and services.	
ZHNL5	The digital platforms of sci-tech industrial parks can coordinate the platforms-integrated resources and services, providing us with professional platform services.	

4.2.2.2 Measure of moderating variables

The moderating variables in this study include two constructs: project-based operating system and collaboration ecosystem. The project-based operating system refers to the professional management of an industrial park by project teams to provide professional and continuous services for entrepreneurial enterprises. The existing literature discussing incubators and industrial park management (Bergek & Norrman, 2008; Scillitoe & Chakrabarti, 2010; Wu & Feng, 2021) serves as a reference and inspiration for designing this item. This study, in conjunction with case study results, measures the project-based operating system through the following five items.

Table 4.3 Items for Measuring Project-based Operating System

Code	Item	References
XMH1	The park's project teams have a deep understanding of industry development trends and needs.	Results of case studies; Bergek & Norrman, 2008; Scillitoe & Chakrabarti, 2010; Wu & Feng, 2021
XMH2	The park's project teams can provide various services required by enterprises at all stages.	
XMH3	The park's project teams regularly hold meetings with us and utilize various other forms of communication.	
XMH4	The digital platform staff of sci-tech industrial parks possess excellent professional qualities (e.g., familiarity with park operations, understanding of industry conditions, and capability to facilitate business connections).	
XMH5	The digital platform staff of sci-tech industrial parks exhibits good service quality (e.g. prompt response and friendly attitude).	

Collaboration ecosystem refers to multiple entities such as platform enterprises, platform participants with complementary resources, and entrepreneurial enterprises forming an entrepreneurial ecosystem to achieve synergies across industries and domains. The existing literature discussing entrepreneurial collaboration ecosystems and enterprise network cooperation provides reference and inspiration for designing this item (Cenamor et al., 2019; Den Hartigh, 2006; Xiang et al., 2021). This study, in conjunction with case study results, measures the collaboration ecosystem through the following five items.

Table 4.4 Items for Measuring Collaboration Ecosystem

Code	Item	References
XTH1	In sci-tech industrial parks, we can collaborate with multiple enterprises within and outside the parks.	Results of case studies; Cenamor et al., 2019; Den Hartigh, 2006; Xiang et al., 2021
XTH2	In sci-tech industrial parks, we can form long-term collaborations with partners within and outside the parks.	
XTH3	In sci-tech industrial parks, we frequently engage in discussions with partners within and outside the parks on how to achieve mutual benefits and reciprocity.	
XTH4	In sci-tech industrial parks, we can establish complementary relationships with partners both inside and outside the parks.	
XTH5	In sci-tech industrial parks, we can collaborate with partners in different fields/industries inside and outside the parks.	

4.2.2.3 Measurement of dependent variables

The dependent variables in this study are “direct entrepreneurship empowerment performance” and “indirect entrepreneurship empowerment performance.” Specifically, “direct entrepreneurship empowerment performance” refers to the performance of entrepreneurial enterprises after they enter sci-tech industrial parks. The existing literature provides a basis for designing items, as it measures the entrepreneurship ecosystem and the performance of entrepreneurial enterprises in industrial parks (Eveleens et al., 2017; Y. Li & Zhang Yanming, 2012). This study incorporates findings from case studies and evaluates the “project-based operating system” using the following five items.

Table 4.5 Items of Direct Entrepreneurship Empowerment Performance

Code	Item	References
ZJJX1	After entering parks, enterprises have enhanced their entrepreneurial and operational efficiency.	Results of case studies; Eveleens et al., 2017; Y. Li & Zhang Yanming, 2012
ZJJX2	After entering parks, enterprises have increased their market shares.	
ZJJX3	After entering parks, enterprises have boosted their return on investment and profit margins.	
ZJJX4	After entering parks, enterprises have increased the growth rate of sales revenue.	
ZJJX5	After entering parks, enterprises have enhanced their capability and level of technological innovation.	

"Indirect entrepreneurship empowerment performance" refers to the perceived service efficiency in sci-tech industrial parks by entrepreneurial enterprises during their entrepreneurial process. The exploration of industrial park evaluation in existing literature provides a reference for designing items (H. Wang, 2022). This study combines findings from case studies to measure the "project-based operating system" using the following five items.

Table 4.6 Items of Indirect Entrepreneurship Empowerment Performance

Code	Item	References
JJJX1	We are satisfied with the space provided by the platform in the entrepreneurial process.	Wang, H. (2022). Research on the competitiveness of Xi'an High-tech Industries Development Zone from the perspective of innovation and entrepreneurship ecosystem. *Management & Technology of SME*, (16), 40-42.
JJJX2	We are satisfied with the industry-related services provided by the platform in the entrepreneurial process.	
JJJX3	We are satisfied with the platform information services provided by the platform in the entrepreneurial process.	
JJJX4	We are satisfied with the living supporting services provided by the platform in the entrepreneurial process.	
JJJX5	We are willing to keep using the resources and services offered by the platform.	

4.2.2.4 Control variables

To more accurately analyze the relationship between digital platform capabilities, basic standardized systems, and entrepreneurship empowerment performance, this study sets control variables at both the industry and enterprise levels. A total of eight control variables are included: industry type (including whether it is a service industry or a high-tech industry), enterprise size, enterprise age, amount of government subsidies, number of patents, enterprise revenue, and annual growth rate of revenue.

4.3 Hypothesis Testing

4.3.1 Data collection and sample

4.3.1.1 Sample

This study focuses on the relationship between the digital platform capability system and entrepreneurship empowerment performance in digital industrial parks. Therefore, the sample consists of entrepreneurial enterprises in these parks. The sample collection criteria are as follows: (1) To enhance the accuracy of respondents' evaluations of digital platform capabilities, sample enterprises must have used the digital platforms provided by parks where they operate in the past three years. (2) Sample enterprises should be those that have engaged or are engaging in entrepreneurial activities in digital industrial parks. (3) Considering the diversity of entrepreneurial enterprises, this study does not impose further restrictions on industry, region, size, or other factors.

4.3.1.2 Data collection

The questionnaire for this study was distributed over three months, from March 2024 to May 2024. A total of 370 questionnaires were distributed through online and offline channels with the assistance of park management enterprises. Out of these, 291 questionnaires were collected. After 39 invalid questionnaires were excluded, 252 valid questionnaires were obtained, accounting for 68.1% of the total collected.

The criteria for excluding invalid questionnaires are as follows: (1) The questionnaire is incomplete or key variables are not filled in by the respondent. (2) All items in the questionnaire are filled with the same value. (3) The online questionnaire is completed in a short time. The basic information of the final sample is shown in Table 4.7.

Table 4.7 Distribution of Sample Characteristics (N=252)

Sample characteristics	Enterprise characteristics	Number of samples	Proportion
Enterprise age	1-2 years	99	39.29
	3-4 years	55	21.82
	5-10 years	77	30.56
	11-20 years	16	6.35
	20+ years	5	2.00
Number of employees	1-12 employees	32	12.69
	13-25 employees	103	40.86
	26-50 employees	89	35.34
Number of employees	51-100 employees	21	8.35
	100+ employees	7	2.80
Industry	High-tech industry	91	36.11
	Non-high-tech industry	161	63.89
	Manufacturing industry	15	5.95
	Service industry	237	94.05

Regarding enterprise age, 60% of the enterprises have operated for over two years. About 50% of the respondents' enterprises have fewer than 25 employees, 35% have 26-50 employees, and around 11% have more than 50 employees. In terms of industry classification, enterprises from high-tech industries account for 36.11%, while those from non-high-tech industries account for 63.89%. Specifically, manufacturing enterprises make up 5.95% and service enterprises constitute 94.05%.

4.3.1.3 Descriptive statistical analysis

The mean value, standard deviation, skewness, kurtosis, and Pearson correlation coefficient of the independent variables, intermediary variables, dependent variables, and control variables involved in this study are presented in Table 4.8. The mean values of the variables range from .007 to 5.690, and the standard deviations range from .025 to 5.061. The dependent and independent variables are positively correlated, with significant correlation coefficients at the .05 level and specific values less than .75. Therefore, it is inferred that while there is a correlation between the variables, no multicollinearity exists.

4.3.2 Reliability and validity tests

4.3.2.1 Reliability test

First, the questionnaire was tested for reliability. Given the dimensions of integration and complementarity capabilities of independent variables, the project- and collaboration-based features of moderating variables, and the Cronbach's α between the direct and indirect performance of dependent variables are greater than .8, indicating that the measurements exhibit good internal consistency. The specific testing results are shown in Table 4.9.

