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Research on the industrial chain network-driven innovation model of China's audio-visual industry park

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RESEARCH ON THE INDUSTRIAL CHAIN NETWORK-DRIVEN INNOVATION MODEL OF CHINA'S AUDIO-VISUAL INDUSTRY PARK

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2024

I hereby declare that this dissertation is my original work

and it has been written by me in its entirety.

I have duly acknowledged all the sources of information

which have been used in this dissertation.

This dissertation has also not been submitted for any degree

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Chen Yang

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ABSTRACT

This dissertation explores the model through which Chinese audio-visual industry parks drive innovation leveraging industrial chain networks, with Starpark as the core case study. It also integrates analyses of several other representative Chinese audio-visual industry parks. Based on these case analyses, it identifies critical elements essential for successful innovation within audio-visual industry parks driven by industrial chain networks, thereby providing a realistic foundation for the theoretical framework of the thesis.

Drawing on innovation theory, network theory, industrial chain network theory, and collaborative capability theory, this study abstracts the model driving innovation through industrial chain networks into theoretical constructs: the impact of network embeddedness on innovative performance and the process by which network embeddedness enhances innovative performance through collaborative capabilities. This forms the theoretical research framework of the thesis, presenting six theoretical hypotheses for testing.

To test these hypotheses, the thesis surveyed 150 companies within the Starpark, collecting data on companies' network embeddedness, collaborative capabilities, and innovative performance. The empirical research supports all the above six hypotheses.

Finally, the thesis proposes recommendations to foster innovation within Chinese audio-visual industry parks, including developing innovation carriers, establishing industry collaboration platforms, creating industry incubation bases, and enhancing legal or policy frameworks governing corporate relationships.

This thesis provides in-depth insights into the innovation model of Chinese audio-visual industry parks, offering valuable implications for enterprises, park administrators, and policymakers.

Keywords: Audio-visual Industry, Industrial Chain Networks, Structural Embeddedness, Relational Embeddedness, Collaborative Capabilities

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This thesis is a culmination of my team's and my nearly two decades of exploration, practical experience, and theoretical learning achievements in China's audio-visual industry and audio-visual industry parks. It is a collection of wisdom acquired from years of study and exchanges at Singapore Management University and Cheung Kong Graduate School of Business. I had the privilege of receiving meticulous guidance from professors Cyndi ZHANG Man, LIU Jing, Eric Zhao, and GENG Xuesong, among others. I gained numerous valuable suggestions during this journey, which have been immensely beneficial.

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Chapter 1 Introduction

1.1 Background

The development of China's audio-visual industry started relatively late and initially coexisted with both an institutional and industrial orientation, with a notably excessive degree of institutionalisation. With the promulgation of industrial policies, such as the separation of production and broadcasting, and the rise and rapid development of the online audio-visual industry in China, the audio-visual sector has gradually shown a prosperous development trend. Platforms like Tencent Video and Douyin, offering both long and short video content, have reaped huge profits in China and successfully expanded into foreign markets.

The Chinese audio-visual industry has continuously explored a development path suitable for China's national conditions, policy environment, and development context. However, its overall development still faces some adverse factors. Firstly, the industry, particularly the content sector, demonstrates poor overall coordination, exhibiting a diverse and fragmented development trend, leading to low utilisation of industrial resources, significant internal consumption, and waste. Secondly, the characteristic of the audio-visual industry is "content is king + technology first", which means that, compared to developed countries, China's audio-visual sector has a relatively weak foundation in innovation, such as in research, application technology, content creativity, copyrights, and so on. Thirdly, the parallel development of industrialisation and institutionalisation for an extended period has led to a mix of administrative and industrial management policies, with the development of the industry being influenced and suppressed by institutionalisation. Private enterprises, which are highly marketised and self-financed, compete with state-owned and centrally-owned enterprises, enjoying state financial allocations and subsidies, putting significant external pressure on the innovation and development of private enterprises.

Representative parks in China's audio-visual industry, such as Starpark and Hengdian Movie and Television Base, have been exploring development models for the Chinese cultural sector for many years since 2000, forming an innovation-driven model conducive to rapid resource integration, industrial synergy, and combined development forces. So, is this model that encourages enterprises to create networks, develop industrial chain networks, and utilise collaborative capabilities truly beneficial in enhancing corporate innovative performance?