Table 4.8 Statistical Description

	Mean value	Standard deviation	Number of employees (log)	Enterprise age (log)	Number of patents (log)	Annual revenue (log)	Industry	High-tech	Revenue growth	Government subsidies	Integration capability	Complementarity capability	Project-based	Collaboration-based	Direct performance	Indirect performance
Enterprise size (log)	3.243	.759	1.000													
Enterprise age (log)	1.468	.75	.161*	1.000												
Number of patents (log)	.671	.887	.300**	.211**	1.000											
Annual revenue (log)	5.69	1.15	.569**	.209**	.151*	1.000										
Industry	.94	.237	-.017	-.001	.009	-.024	1.000									
High-tech	.361	.481	.432**	-.004	.475**	.080	-.090	1.000								
Revenue growth	.007	.025	.081	.046	.178**	.069	.012	.027	1.000							
Government subsidy	.857	5.061	.026	.012	.093	.024	.026	-.036	.454**	1.000						
Integration capability	4.487	.496	-.048	.220**	.075	-.100	-.010	-.025	-.015	-.006	1.000					
Complementarity capability	4.437	.537	.013	.148*	.131*	-.055	.080	.057	.169**	.132*	.322**	1.000				
Project-based	4.598	.428	.122	.006	.086	.049	-.001	.147*	.121	.018	.024	.332**	1.000			
Collaboration-based	4.687	.478	.034	-.085	.067	-.031	.018	.141*	.061	-.006	.193**	.240**	.396**	1.000		
Direct performance	4.01	.697	-.075	.173**	.047	-.169**	.105	-.008	.086	.086	.713**	.613**	.195**	.211**	1.000	
Indirect performance	4.183	.657	.107	.047	.192**	-.027	-.063	.184**	.111	.063	.457**	.523**	.549**	.430**	.503**	1.000

Table 4.9 Cronbach's Alpha Reliability Analysis of Measurement Scale Primary Variables (N=252)

	Item	Corrected item total correlation	Cronbach's α if item is deleted	Cronbach's α
ZHNL	ZHNL1	.851	.948	.954
	ZHNL2	.845	.949	
	ZHNL3	.948	.931	
	ZHNL4	.879	.943	
	ZHNL5	.846	.948	
HBNL	HBNL1	.786	.886	.909
	HBNL2	.730	.898	
	HBNL3	.760	.892	
	HBNL4	.768	.890	
	HBNL5	.811	.881	
XMH	XMH1	.790	.890	.912
	XMH2	.742	.900	
	XMH3	.836	.880	
	XMH4	.752	.897	
	XMH5	.762	.895	
XTH	XTH1	.792	.934	.939
	XTH2	.815	.928	
	XTH3	.843	.924	
	XTH4	.891	.915	
	XTH5	.914	.949	
ZJJX	ZJJX1	.890	.936	.952
	ZJJX2	.889	.936	
	ZJJX3	.844	.944	
	ZJJX4	.849	.943	
	ZJJX5	.859	.941	
JJJX	JJJX1	.907	.923	.945
	JJJX2	.804	.941	
	JJJX3	.919	.919	
	JJJX4	.905	.922	
	JJJX5	.734	.953	

4.3.2.2 Exploratory factor analysis

The suitability of the study variables for exploratory factor analysis was first verified. According to the Kaiser–Meyer–Olkin (KMO) test for sampling adequacy, the KMO value is .925, which exceeds the reference value of .7. Besides, Bartlett's sphericity test shows high significance. Thus, this study is deemed suitable for exploratory factor analysis.

Table 4.10 KMO and Bartlett's Tests

KMO value		. 925
Bartlett's sphericity test	Approximate chi-square	7,694.067
	df	435
Bartlett's sphericity test	P-value	0

The results of the exploratory factor analysis are shown in Table 4.11. The criteria adopted for this analysis are as follows: The extraction principle is that the eigenvalue must be greater than 1, the maximum number of rotation iterations is 25, and the rotation solution method used is the maximum variance method. The minimum factor loading coefficient for each item is .656, and the results pass the tests.

Table 4.11 Descriptive Statistics of Variables and Exploratory Factor Analysis Results (N=252)

Item	Descriptive statistics		Integration capability	Complementarity capability	Project-based	Collaboration-based	Direct performance	Indirect performance
	Mean value	Standard deviation						
ZHNL 1	4.365	.587	.817					
ZHNL 2	4.381	.604	.829					
ZHNL 3	4.488	.582	.902					
ZHNL 4	4.492	.582	.877					
ZHNL 5	4.456	.566	.862					
HBNL1	4.492	.589		.832				
HBNL2	4.516	.582		.749				
HBNL3	4.417	.583		.790				
HBNL4	4.496	.568		.828				
HBNL5	4.512	.575		.840				
XMH 1	4.591	.508			.806			
XMH 2	4.615	.504			.782			
XMH 3	4.567	.496			.866			
XMH 4	4.595	.492			.811			
XMH 5	4.619	.487			.799			
XTH1	4.702	.574				.845		
XTH2	4.706	.529				.854		
XTH3	4.694	.495				.857		
XTH4	4.683	.515				.904		
XTH5	4.647	.549				.869		
ZJJX1	4.012	.749					.672	
ZJJX2	4.004	.765					.681	
ZJJX3	3.984	.752					.686	
ZJJX4	4.032	.798					.662	
ZJJX5	4.016	.741					.656	
JJJX1	4.218	.671						.812
JJJX2	4.175	.769						.722
JJJX3	4.139	.726						.788
JJJX4	4.198	.692						.809
JJJX5	4.183	.767						.702

4.3.2.3 Confirmatory factor analysis

Confirmatory factor analysis (CFA) was primarily used to test the convergent validity and discriminant validity of the measurement questionnaire. High convergent validity requires that in the measurement model, the indicators of the same construct load onto the same factor. High discriminant validity requires that the square root of the average variance extracted (AVE) of a measure within a variable is greater than the correlation coefficient between that variable and other variables, indicating that the constructs are distinct. Through this analysis, the data from 252 valid questionnaires can be tested for the appropriateness and realness of model construction validity.

The CFA model is shown in Figure 4.1, and the analysis results are presented in Tables 4.12 and Table 4.13.

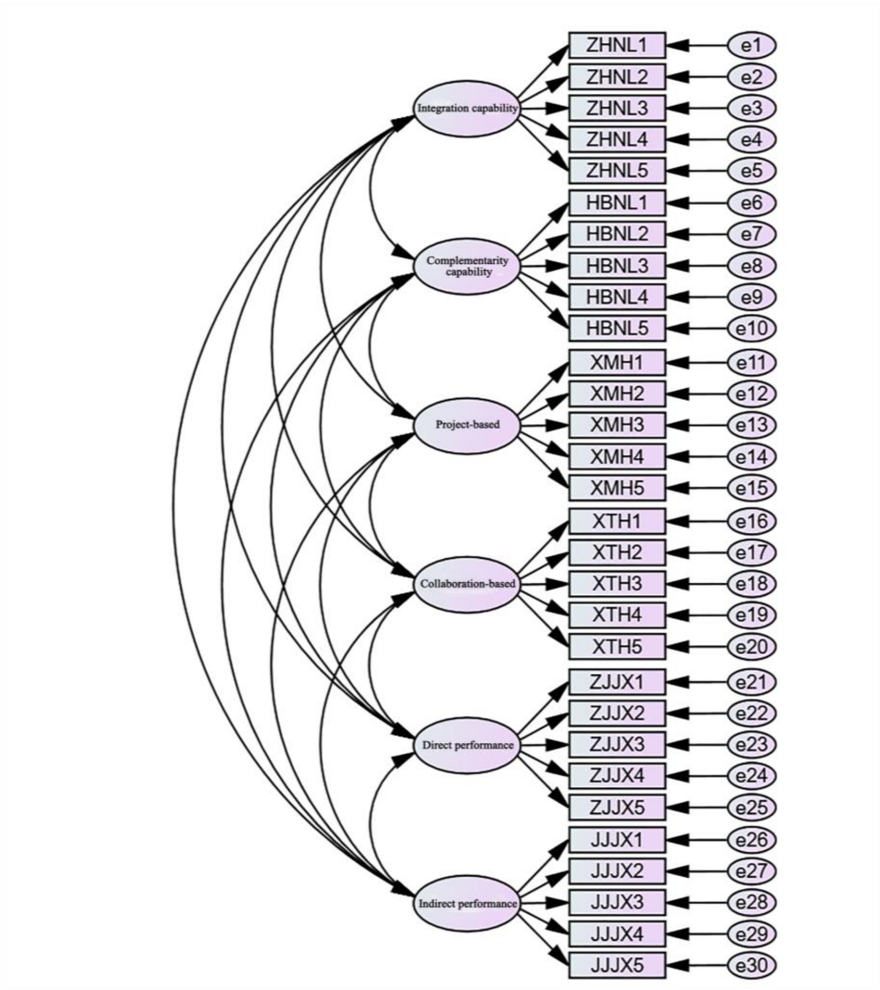

Figure 4.1 CFA Measurement Model

Table 4.12 Fit Index of Variable Construct CFA (N=606)

Model fit index	χ^2/df	RMSEA	PGFI	TLI	NFI	IFI	CFI
Independent variable model	1.968	.062	.699	.945	.905	.951	.951
Reference value	<3	<.10	>.5	>.9	>.9	>.9	>.9

Table 4.13 Estimates of CFA Construct and Path Coefficient (N=252)

			Unstandardized loading coefficient	Standardized loading coefficient	S.E.	p	CR	AVE	Square root of AVE
ZHNL1	<---	Integration capability	1.000	.858	-	-	.955	.810	.900
ZHNL2	<---	Integration capability	1.025	.855	.056	***			
ZHNL3	<---	Integration capability	1.137	.984	.046	***			
ZHNL4	<---	Integration capability	1.065	.922	.050	***			
ZHNL5	<---	Integration capability	.983	.874	.051	***			
HBNL1	<---	Complementarity capability	1.000	.832	-	-	.910	.670	.819
HBNL2	<---	Complementarity capability	.932	.785	.064	***			
HBNL3	<---	Complementarity capability	.965	.811	.063	***			
HBNL4	<---	Complementarity capability	.943	.813	.062	***			
HBNL5	<---	Complementarity capability	.999	.851	.061	***			
XMH1	<---	Project-based	1.000	.849	-	-	.913	.677	.823
XMH2	<---	Project-based	.919	.788	.061	***			
XMH3	<---	Project-based	1.020	.887	.056	***			
XMH4	<---	Project-based	.902	.792	.060	***			
XMH5	<---	Project-based	.896	.795	.059	***			
XTH1	<---	Collaboration-based	1.000	.812	-	-	.94	.760	.872
XTH2	<---	Collaboration-based	.965	.850	.060	***			
XTH3	<---	Collaboration-based	.934	.879	.055	***			
XTH4	<---	Collaboration-based	1.028	.930	.055	***			
XTH5	<---	Collaboration-based	1.038	.882	.061	***			
ZJJX1	<---	Direct performance	1.000	.919	-	-	.952	.799	.894
ZJJX2	<---	Direct performance	1.020	.918	.041	***			
ZJJX3	<---	Direct performance	.950	.870	.044	***			
ZJJX4	<---	Direct performance	1.012	.874	.046	***			
ZJJX5	<---	Direct performance	.952	.885	.042	***			
JJJX1	<---	Indirect performance	1.000	.898	-	-	.981	.911	.954
JJJX2	<---	Indirect performance	1.176	1.000	.036	***			
JJJX3	<---	Indirect performance	1.161	.992	.037	***			
JJJX4	<---	Indirect performance	1.006	.897	.044	***			
JJJX5	<---	Indirect performance	1.118	.980	.037	***			

***: $p<.001$

With reference to Anderson and Gerbing (1988), the following indicators were analyzed in this study: TLI, NFI, IFI, and CFI are all greater than .9, and PGFI is greater than .5, indicating that the model and data have a high degree of fit, as shown in the table. The items in this measurement questionnaire correspond to the hypothesized factors one by one, and the standardized factor loads of the items are all greater than .5, meeting the criteria. This shows good convergent validity of the measurement. The constructs all have CR values exceeding .7 and AVE values exceeding .5 (Fornell & Larcker, 1981), demonstrating good discriminant validity of the measurement. The comparison indicates that the correlation coefficients between the table's statistical expressions and table factors, as well as between the independent variable dimensions and other dimensions, are less than the square root of the diagonal AVE of the correlation matrix.

4.3.3 Multiple regression analysis

Based on the validity and reliability tests of large sample questionnaires, this section further performs correlation analysis and causal regression analysis on variable relations to verify the hypotheses in the conceptual model of this study.

4.3.3.1 Research on platform complementarity capability, platform integration capability, and direct entrepreneurship empowerment performance

For Hypotheses 1a, 2a, and 3a of this study, multiple linear regression was used to test the direct entrepreneurship empowerment performance as a dependent variable. The analysis results are shown in Table 4.14. Model 1.1 incorporates platform integration capability. Model 1.2 incorporates platform complementarity capability. Model 1.3 incorporates both platform integration and complementarity capabilities. Model 1.4, based on Model 1.3, adds the interaction term between platform integration capability and platform complementarity capability. The results show that: (1) When platform integration capability is included in the model alone, the β coefficient is .981. (2) When platform complementarity capability is included in the model alone, the β coefficient is .760. (3) When both platform integration capability and platform complementarity capability are included in the model, the β coefficients are .807 and .536 respectively. All these coefficients have significant effects on direct performance at the .001 level, indicating that Hypotheses 1a and 2a are supported. (4) When the interaction term is added, its β coefficient is .233, which is significant for direct performance at the .01 level, indicating that Hypothesis 3a is supported.

Table 4.14 Impact of Platform Complementarity Capability and Platform Integration Capability on Direct Entrepreneurship Empowerment Performance

	Model 1.1	Model 1.2	Model 1.3	Model 1.4
Integration capability	.981***		.807***	-.166
	(.063)		(.055)	(.342)
Complementarity capability		.760***	.536***	-.468
		(.066)	(.051)	(.352)
Interaction term				.233**
				(.081)
Revenue growth	2.206	-.288	.715	.759
	(1.347)	(1.543)	(1.125)	(1.108)
Government subsidy	.008	.002	.004	.004
	(.007)	(.008)	(.006)	(.005)
Industry	.328*	.158	.228*	.231*
	(.128)	(.146)	(.107)	(.105)
High-tech	.071	-.012	.039	.009
	(.080)	(.091)	(.066)	(.066)
Annual revenue (log)	-.067*	-.095*	-.051	-.056*
	(.033)	(.038)	(.028)	(.027)
Enterprise size (log)	-.001	.000	-.002	.005
	(.055)	(.063)	(.046)	(.045)
Enterprise age (log)	.044	.117*	.014	.010
	(.043)	(.049)	(.036)	(.036)
Number of patents (log)	-.033	-.023	-.048	-.040
	(.041)	(.046)	(.034)	(.033)
Constant	-.404	.881*	4.084**	2.260
	(.360)	(.371)	(23.863)	(1.484)
Sample size	252	252	252	252
R square	.546	.412	.690	.701
DW	1.748	1.866	2.016	2.019

* p<.05 ** p<.01 ***p<.001

4.3.3.2 Research on platform complementarity capability, platform integration capability, and indirect entrepreneurship empowerment performance

For Hypotheses 1b, 2b, and 3b of this study, multiple linear regression was adopted to test the indirect entrepreneurship empowerment performance as a dependent variable. The analysis results are shown in Table 4.15. The specific operation process is the same as that in the previous section: Model 2.1 incorporates platform integration capability. Model 2.2 incorporates platform complementarity capability. Model 2.3 incorporates both platform integration and complementarity capabilities. Model 2.4 adds the interaction term between platform integration capability and platform complementarity capability. The results show that: (1) When platform integration capability is included in the model alone, the β coefficient is .627. (2) When platform complementarity capability is included in the model alone, the β coefficient is .634. (3) When both platform integration capability and platform complementarity capability are included in the model simultaneously, the β coefficients are .463 and .505 respectively. All these coefficients have significant effects on indirect performance at the .001 level, indicating that Hypotheses 1b and 2b are supported. (4) When the interaction term is added, its β coefficient is .242, which is significant for indirect performance at the .05 level. This indicates that Hypothesis 3b is supported.

Table 4.15 Impact of Platform Complementarity Capability and Platform Integration Capability on Indirect Entrepreneurship Empowerment Performance

	Model 2.1	Model 2.2	Model 2.3	Model 2.4
Integration capability	.627***		.463***	-.548
	(.075)		(.071)	(.444)
Complementarity capability		.634***	.505***	-.538
		(.068)	(.065)	(.457)
Interaction term				.242*
				(.105)
Revenue growth	2.345	.364	.939	.984
	(1.606)	(1.569)	(1.452)	(1.439)
Government subsidy	.003	-.002	-.001	-.001
	(.008)	(.008)	(.007)	(.007)
Industry	-.137	-.272	-.231	-.228
	(.153)	(.149)	(.138)	(.136)
High-tech	.162	.103	.132	.101
	(.095)	(.092)	(.085)	(.086)
Annual revenue (log)	-.021	-.031	-.006	-.011
	(.040)	(.038)	(.036)	(.035)
Enterprise size (log)	.068	.068	.067	.074
	(.066)	(.064)	(.059)	(.058)
Enterprise age (log)	-.074	-.043	-.102*	-.106*
	(.052)	(.049)	(.047)	(.046)
Number of patents (log)	.061	.062	.047	.056
	(.049)	(.047)	(.044)	(.043)
Constant	1.388**	1.567***	-.035	4.303*
	(.429)	(.378)	(.427)	(1.928)
Sample size	252	252	252	252
R square	.274	.412	.418	.431
DW	1.627	1.626	1.725	1.699

* p<.05 ** p<.01 ***p<.001

4.3.3.3 Moderating effect test of the project-based operating system

For Hypotheses 4a and 5a, multiple linear regression was employed to test the direct entrepreneurship empowerment performance as a dependent variable. The results are shown in Table 4.16. Model 3.1 incorporates platform integration capability. Model 3.2, based on Model 3.1, adds the interaction term between platform integration capability and the project-based operating system.

Model 3.3 incorporates platform complementarity capability. Model 3.4, based on Model 3.3, adds the interaction term between platform complementarity capability and the project-based operating system. The results show that: (1) The interaction term between platform integration capability and the project-based operating system has a β coefficient of .653. (2) The interaction term between platform complementarity capability and the project-based operating system has a β coefficient of .648. Both interaction terms are significant for direct entrepreneurship empowerment performance at the .001 level. Thus, Hypotheses 4a and 5a are supported.