Looking at the theoretical field, there has been considerable discussion about networked innovation and collaborative innovation (Ahuja, 2000; Guan & Liu, 2016; Helena Chiu & Lee, 2012; B. Yang et al., 2022), but research on the driving factors of innovation from both a network and collaborative perspective is still very scarce, especially in the field of management, where there is no research on the innovation issues of the audio-visual industry. Therefore, this paper intends to choose Starpark as the research carrier to study the impact of industrial chain networks and enterprises' collaborative capabilities on corporate innovative performance. The reason for choosing Starpark is that it is one of the few purely private audio-visual industry bases in China. Its shareholding structure, management and operation team, business system construction and derivative development align with China's audio-visual industry's industrialisation and marketisation trends. Compared to parks with government or state-owned enterprise backgrounds, it better reflects the objective development laws and existing issues of the industry.

Moreover, in terms of development history, Starpark has gone through different industrial stages, including audio-visual equipment production, a transition from audio-visual equipment production to audio-visual services, and the development of integrated audio-visual industry ecological parks. It has experienced the institutional development of China's audio-visual industry, the transformation from institutionalisation to industrialisation, parallel development of institutionalisation and industrialisation, and primarily industrialised development. Additionally, it has undergone technological iterations such as analogue, standard definition, high definition, ultra-high definition, and intelligent integrated audio-visual. Furthermore, compared to similar parks, enterprises within Starpark have achieved commendable results in content creativity and technological innovation, providing rich experience and theoretical models for reference.

Thus, Starpark is a representative development case among many audio-visual industry parks in China. The paper will base its research on the industrial development case of Starpark, supplemented with cases from other audio-visual industry parks, and combined with theoretical deductions to propose the main research question of the paper: whether industrial chain networks and enterprises' collaborative capabilities are beneficial in enhancing corporate innovative performance. The paper will then put forward theoretical hypotheses and empirically test these hypotheses.

1.2 Objectives

To analyse case studies of Starpark and other representative audio-visual industry parks in China, extracting critical elements from their development experiences, such as the role of industrial chain networks and industrial collaborative capabilities in driving innovation.

To construct a theoretical framework for promoting corporate innovative performance through industrial chain networks and collaborative capabilities and to empirically test the impact of structural embeddedness, relational embeddedness, and collaborative capabilities of different node enterprises in the industrial chain network on their innovative performance.

To compare Starpark’s industrial chain network with its industrial network (considering only enterprises within the park).

To provide theoretical and practical references for China's audio-visual industry parks to promote corporate innovative performance by building industrial chain networks and enhancing corporate collaborative capabilities.

1.3 Significance

1.3.1 Theoretical Significance

The study of the audio-visual industry and its industry parks represents a branch within the field of cultural industry and cultural industry parks research. There is a situation where theory development significantly lags behind practical development, while various problems arising from rapid industrial development require guidance from relevant theories and practices. This study, referencing theories such as network innovation theory, social network theory, industrial chain network theory, network embeddedness theory, and collaborative capability theory, constructs a theoretical model on the impact of network embeddedness and collaborative capability on corporate innovative performance, which fills the research gaps in this field and holds theoretical value.

1.3.2 Practical Significance

Having developed more than 40 years, China's audio-visual industry and its industry parks, which have emerged over the past nearly 20 years, possess tremendous development potential in the intelligent audio-visual, big data industry, digital economy, and the metaverse, forming the backbone of digital economic development. The thesis explores the paths of innovation-driven development of China's audio-visual industry parks and their industrial chain networks, providing a reference for the Chinese government in guiding innovative policy formulation for audio-visual industry parks. It also theoretically demonstrates the audio-visual industry's practical significance in creating innovative, collaborative, and incubation carriers. For instance, creating innovative carriers for the audio-visual sector involves building an innovative application production platform covering the entire industry chain, promoting new technologies, new scenarios, new models, and new business types in audio-visual content production, and cultivating new business types. Creating collaborative carriers for the audio-visual industry revolves around configuring service resources around the industrial chain, establishing an innovation service system covering the entire chain, and strengthening resource sharing and complementary advantages, thus forming a concerted force to drive the development of the audio-visual industry. Creating incubation carriers for the audio-visual sector entails constructing a full-chain incubation mechanism and policies for talent, technology, scenarios, production, and value transformation, providing survival space and soil for talent cultivation, innovation, and entrepreneurship in the industrial chain, and offering practical guidance for incubating audio-visual industry projects with Chinese genes and innovation genes.