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Table 4.16 Digital Platform Capabilities, Project-based Operating System, and Direct Entrepreneurship Empowerment Performance

Dependent Variable: Direct Entrepreneurship Empowerment Performance

	Model 3.1	Model 3.2	Model 3.3	Model 3.4
Integration capability	.972***	-2.080**		
	(.061)	(.632)		
Integration capability * Project-based		.653***		
		(.135)		
Complementarity capability			.753***	-2.185**
			(.07)	(.677)
Complementarity capability * Project-based				.648***
				(.149)
Project-based	.287***	-2.615***	.023	-2.792***
	(.070)	(.602)	(.087)	(.651)
Revenue growth	1.570	1.773	-.322	-.634
	(1.314)	(1.257)	(1.551)	(1.498)
Government subsidy	.009	.006	.002	.003
	(.007)	(.006)	(.008)	(.007)
Industry	.322**	.316**	.158	.082
	(.124)	(.119)	(.147)	(.143)
High-tech	.040	.02	-.014	-.002
	(.078)	(.074)	(.091)	(.088)
Annual revenue (log)	-.067*	-.077*	-.095*	-.089*
	(.032)	(.031)	(.038)	(.037)
Enterprise size (log)	-.012	.001	-.001	-.007
	(.053)	(.051)	(.063)	(.061)
Enterprise age (log)	.047	.03	.118*	.085
	(.042)	(.04)	(.049)	(.048)
Number of patents (log)	-.032	-.022	-.023	-.016
	(.040)	(.038)	(.047)	(.045)
Constant	-1.630**	11.976***	.805	13.612***
	(.459)	(2.839)	(.468)	(2.971)
Sample size	252	252	252	252
R square	.576	.614	.412	.456
DW	1.830	1.772	1.868	1.809

* p<.05 ** p<.01 ***p<.001

For Hypotheses 4b and 5b, multiple linear regression was used to test the indirect entrepreneurship empowerment performance as a dependent variable. The results are shown in Table 4.17. Model 4.1 incorporates platform integration capability. Model 4.2, based on Model 4.1, adds the interaction term between platform integration capability and the project-based operating system. Model 4.3 incorporates platform complementarity capability. Model 4.4, based on Model 4.3, adds the interaction term between platform complementarity capability and the project-based operating system. The results show that: (1) The interaction term between platform integration capability and the project-based operating system has a β coefficient of .142, which has no significant effect on indirect entrepreneurship empowerment performance. (2) The interaction term between platform complementarity capability and the project-based operating system has a β coefficient of .353, which has a significant effect on indirect entrepreneurship empowerment performance at the .05 level. These results indicate that Hypothesis 4b is supported, while Hypothesis 5b is not supported.

Table 4.17 Digital Platform Capabilities, Project-based Operating System, and Indirect Entrepreneurship Empowerment Performance

Dependent Variable: Indirect Entrepreneurship Empowerment Performance

	Model 4.1	Model 4.2	Model 4.3	Model 4.4
Integration capability	.602***	-.064		
	(.061)	(.656)		
Integration capability * Project-based		.142		
		(.14)		
Complementarity capability			.467***	-1.132
			(.064)	(.628)
Complementarity capability * Project-based				.353*
				(.138)
Project-based	.791***	.158	.627***	-.905
	(.069)	(.625)	(.079)	(.604)
Revenue growth	.59	.634	-.583	-.752
	(1.306)	(1.306)	(1.403)	(1.389)
Government subsidy	.005	.005	.001	.002
	(.006)	(.006)	(.007)	(.007)
Industry	-.152	-.153	-.254	-.295*
	(.123)	(.123)	(.133)	(.132)
High-tech	.078	.073	.044	.051
	(.077)	(.077)	(.083)	(.082)
Annual revenue (log)	-.021	-.024	-.039	-.036
	(.032)	(.032)	(.034)	(.034)
Enterprise size (log)	.038	.041	.044	.041
	(.053)	(.053)	(.057)	(.056)
Enterprise age (log)	-.066	-.07	-.022	-.04
	(.042)	(.042)	(.044)	(.044)
Number of patents (log)	.065	.067	.071	.074
	(.039)	(.039)	(.042)	(.042)
Constant	-1.992***	.975	-.486	6.483*
	(.456)	(2.949)	(.424)	(2.755)

Table 4.17 Digital Platform Capabilities, Project-based Operating System, and Indirect Entrepreneurship Empowerment Performance (Continued)

Dependent Variable: Indirect Entrepreneurship Empowerment Performance

	Model 4.1	Model 4.2	Model 4.3	Model 4.4
Sample size	252	252	252	252
R square	.529	.531	.459	.473
DW	1.778	1.770	1.665	1.667

* p<.05 ** p<.01 ***p<.001

4.3.3.4 Moderating effect test of collaboration ecosystem

For Hypotheses 6a and 7a of this study, multiple linear regression was adopted to test the direct entrepreneurship empowerment performance as a dependent variable. The analysis results are shown in Table 4.18. Model 5.1 incorporates platform integration capability. Model 5.2, based on Model 5.1, adds the interaction term between platform integration capability and the collaboration ecosystem. Model 5.3 incorporates platform complementarity capability. Model 5.4, based on Model 5.3, adds the interaction term between platform complementarity capability and the collaboration ecosystem. The results show that: (1) The interaction term between platform integration capability and the collaboration ecosystem has a β coefficient of .323, which is significant for direct entrepreneurship empowerment performance at the .05 level. (2) The interaction term between platform complementarity capability and the collaboration ecosystem has a β coefficient of .454, which is significant for direct entrepreneurship empowerment performance at the .001 level. These results indicate that Hypotheses 6a and 7a are supported.

Table 4.18 Digital Platform Capabilities, Collaboration Ecosystem, and Direct Entrepreneurship Empowerment Performance

Dependent Variable: Direct Entrepreneurship Empowerment Performance

	Model 5.1	Model 5.2	Model 5.3	Model 5.4
Integration capability	.958***	-.564		
	(.065)	(.679)		
Integration capability * Collaboration		.323*		
		(.144)		
Complementarity capability			.732***	-1.375*
			(.068)	(.583)
Complementarity capability * Collaboration				.454***
				(.125)
Collaboration-based	.105	-1.312*	.126	-1.841***
	(.066)	(.633)	(.075)	(.546)
Revenue growth	2.044	1.893	-.395	-.335
	(1.347)	(1.337)	(1.538)	(1.501)
Government subsidy	.008	.008	.003	.003
	(.007)	(.007)	(.008)	(.007)
Industry	.321*	.303*	.155	.112
	(.128)	(.127)	(.146)	(.143)
High-tech	.055	.043	-.028	-.044
	(.08)	(.080)	(.091)	(.089)
Annual revenue (log)	-.068*	-.065*	-.095*	-.099**
	(.033)	(.033)	(.038)	(.037)
Enterprise size (log)	0	-.002	0	.008
	(.055)	(.054)	(.062)	(.061)
Enterprise age (log)	.053	.05	.127*	.111*
	(.044)	(.043)	(.049)	(.048)
Number of patents (log)	-.033	-.031	-.023	-.018
	(.041)	(.040)	(.046)	(.045)
Constant	-.791	5.883	.407	9.565***
	(.433)	(2.996)	(.466)	(2.559)
Sample size	252	252	252	252
R square	.551	.560	.419	.449
DW	1.773	1.744	1.866	1.864

* p<.05 ** p<.01 ***p<.001

For Hypotheses 6b and 7b of this study, multiple linear regression was employed to test the indirect entrepreneurship empowerment performance as a dependent variable. The analysis results are shown in Table 4.19. Model 6.1 incorporates platform integration capability. Model 6.2, based on Model 6.1, adds the interaction term between platform integration capability and the collaboration ecosystem. Model 6.3 incorporates platform complementarity capability. Model 6.4, based on Model 6.3, adds the interaction term between platform complementarity capability and the collaboration ecosystem. The results show that: (1) The interaction term between platform integration capability and the collaboration ecosystem has a β coefficient of .177, which has no significant effect on indirect entrepreneurship empowerment performance. (2) The interaction term between platform complementarity capability and the collaboration ecosystem has a β coefficient of .269, which has a significant effect on indirect entrepreneurship empowerment performance at the .05 level. Thus, Hypothesis 6b is supported, while Hypothesis 7b is not supported.

Table 4.19 Digital Platform Capabilities, Collaboration Ecosystem, and Indirect Entrepreneurship Empowerment Performance

Dependent Variable: Indirect Entrepreneurship Empowerment Performance

	Model 6.1	Model 6.2	Model 6.3	Model 6.4
Integration capability	.528***	-.303		
	(.072)	(.762)		
Integration capability * Collaboration		.177		
		(.161)		
Complementarity capability			.539***	-.709
			(.065)	(.567)
Complementarity capability * Collaboration				.269*
				(.121)
Collaboration-based	.450***	-.324	.425***	-.74
	(.073)	(.711)	(.072)	(.530)
Revenue growth	1.649	1.566	.002	.037
	(1.500)	(1.502)	(1.470)	(1.459)
Government subsidy	.004	.004	.000	.001
	(.007)	(.007)	(.007)	(.007)
Industry	-.167	-.177	-.280*	-.305*
	(.142)	(.143)	(.139)	(.139)
High-tech	.096	.089	.049	.039
	(.089)	(.089)	(.087)	(.086)
Annual revenue (log)	-.023	-.021	-.031	-.034
	(.037)	(.037)	(.036)	(.036)
Enterprise size (log)	.07	.069	.07	.074
	(.061)	(.061)	(.060)	(.059)
Enterprise age (log)	-.034	-.035	-.01	-.019
	(.049)	(.049)	(.047)	(.046)
Number of patents (log)	.062	.063	.062	.065
	(.045)	(.045)	(.044)	(.044)
Constant	-.275	3.369	-.032	5.394*
	(.482)	(3.364)	(.445)	(2.487)
Sample size	252	252	252	252
R square	.373	.376	.402	.414
DW	1.660	1.659	1.608	1.646

4.3.4 Results discussion

The hypothesis testing results are shown in Table 4.20.

Table 4.20 Hypothesis Testing Results

Research hypothesis	Analysis result
Hypothesis 1a: Digital platform complementarity capability positively promotes direct entrepreneurship empowerment performance.	Supported
Hypothesis 1b: Digital platform complementarity capability positively promotes indirect entrepreneurship empowerment performance.	Supported
Hypothesis 2a: Digital platform integration capability positively promotes direct entrepreneurship empowerment performance.	Supported
Hypothesis 2b: Digital platform integration capability positively promotes indirect entrepreneurship empowerment performance.	Supported
Hypothesis 3a: The interaction between platform integration capability and platform complementarity capability can significantly promote direct entrepreneurship empowerment performance.	Supported
Hypothesis 3b: The interaction between platform integration capability and platform complementarity capability can significantly promote indirect entrepreneurship empowerment performance.	Supported
Hypothesis 4a: The project-based operating system promotes a positive correlation between platform complementarity capability and direct entrepreneurship empowerment performance.	Supported
Hypothesis 4b: The project-based operating system promotes a positive correlation between platform complementarity capability and indirect entrepreneurship empowerment performance.	Supported
Hypothesis 5a: The project-based operating system promotes a positive correlation between platform integration capability and direct entrepreneurship empowerment performance.	Supported
Hypothesis 5b: The project-based operating system promotes a positive correlation between platform integration capability and indirect entrepreneurship empowerment performance.	Not supported
Hypothesis 6a: The collaboration ecosystem promotes a positive correlation between platform complementarity capability and direct entrepreneurship empowerment performance.	Supported
Hypothesis 6b: The collaboration ecosystem promotes a positive correlation between platform complementarity capability and indirect entrepreneurship empowerment performance.	Supported
Hypothesis 7a: The collaboration ecosystem promotes a positive correlation between platform integration capability and direct entrepreneurship empowerment performance.	Supported
Hypothesis 7b: The collaboration ecosystem promotes a positive correlation between platform integration capability and indirect entrepreneurship empowerment performance.	Not supported

4.3.4.1 Impact of digital platform capabilities on entrepreneurship empowerment performance

According to the testing results, the digital platform capability system includes two dimensions: platform complementarity capability and platform integration capability, both of which can promote entrepreneurship empowerment performance. The platform complementarity capability emphasizes that the platform accesses core and auxiliary complementary resources. It promotes information exchange and resource complementarity between entrepreneurial enterprises in the parks and service enterprises on the platforms, thus improving direct and indirect entrepreneurial performance. The platform integration capability represents that platform enterprises integrate and reconstruct internal and external resources based on digital platforms. It provides professional industrial and entrepreneurial services for entrepreneurial enterprises, improving direct and indirect entrepreneurial performance. Regarding theoretical logic, these two dimensions are consistent with the discussion on platform resources and platform leaders in existing platform theories. However, they also take into account the situational characteristics of digital industrial parks to form a framework for the digital platform capability system. The interaction between platform complementarity capability and platform integration capability can also promote entrepreneurship empowerment performance. This demonstrates that the breadth and depth of platform resources and the integration and reconstruction of resources by platform enterprises promote each other. The more resources the platform accesses, the more professional services platform enterprises can provide after resource integration. Conversely, the more professional services platform enterprises provide, the more resources the platform can access. Therefore, digital platforms need to have both platform complementarity capability and platform integration capability to maximize their empowerment of entrepreneurial enterprises.

The comparison of model coefficients shows that platform integration capability is more influential than platform complementarity capability in promoting entrepreneurship empowerment performance. This indicates that when digital platforms possess both capabilities, platform integration capability plays a more significant role in promoting entrepreneurship empowerment performance. This provides further evidence that digital platforms cannot only rely on complementary resources but also need to integrate and reconstruct these resources through the management of platform enterprises to provide professional services that meet the needs of entrepreneurial enterprises. It highlights the importance of park management enterprises as platform enterprises in digital industrial parks. Thus, the current digital platform capability framework is an inheritance and development of existing platform theories.

4.3.4.2 Moderating effects of basic standardized systems

The tests indicate that basic standardized systems encompass two dimensions: the project-based operating system and the collaboration ecosystem. Both of these dimensions moderate the relationship between digital platform capabilities and entrepreneurship empowerment performance.

On the one hand, the project-based operating system fosters a positive correlation between platform complementarity capability and both direct and indirect entrepreneurship empowerment performance. It also promotes a positive correlation between platform integration capability and direct entrepreneurship empowerment performance. This suggests that the project-based operating system can significantly enhance the results of entrepreneurial activities. By implementing professional management within each industrial park through project teams, it provides continuous, long-term, and specialized services for entrepreneurial enterprises centered around project themes, enhancing the growth, profitability, and innovation of entrepreneurial enterprises. Additionally, the project team's role as a bridge strengthens the relationship between entrepreneurial enterprises and platform complementary parties. This, in turn, improves the perceived service efficiency for entrepreneurial enterprises throughout the entrepreneurial process.

On the other hand, the collaboration ecosystem promotes the positive correlation between platform complementarity capability and both direct and indirect entrepreneurship empowerment performance, as well as the positive correlation between platform integration capability and direct entrepreneurship empowerment performance. This demonstrates that the collaboration ecosystem can better fulfill the diversified, total-factor, and whole-process needs of entrepreneurial enterprises by establishing a cross-industry and cross-regional ecosystem. This approach effectively enhances the efficiency and outcomes of entrepreneurial activities, enabling enterprises to achieve better direct performance. Moreover, the growing ecosystem generates positive externalities for digital platforms, allowing entrepreneurial enterprises to benefit from an improved entrepreneurial atmosphere and increased service efficiency during the entrepreneurial process.

However, two hypotheses were not verified in this study: the promotion of the project-based operating system on the positive correlation between platform integration capability and indirect entrepreneurship empowerment performance, and the role of the collaboration ecosystem in the positive correlation between platform integration capability and indirect entrepreneurship empowerment performance. This study suggests that this may be due to several factors: (1) There is a potential substitution relationship between platform integration capability and basic standardized systems. While basic standardized systems can enhance the role of platform integration capability in promoting the outcomes of entrepreneurial enterprises, in terms of perceived service efficiency, basic standardized systems and platform integration capability may exhibit similar characteristics. Both of them provide more professional services for entrepreneurial enterprises through digital industrial park management enterprises. Therefore, entrepreneurial enterprises might not perceive a significant improvement in service efficiency. (2) This study collected data through questionnaire distribution. The respondents of the questionnaire were entrepreneurial enterprises in the parks, and the measurement of basic standardized systems was based on the subjective perception of respondents. However, employees of entrepreneurial enterprises may not directly experience the operation and management mode of park management enterprises. Hence, they may not perceive the service efficiency of basic standardized systems clearly. (3) During the questionnaire distribution process, despite efforts to collect data from multiple channels and parks to improve data quality, successful enterprises were often more willing to participate. These enterprises typically possess rich entrepreneurial resources and might not perceive the service efficiency provided by park management enterprises as significantly improved. In conclusion, the promotion effect of basic standardized systems (the project-based operating system and the collaboration ecosystem) on the positive correlation between platform integration capability and indirect entrepreneurship empowerment performance is not significant.

5 Conclusions and Outlook

This chapter summarizes the study's key conclusions and, based on these findings, refines the main theoretical contributions and practical implications of this study. Furthermore, it analyzes the study's limitations and proposes directions for future research.

5.1 Main Conclusions

This study presents the fundamental idea of using digital technology to empower the transformation and upgrading of industrial parks. It emphasizes the urgent need for industrial technology parks to build digital platforms that empower entrepreneurial enterprises in the parks, facilitating high-quality development through digital transformation, intelligent upgrading, and integrated innovation. This study points out the challenges in building digital platforms and achieving the transformation of industrial parks. For instance, current platform functions mainly focus on information display, which hampers their empowering role in innovation and entrepreneurship. The systems of digital platform capabilities and entrepreneurship empowerment evaluation have not been systematically constructed, and the pathway for digital platforms to empower entrepreneurial enterprises needs further exploration. This study focuses on the core question of "how to build digital platform capabilities for sci-tech industrial parks to empower entrepreneurship of enterprises in the parks."

It centers on three sub-questions. First, what digital platform capabilities should be developed for sci-tech industrial parks? Second, how can these digital platform capabilities empower entrepreneurial enterprises in the parks? Third, how do the basic standardized management systems impact the empowerment of digital platform capabilities on entrepreneurial enterprises in industrial parks? To answer these questions, this study employs literature analysis, case studies, and statistical tests, leading to the following conclusions:

First, sci-tech industrial parks' digital platform capabilities comprise platform complementarity capability and platform integration capability. Through an exploratory longitudinal single-case analysis of Zhixin Zedi Artificial Intelligence Industrial Park, this study provides an in-depth description of the process of building digital platform capabilities and summarizes the capabilities' dimensions. Specifically, access-based platform complementarity capability focuses on building a platform ecosystem and capabilities from a "chain" perspective. It considers the diverse needs of entrepreneurial enterprises, emphasizing the importance of strengthening, supplementing, and extending the industry, supply, talent, innovation, and capital chains. This approach aims to build collaboration and complementarity ecosystems and capabilities that center on the development needs of industries and entrepreneurship. Platform integration capability highlights platform owners' role in integrating relevant resources to build a platform ecosystem and capabilities. From the perspective of platform owner management, this involves establishing a total-factor service system according to the development needs of entrepreneurial enterprises and restructuring resources to provide entrepreneurial enterprises with industrial and platform professional services that align with these needs. These two dimensions explain digital platform capabilities from the perspectives of platform resource characteristics and the management of platforms by platform enterprises. Through the development of platform complementarity capability and platform integration capability of digital platforms in industrial parks, a total-factor ecosystem featuring comprehensive factors and a full-link ecosystem featuring collaboration are formed. This enhances the empowerment capability of digital platforms, thus meeting the growth needs of entrepreneurial enterprises and promoting industrial development to the greatest extent.