1.4 Methodology

1.4.1 Literature Research Method

This method thoroughly examines domestic and international materials related to this research field, ensuring a comprehensive grasp of the literature pertinent to the study. It provides material for constructing the theoretical model of the thesis, developing measurement scales, and applying analytical tools. Specifically, it entails reviewing theories and methods related to corporate innovation and network theory and defining key concepts such as industrial agglomeration and virtual agglomeration, industrial networks and industrial chain networks, network embeddedness, and collaborative capability. A theoretical framework suggests that network embeddedness in businesses is conducive to corporate innovation and that a company's collaborative capability benefits its innovation. Based on this research framework, six theoretical hypotheses to be tested in the thesis are proposed.

1.4.2 Case Study

This part involves an in-depth analysis of the innovation model driven by the industrial chain network of Starpark. Research reports and commentaries on several other audio-visual industry parks in China are collected from official media and industry experts' social media accounts. These real-world cases are used to deduce the theoretical framework of the thesis, which posits that industrial chain networks and collaborative capabilities are conducive to corporate innovation.

1.4.3 Survey

The thesis utilises a survey method, designing a 5-point Likert scale for measuring relational embeddedness and collaborative capability based on existing related research. It also adopts a well-established measurement scale for innovative performance. The Name-generator method is used to collect the names of partner companies of the surveyed businesses. An industrial chain network structure diagram is drawn based on the relationships between all surveyed businesses and their nominated partners, which aids in calculating related indicators of structural embeddedness, such as degree centrality and constraint.

1.4.4 Social Network Analysis

Drawing on concepts and methods from sociology concerning social networks, network analysis is a standard method in studying industrial chain networks and innovation cooperation networks. It investigates the degree of embeddedness of different entities within the innovation cooperation network. This research uses the social network analysis software UCINET6.421 to depict businesses' industrial chain network diagram and measures related indicators of the ego network structure embeddedness of surveyed businesses, which provides tools and methods to explore further the impact of network embeddedness and collaborative capability on innovative performance.

1.4.5 Statistical Analysis

The thesis applies various statistical analysis methods, using SPSS software for exploratory factor analysis, reliability and validity tests, and mediating effect tests of the scales measuring relational embeddedness, collaborative capability, and innovative performance. AMOS software is used for confirmatory factor analysis and reliability and validity tests of the scales.

Chapter 2 Conceptual Definitions and Literature Review

2.1 Innovation-Related Theories

In modern corporate theory, enterprises are no longer viewed as isolated entities, but instead rely on collaboration with stakeholders to create and realise value. The higher the quality, scope, and degree of cooperation, the greater the developmental space and potential for the enterprise.

2.1.1 Linear Innovation

The theory of technological innovation originates from the early 20th century, with Schumpeter as a representative figure. He first proposed the innovation theory in "The Theory of Economic Development" in 1921, defining innovation as a new combination of production factors and conditions. Schumpeter considered innovation to be the driving force of capitalist economic growth, encompassing the adoption of new products, new methods of production, the opening of new markets, the acquisition or control of new sources of raw materials, and the realisation of new industrial organisations. He believed that innovation has characteristics of endogeneity, revolutionary nature, creative destruction, and entrepreneurial spirit (Schumpeter & Swedberg, 2021).

After the 1950s, New-Schumpeterism emerged, emphasising that knowledge is an interactive process. Innovation occurs within the interactions between firms, research institutions, users, and the broader institutional environment (Dosi, 1988). Interactions between innovators and firms facilitate the transfer and diffusion of knowledge, information, and technology.

2.1.2 Network-Based Innovation

German sociologist Simmel (1922) first used the concept of "network" in

"Conflict and the Web of Group Affiliations". Mitchell defined a network as a relationship connecting people, objects, or events. Hakanson views networks as comprising acting subjects, the occurrence of activities, and the flow of resources (H. Hakansson, 2015). Easton and Nohria further explored the concept and characteristics of networks (Easton, 1996; Nohria, 1992).

Ronald S. Burt pointed out the significant impact of information dissemination and social influence within social networks on the diffusion of technological innovation. Scholars like Lundvall emphasise the importance of the interaction between producers and users in innovation. Freeman and others defined "innovation networks" as the primary institutional arrangements for systemic innovation (Freeman et al., 1991). GREMI highlights the critical role of innovation networks formed between enterprises and innovation elements on innovation (Camagni, 1991).

Innovation networks can reduce technological and market uncertainties, access complementary resources and skills (Guan & Liu, 2016), share R&D costs (G. Xu et al., 2012), and enhance technological and business competitiveness. Baptista and Swann emphasise that enterprises should value communication and interaction with suppliers and customers in the innovation process to benefit from knowledge spillovers and information sharing (Baptista & Swann, 1998). Hoffman et al.'s research also supports this viewpoint (Hoffman et al., 1998).