Second, digital platform capabilities facilitate entrepreneurial enterprises in accessing complementary resources, offering them industrial and platform professional services, thus enhancing both direct and indirect entrepreneurship empowerment performance. Direct entrepreneurship empowerment performance emphasizes the growth, innovation, and profitability of entrepreneurial enterprises. This is because parks have firsthand knowledge of the needs of settled enterprises, allowing them to provide the most targeted services. The impact of this is evident, directly reflected in the development dimensions of the enterprises within the parks. Indirect entrepreneurship empowerment performance emphasizes the perceived service efficiency by entrepreneurial enterprises during their entrepreneurial process. Given the large number of settled enterprises, it is impractical to provide direct services for each one. Therefore, creating a favorable atmosphere for entrepreneurial growth and industrial development within the parks is crucial. This fosters a favorable environment for unified entrepreneurship, instilling high hopes and making the parks a fertile ground for enterprise growth and industrial development.

Third, basic standardized management systems significantly enhance the empowerment of digital platform capabilities for entrepreneurial enterprises. Basic standardized systems encompass two dimensions: the project-based operating system and the collaboration ecosystem. The former involves the professional management of each industrial park by project teams. These teams featuring strong professional and service quality provide continuous, long-term, and specialized services centered around project themes, promoting the efficient and pragmatic operation of platforms. The latter emphasizes cross-industry and cross-domain collaboration. Platform enterprises, platform participants with complementary resources, entrepreneurial enterprises, and other entities collaborate to form an ecosystem integrating factors (dot), links (line), and platforms (plane) according to the diversified, total-factor, and whole-process needs of entrepreneurial enterprises. This meets their growth and development needs. The project-based operating system and collaboration ecosystem represent management systems at the project and ecosystem levels respectively. By building a professional and continuous project-based operating system, the correlation between entrepreneurial enterprises and digital platforms is enhanced, allowing digital platform capabilities to impact entrepreneurial enterprises more directly and efficiently. Meanwhile, by establishing a cross-industry and cross-regional collaboration ecosystem, the depth and breadth of the correlation between entrepreneurial enterprises and complementary parties are further improved, making the enhancement effect of digital platform capabilities on entrepreneurial enterprises more evident.

5.2 Theoretical Contributions

This study explores the relationship between the building of digital platform capabilities and entrepreneurship empowerment performance in industrial parks, contributing to the research on digital platform capabilities and the empowerment of industrial parks to entrepreneurial enterprises:

First, it constructs a framework for digital platform capabilities. Existing studies have examined digital platform capabilities from two perspectives: digital industrial park capability systems and platform capability systems. However, discussions on industrial park capability systems often lack the identification of key dimensions and analysis of mechanisms and those on platform capability systems overlook the role of platform leaders. By integrating these perspectives, this study proposes the concepts of platform complementarity capability and platform integration capability from the viewpoints of the platform itself and platform enterprise management. It establishes a foundational framework for digital platform capability systems in industrial parks, offering new insights into platform capability systems and identifying key capability dimensions for industrial park managers in the digital economy era.

Second, this study delves into the mechanisms by which industrial parks empower entrepreneurial enterprises. While existing studies have explored how industrial parks empower entrepreneurial enterprises through opportunity identification, activity implementation, and achievement transformation, they focus on traditional industrial parks and lack exploration of empowerment mechanisms and pathways in the digital era. This study asserts that digital platforms should be the core medium for empowering entrepreneurial enterprises in industrial parks. It analyzes the mechanism of digital platform capabilities on entrepreneurship empowerment performance.

Third, this study identifies and tests basic standardized systems as a crucial moderating variable. Although existing studies suggest that platform capabilities are essential for platform and digital industrial park development, they seldom answer the question of "what organizational management system ensures the implementation of these capabilities." Developing and achieving organizational capability must be supported by an effective organizational management system. Therefore, building a basic standardized management system is a crucial prerequisite for digital platforms in industrial parks to effectively empower entrepreneurial enterprises. This study identifies the project-based operating system and collaboration ecosystem as vital dimensions of basic standardized management systems from both park management and cross-park management levels. It explores and tests the moderating role of basic standardized systems.

Fourth, this study develops an empowerment performance evaluation system. Existing studies of empowerment performance often focus on single or multiple dimensions, such as achievement and efficiency improvement, but lack a comprehensive and systematic evaluation system. They also tend to emphasize entrepreneurial results over entrepreneurial experiences. This study proposes that entrepreneurship empowerment performance encompasses two dimensions: direct entrepreneurship empowerment performance and indirect entrepreneurship empowerment performance. The former is reflected by traditional indicators such as growth, profitability, and innovation of entrepreneurial enterprises, while the latter focuses on the service efficiency of industrial parks during the entrepreneurial process. By combining financial and non-financial indicators as well as subjective and objective indicators, this study provides a holistic evaluation of entrepreneurship empowerment performance. It also analyzes the impact of digital technology on industrial parks' empowerment. Specifically, it is necessary to further stimulate the network effect by improving the efficiency of entrepreneurship services to achieve the long-term sustainable development of industrial parks.

5.3 Management Significance

In the digital economy era, building digital empowerment platforms in industrial parks holds great management significance. These platforms can integrate various service resources, create a replicable entrepreneurship service system, improve the operational efficiency and service quality of industrial parks, meet the diversified needs of enterprises, and promote the high-quality development of industrial parks.

From a park operation perspective, digital empowerment platforms can significantly enhance the intelligence level of park management. They allow for real-time monitoring of various operational data within the park, providing accurate and timely decision support for managers. These platforms can integrate various service resources, enabling centralized management and efficient allocation. This makes services offered by the parks more targeted and effective. Digital empowerment platforms can facilitate deeper exchanges and cooperation among enterprises, fostering a closely-knit industry chain and ecosystem. This, in turn, attracts more high-quality enterprises to settle in the parks.

From an enterprise service perspective, by integrating various service resources, digital empowerment platforms in the parks can reduce intermediate links and operating costs, ensuring efficient utilization and optimal allocation of resources. These platforms help to form a replicable entrepreneurship service system where standardized processes can serve as a model for other parks. Digital empowerment platforms can provide customized service solutions tailored to the actual needs of enterprises.

From an industrial development perspective, digital empowerment platforms can offer efficient and targeted data support for parks and enterprises. This enables better insights into market dynamics, optimizes decision-making processes, and supports industrial innovation and development. These platforms can gather resources from governments, enterprises, and scientific research institutions, as well as talent, technology, and financial support, achieving resource sharing and complementary advantages. They help deeply understand the needs of enterprises, link upstream and downstream industry resources, and meet the diversified needs of enterprises during industrial upgrading.

From a government support perspective, digital empowerment platforms enable real-time park monitoring by integrating advanced information technology and data resources. This provides scientific and accurate information, aiding governments in achieving refined and intelligent park management. These platforms gather various production factors and resources, facilitate governments in providing one-stop services, optimize resource allocation, and enhance service efficiency. They can offer various services such as technology transfer, financial support, and market promotion. This all-round support reduces entrepreneurial costs, stimulates innovation, and deepens communication and cooperation among stakeholders, fostering a joint force to drive development.

5.4 Shortcomings and Future Research Prospects

5.4.1 Shortcomings

This study explores, summarizes, and tests the relationship between digital platform capabilities, basic standardized systems, and entrepreneurship empowerment performance using an exploratory longitudinal single-case study and a large-sample empirical test. It establishes a theoretical model for digital platforms to empower entrepreneurial enterprises. However, there are still some shortcomings in the research methods, primarily concerning the insufficient universality of case studies and the limitations of sample data.

Insufficient universality of case studies. Although a longitudinal single-case study can describe the development process of cases in depth and vividly, it faces the problem of lacking universality. The establishment process of different types of industrial parks, the building of digital platform capabilities, and their explanation of the empowerment performance of different enterprises need further exploration and discussion. Future studies should observe and interview industrial parks across various industries and development stages. Furthermore, more abundant data should be statistically analyzed to test the replicability of case results.

Sample data limitations. Despite using various methods to obtain data and attempting to control common method bias, there are still data limitations in the model's statistical analysis based on cross-sectional and first-hand data. These limitations hinder understanding the changes in key variables over time. During data collection, this study was constrained by time and resources, distributing questionnaires only to several industrial parks in Hangzhou with the help of park management enterprises. This approach caused problems such as insufficient variability and social desirability issues, affecting the universality and replicability of the study's conclusions. Future studies should try to test the model based on panel data and incorporate more second-hand data for analysis. It is also crucial to expand the scope of sample collection, conducting in-depth investigations and data collection from industrial parks in different regions and different types of entrepreneurial enterprises. This will further enhance the reliability of study results.

5.4.2 Future research prospects

Although this study has made progress in the digital platform capability system's composition, the empowerment mechanism of digital platforms, and the moderating role of basic standardized management systems, there are still many areas that can be further explored. First, current studies assume that digital platforms can empower entrepreneurial enterprises. This study explores digital platform capabilities' composition and the empowerment mechanism based on this assumption. Nevertheless, this premise requires further testing. Future research could use quasi-experiments and second-hand data verification to explore the differences in empowerment performance and approaches of entrepreneurial enterprises in industrial parks with and without digital platforms. This would further clarify the role of digital platform capabilities and provide references for practical and theoretical development.

Second, current studies mainly discuss the empowerment of digital platforms from the perspective of digital platform managers and provide general resources and services for entrepreneurial enterprises. However, there should be differences in the dimensions and mechanisms of empowerment for enterprises at different development stages and in various industries. It is necessary to pay attention to the impact of different characteristics of entrepreneurial enterprises on digital platform capabilities from an enterprise perspective. This will improve the consistency between platform capabilities and the needs of entrepreneurial enterprises and provide customized digital services.

Third, digital infrastructure is the cornerstone of digital platform empowerment. A solid digital infrastructure is necessary to provide better services for entrepreneurial enterprises. While this study discusses the moderating role of basic standardized management systems and explores the boundary conditions for ensuring digital platform empowerment from an organizational perspective, it lacks further attention to digital infrastructure from a technical perspective. Future studies should establish a more systematic digital platform empowerment model by integrating organizational and technical perspectives.

Fourth, future studies should pay attention to the development of digital technology and AI technology. This study still focuses on the analysis and utilization of static data. With the continuous progress of technology and the deep integration of industries, platforms will use big data, AI, and other technologies to deeply analyze the needs of enterprises, build a comprehensive digital ecosystem, promote close cooperation between upstream and downstream enterprises in the industry chain, and provide more targeted services and solutions. Digital empowerment platforms of sci-tech industrial parks will develop more comprehensive content, more intelligent functions, and more customized services. Therefore, it is necessary to further explore the relationship between digital platform empowerment supported by emerging digital technologies and entrepreneurial enterprise performance.

References:

Acs Z J, Autio E, Szerb L. National Systems of Entrepreneurship: Measurement issues and policy implications [J]. *Research Policy*, 2014, 43(3): 476-494.

Agarwal R, Selen W. Dynamic capability building in service value networks for achieving service innovation[J]. *Decision sciences*, 2009, 40(3): 431-475.

Ai, D., Liu, Y. [Yanpeng], & Yang, J. (2016). Research on smart park construction scheme. *Modern Electronics Technique*, (39), 45-48.

Anderson, J. C, & Gerbing, D. W. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, 1988, 103(3), 411-423.

Attour A, Barbaroux P. Architectural knowledge and the birth of a platform ecosystem: a case study[J]. *Journal of Innovation Economics & Management*, 2016 (1): 11-30.

Autio E, Levie J, Management of entrepreneurial ecosystems[M]. 2017: *The Wiley Handbook of Entrepreneurship*.

Autio E, Nambisan S, Thomas L D W, et al. Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems [J]. *Strategic Entrepreneurship Journal*, 2018, 12(1): 72-95.

Baldwin C Y, Clark K B. Design rules, Volume 1: The power of modularity[M]. MIT press, 2000.

Baldwin R E. Global supply chains: why they emerged, why they matter, and where they are going[J]. 2012.

Barrera G A F, Durany X Gi, Ponsjr, et al. Trends in global research on industrial parks: a bibliometric analysis from 1996-2019[J]. Heliyon, 2021, 7(8): 1-14.

Beltagui A, Rosli A, Candi M. Exaptation in a digital innovation ecosystem: The disruptive impacts of 3D printing[J]. *Research policy*, 2020, 49(1): 103833.

Bergek A, Norrman C. Incubator best practice: A framework[J]. *Technovation*, 2008, 28(1-2): 20-28.

Boudreau K J. Platform Boundary Choices & Governance: Opening-Up While Still Coordinating and Orchestrating☆[M]//Entrepreneurship, innovation, and platforms. Emerald Publishing Limited, 2017: 227-297.

Brahm F, Tarziján J. Toward an integrated theory of the firm: The interplay between internal organization and vertical integration[J]. *Strategic Management Journal*, 2016, 37(12): 2481-2502.

Cenamor J, Parida V, Wincent J. How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity[J]. *Journal of Business Research*, 2019, 100: 196-206.

Cenamor J, Sjödin D R, Parida V. Adopting a platform approach in servitization: Leveraging the value of digitalization[J]. *International Journal of Production Economics*, 2017, 192: 54-65.

Cennamo C, Santaló J. Generativity tension and value creation in platform ecosystems[J]. *Organization science*, 2019, 30(3): 617-641.

Chang, M., Chen, Q., Xu, X., Wang, S. [Shiwen], & Yang, L. (2021). Comparative analysis on innovation and entrepreneurship development paths and resources environment of environmental protection industrial parks in China. *Sichuan Environment*, *40*(05), 150-156.

Chen, W., & Wang, J. [Jiexiang]. (2021). Dependent upgrading: Digital transformation strategy of participants in the platform ecosystem. *Management World*, *37*(10), 195-214.

Chen, X. (2015). Intelligent transformation and evaluation of industrial parks. *Science & Technology Progress and Policy*, (10), 114-118.

Clarysse B, Wright M, Bruneel J, et al. Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems[J]. *Research policy*, 2014, 43(7): 1164-1176.

Cumming D, Werth J C, Zhang Y. Governance in entrepreneurial ecosystems: venture capitalists vs. technology parks[J]. *Small Business Economics*, 2019, 52: 455-484.

den Hartigh E, Tol M, Visscher W. The health measurement of a business ecosystem[C]//Proceedings of the European Network on Chaos and Complexity Research and Management Practice Meeting. 2006: 1-39.

Dong, S., & Li, Z. [Zhi]. (2018). Research review of industrial agglomeration and park economic development. *Modern Economic Information*, (18), 474-475.

Dunn, S. C., Seaker, R. F., & Waller, M. A. Latent variables in business logistics research: Scale development and validation. *Journal of Business Logistics*, 1994, 15(2), 145-172.

Du, Y., Liu, Q., & Cheng, J. (2020). What kind of business environment ecology produces high entrepreneurial dynamism in cities: An analysis at the institutional level. *Management World*, *36*(9), 141-155.

Eaton, B., Elaluf-Calderwood, S., Sørensen, C., & Youngjin, Y. Distributed tuning of boundary resources: The case of Apple's IOS service system. *MIS Quarterly*, 2015(39): 212-217.

Eisenhardt, K. M. Building Theories from Case Study Research[J]. *Academy of Management Review*, 1989, 14(4):532-550.

Elia G, Margherita A, Petti C. An operational model to develop technology entrepreneurship "EGO-system" [J]. *International Journal of Innovation & Technology Management*, 2016, 13.

Eveleens C P, van Rijnsoever F J, Niesten E M M I. How network-based incubation helps start-up performance: a systematic review against the background of management theories[J]. *The Journal of Technology Transfer*, 2017, 42: 676-713.

Fornell C, Larcker D F. Evaluating structural equation models with unobservable variables and measurement error[J]. *Journal of marketing research*, 1981, 18(1): 39-50.

Ghazawneh, A., & Henfridsson, O. Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal*, 2013(23): 173-192.

Grant R M. Prospering in dynamically-competitive environments: Organizational capability as knowledge integration[J]. *Organization science*, 1996, 7(4): 375-387.

Hannah D. P, Eisenhardt K. M. How Firms Navigate Cooperation and Competition in Nascent Ecosystems[J].*Strategic Management Journal*, 2018, 39(3):3163-3192.

He, J., Zhou, G., & Yang, Y. [Yunyuan]. (2016). Domestic literature review on transformation and upgrading of industrial parks. *Journal of Chuxiong Normal University*, *31*(9), 73-78.

Helfat C E, Raubitschek R S. Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems[J]. *Research policy*, 2018, 47(8): 1391-1399.

Howells J. Intermediation and the role of intermediaries in innovation[J]. *Research policy*, 2006, 35(5): 715-728.

Hu, W., Li, J. [Jun], & Mou, H. (2010). Exploration of building park innovation service system. *Chinese University Technology Transfer*.

Innovation communities: Teamworking of key persons-a success factor in radical innovation[M]. Springer Science & Business Media, 2012.

Isenberg P, Elmqvist N, Scholtz J, et al. Collaborative visualization: Definition, challenges, and research agenda[J]. *Information Visualization*, 2011, 10(4): 310-326.

Jacobides, M. G., Cennamo, C., & Gawer, A. Towards a theory of ecosystems[J]. *Strategic Management Journal*, 2018(39): 2255-2276.

Li, J. [Jingye]. (2016). Research on the agglomeration development of industrial parks from a new industrialization perspective. *Commercial Research*, (9), 46-53.

Li, Y., & Zhang, Y. [Yanming]. (2012). Research on network resources, entrepreneurial orientation, and performance of incubated enterprises: An empirical analysis based on national business incubation bases in Dalian. *China Soft Science*, (08), 98-110.

Li, Z. [Zhenhua], & Li, F. (2018). Correlation among incubation networks, cluster social capital, and incubation performance. *Management Review*, 30(08), 79-89.

Li, Z. [Zhenhua], Liu, C., & Wu, W. (2019). Incubation network structure social capital, resource integration capability, and incubation performance. *Science Research Management*, *40*(09), 190-198.

Liu, H. (2016). Building smart parks to promote the upgrading of traditional parks. *Economic Research Guide*, (4), 113-114.

Liu, J. (2015). Out of the homogenization dilemma of park development. *China Industry Review*, (4), 16-20.

Liu, L., Zhang, M. [Min], Han, L., & Zheng, W. (2020). Problems to be solved urgently in environmental impact assessment of industrial park planning and countermeasures. *Chinese Journal of Environmental Management*, *12*(06), 47-51.

Liu, Y. [Yi], Zhang, Y. [Yi], & Xie, X. (2024). Research on resource reconstruction mechanism of industrial Internet platforms: From breadth and depth perspectives. *Research on Economics and Management*, *45*(01), 112-126.

Ma, M. (2016). Research review of smart parks in China. *Computer Knowledge and Technology*, 12(3), 174-176.

Ma, Q. (2002). *Management statistics: Research on data acquisition, statistical principles, SPSS tools, and applications*. China Science Publishing & Media Ltd.

Ma, Z. (2020). Research on sustainable profit model of smart parks. *Business Culture*, (14), 36-37.

Marion T J, Eddleston K A, Friar J H, et al. The evolution of interorganizational relationships in emerging ventures: An ethnographic study within the new product development process[J]. *Journal of business Venturing*, 2015, 30(1): 167-184.

Mikalef P, Pateli A. Information technology-enabled dynamic capabilities and their indirect effect on competitive performance: Findings from PLS-SEM and fsQCA[J]. *Journal of Business Research*, 2017, 70: 1-16.

Nambisan S, Sawhney M. Orchestration processes in network-centric innovation: Evidence from the field[J]. *Academy of management perspectives*, 2011, 25(3): 40-57.

Nambisan S, Siegel D, Kenney M. On open innovation, platforms, and entrepreneurship [J]. *Strategic Entrepreneurship Journal*, 2018, 12(3): 354-368.

Nooteboom B. Trust and innovation[M]//Handbook of advances in trust research. Edward Elgar Publishing, 2013: 106-122.

Oh D S, Phillips F, Park S, et al. Innovation ecosystems: A critical examination[J]. *Technovation*, 2016, 54: 1-6.

Pan, J. (2014). *Research on characteristics of the sci-tech park entrepreneurship ecosystem and the adjustment mechanism of enterprise actions*. Zhejiang University.

Pettigrew, A. M. Longitudinal field research on change: Theory and practice[J]. *Organization Science*, 1990, 1(3): 267-292.

Qin, X., & Li, D. (2022). Research on the development strategy of cultural and creative industrial parks from a metaverse perspective: Taking Shenzhen Cultural and Creative Industrial Park as an example. *On Economic Problems*, (11), 96-105.

Rai A, Tang X. Leveraging IT capabilities and competitive process capabilities for the management of interorganizational relationship portfolios[J]. *Information systems research*, 2010, 21(3): 516-542.

Ren, H., & Zhen, J. (2021). *General theory of industrial park management*. Shanghai: Shanghai People's Publishing House.

Rippa P, Secundo G. Digital academic entrepreneurship: The potential of digital technologies on academic entrepreneurship [J]. *Technological Forecasting and Social Change*, 2019, 146: 900-911.

Scillitoe J L, Chakrabarti A K. The role of incubator interactions in assisting new ventures[J]. *Technovation*, 2010, 30(3): 155-167.

Shi X, Shi Y. Unpacking the process of resource allocation within an entrepreneurial ecosystem[J]. *Research Policy*, 2022, 51(9): 104378.

Siggelkow, N. Evolution Toward Fit[J]. *Administrative Science Quarterly*, 2002, 47(1):125-159.

Spigel B. The relational organization of entrepreneurial ecosystems[J]. *Entrepreneurship theory and practice*, 2017, 41(1): 49-72.

Stam E. Entrepreneurial ecosystems and regional policy: a sympathetic critique[J]. *European planning studies*, 2015, 23(9): 1759-1769.

Su, J., Lin, J., & Zhang, Y. [Yanming]. (2017). Evolution path and mechanism of resource actions in entrepreneurial enterprises: From gathering to collaboration. *Studies in Science of Science*, *35*(11), 1659-1672.

Su, Z., Wei, J., Zhang, Y. [Yu] et al. (2023). Research on the mechanism of entrepreneurial enterprises building symbiotic ecosystems. *Studies in Science of Science*, 1-14.

Sun, C., & Wei, J. Digging deep into the enterprise innovation ecosystem: How do enterprises build and coordinate innovation ecosystem at firm level. *Chinese Management Studies*, 2019, 13(4), 820-839.

Sun, W. (2021). Innovation ecosystem construction, value co-creation, and governance of technology-based SMEs: Taking sci-tech parks as an example. *Contemporary Economic Management*, *43*(05), 14-22.

Teece D J. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy[J]. *Research policy*, 1986, 15(6): 285-305.

Tiwana A, Konsynski B, Bush A A. Research commentary—Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics[J]. *Information systems research*, 2010, 21(4): 675-687.

Unido (HPED/IPPS). Industrial estates: principles and practice[R]. Vienna: United Nations Industrial Development Organization, 1997.

Van de Ven, A. H., Huber, G. P. Longitudinal Field Research Methods for Studying Processes of Organizational Change[J]. *Organization Science*, 1990, 1(3):213-219.

Wang, D. [Depei]. (2022, July 7). Driving economic growth by over 30%, facing serious overcapacity and eight barriers to park development. *Yicai*. Retrieved from https://m.yicai.com/news/101309151.html

Wang, D. [Dongyang]. (2022). Smart park construction is the development direction of future industrial park transformation and upgrading. *Chinese Industry & Economy*, (13), 52-55.

Wang, H. (2022). Research on the competitiveness of Xi'an High-tech Industries Development Zone from the perspective of innovation and entrepreneurship ecosystem. Management & Technology of SME, (16), 40-42.

Wang, J. [Jici], & Zhu, K. (2018). Relevant theories of foreign industrial parks and their implications for China. *Urban Planning International*, 33(02), 1-7.

Wang, J. [Jiexiang], Chen, W., Jiang, S. et al. (2021). Participant strategy in platform ecosystem: Decoupling of complementarity and dependency. *Management World*, 37(02), 126-147.

Wang, S. [Shuguang], & Liang, S. (2022). New pattern of two-way spillover, cross-regional collaboration, and system dynamic balance in industrial parks. *Expanding Horizons*, (05), 112-120.

Wang, S. [Shuguang], Zheng, L., & Liang, S. (2022). Institutional evolution and model innovation of industrial parks in the process of China's industrialization. *Reform*, (05), 90-101.

Wang, X. (2014). *Interaction and integration between the development zone and city: An empirical analysis based on the Yangtze River Delta*. Nanjing: Southeast University Press.

Wang, X., & Gu, H. (2015). 30-year development zone planning in China: Exploration of urban and rural planning facing globalization and marketization. *Planners*, *31*(02), 84-89.

Wareham J, Fox P B, Cano Giner J L. Technology ecosystem governance[J]. *Organization science*, 2014, 25(4): 1195-1215.

Wei, J., & Xu, L. (2014). Double embedding of knowledge networks, knowledge integration, and innovation capability of cluster enterprises. *Journal of Management Sciences in China*, 17(02), 34-47.

Wei, J., Yang, Y. [Yang], Wu, A., Chen, L. et al. (2022). *Digital strategy*. Zhejiang University Press.

Weill P, Ross J W. IT savvy: What top executives must know to go from pain to gain[M]. Harvard Business Press, 2009.

Wilden R, Devinney T M, Dowling G R. The architecture of dynamic capability research identifying the building blocks of a configurational approach[J]. *Academy of management annals*, 2016, 10(1): 997-1076.

Wu, B., Wan, Z., & Levinthal, D. A. Complementary assets as pipes and prisms: Innovation incentives and trajectory choices. *Strategic Management Journal*, 2014, 35(9), 1257-1278.

Wu, M. (2009). *Structural equation model: Operation and application of AMOS*. Chongqing University Press.

Wu, X., & Feng, H. (2021). Establishment and development of incubator ecosystems in sci-tech enterprises. *Science and Technology Management Research*, *41*(8), 94-100.

Xiang, G., Gao, T., & Zeng, C. (2021). How do incubators improve the performance of incubated enterprises: An analysis from a configuration perspective. *East China Economic Management*, *35*(12), 110-119.

Xiang, S. (2006). Analysis of operation effect of park economy based on industrial agglomeration. *Journal of Xiangtan University: Philosophy and Social Sciences*, (3), 62-67.

Xie, K., Xia, Z., & Xiao, J. (2020). Enterprise realization mechanism of big data as a realistic production factor: From a product innovation perspective. *China Industrial Economics*, (5), 42-60.

Yam R C M, Lo W, Tang E P Y, et al. Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries[J]. *Research policy*, 2011, 40(3): 391-402.

Yu, D., Lin, T., & Liang, Z. (2011). Discussion on the development trend of park informatization. *Guangdong Communication Technology*, (7), 15-22.

Zeng, G. (2022). Exploration of public service design in industrial parks. *Urban Development*, (09), 88-89.

Zhang, J. (2020). Research review of industrial agglomeration and park economic development. *Northern Economy and Trade*, (02), 125-126.

Zhang, K., Zhang, Y. [Yi], & Yan, J. (2012). Solutions for informatization of smart parks. *Information & Communications*, (6), 118-119.

Zhang, W., & Zeng, Z. (2022). Problems faced by existing industrial parks and exploration of upgrading paths: Taking Guangzhou Science City improvement planning as an example. *Urban Architecture Space*, *29*(09), 163-165.

Zhong, Z., Shen, L., & Wang, X. (2021). Spatial evolution characteristics and influencing factors of smart industry space in the Yangtze River Delta. *Economic Geography*, *41*(11), 106-117.

Zhu, G. (2021). Transformation of urban comprehensive function agglomeration areas in smart industrial parks. *Informatization of China Construction*, (15), 34-35.

Zhu Z, Zhao J, Tang X, et al. Leveraging e-business process for business value: A layered structure perspective[J]. *Information & Management*, 2015, 52(6): 679-691.