2.1.3 Comparison of Characteristics between Linear Innovation and Network Innovation

From the development of innovation theories, it is possible to broadly summarise the evolution of innovation theory into stages of linear innovation and networked innovation. Before the 1970s, technological innovation was seen as an activity within individual enterprises, but this perspective neglected the social context and the connections between enterprises. With the rapid development of the world economy and accelerated technological changes, external connections of enterprises have become increasingly important. Innovation is no longer a simple linear model but an interactive process in every enterprise production and operation link. Innovation is a learning process, manifested as learning in interaction (Malecki, 2017), characterising the feature of enterprise networked innovation.

Scholars have conducted research from the perspectives of regional innovation networks and industrial dynamic innovation systems. Still, there has been less study on the relationship between network embedding and innovation of individual enterprises from the level of regions or industrial parks. Existing research often regards regions as closed systems without fully considering the external connections of the region, which is precisely what this doctoral dissertation aims to overcome.

2.2 Network Theory and Methodology

This section reviews network theory and methods, initially exploring the theory of corporate networks from a management perspective and their efficacy, followed by a review of social capital theory as an essential branch of social network theory, and analyses the two main perspectives on how social networks create social capital - the theory of structural holes and the theory of social closure. Finally, an overview of social network analysis theory and methods is provided.

2.2.1 Corporate Network Theory

Corporate network theory plays a significant role in management studies, focusing on the connections between individual enterprises, as opposed to macro-level research such as national and regional innovation systems. Traditional management theories often explain profit differences between enterprises based on factors such as size and market position without considering the diversity of the networks enterprises are part of and the impact of their positions within these networks on enterprise performance. Corporate network theory emphasises that with the increasing degree of social networking, the formation and development of inter-enterprise networks have become vital factors affecting the profit-making and innovation capabilities of enterprises, challenging the traditional view of atomistic competition (Gulati, 1998; Gulati et al., 2000; M. W. Peng & Heath, 1996).

Since the 1970s, networks have become a key term in describing modern organisations, widely applied across various organisations and industries, giving rise to various network-related organisational forms such as network organisations, strategic networks, and enterprise networks (Nohria, 1992; Gomes-Casseres, 1994; Uzzi, 1997). In the last two decades, attention to inter-enterprise networks in management has significantly increased. Jarillo, in "On Strategic Networks", views networks between enterprises based on cooperation and trust as a source of enduring competitive advantage for enterprises (Jarillo, 1988). Nohria and Eccles, in "Networks and Organizations: Structure, Form, and Action", mark a flourishing period in network research (Nohria, 1992). Subsequent works like Gulati's "Alliances and Networks" and Madhaven et al.'s "Networks in Transition: How Industry Events (Re)Shape Interfirm Relationships" have provided in-depth reviews and developments of corporate network theory (Madhavan et al., 1998). Grandori, in "Interfirm Networks: Organization and Industrial Competitiveness", emphasises the theoretical exploration of network operational mechanisms, covering the positive and negative externalities of networks and their impact on economics and other social science fields (Grandori, 1999).

Since the 21st century, corporate network theory has entered a phase of systematic research, spanning multiple fields such as organisational economics, organisational sociology, and management, forming numerous theoretical schools. Representative academic schools include economic sociology, organisational, and cultural (Gulati; Jarillo; Richter; Porter; Moor). Related research has delved into the functions and efficiency boundaries of inter-enterprise networks, drawing on enterprise strategic management theory from perspectives such as resource-based and knowledge-based views, explaining how inter-enterprise networks can bring competitive advantages and cooperative quasi-rents to enterprises (Ireland et al., 2002), and based on transaction cost theory, discussing the role of inter-enterprise networks in helping enterprises complete complex tasks.

However, discussions of the "network" concept in economic and management disciplines have long remained at the theoretical level, lacking specific analytical content. This is mainly because enterprise networks are often viewed as a governance structure between markets and enterprises, with less discussion of their topological structure, thus overlooking the interactive relationship between network structure and function. With the rise of complex network theory, researchers have begun to pay attention to the topological configurations of real social networks, such as interpersonal relationship networks and corporate director networks, to explain the impact of network structure on network dynamics processes (Johnston et al., 2006; Newman, 2003). Research on network structure and dynamics based on these theories provides new perspectives and methods for exploring differences in enterprise performance under different network embeddings.

2.2.2 Social Capital Theory

Social capital theory, a significant branch of social network theory, has garnered considerable attention from scholars since the concept of "social capital" was introduced. It is viewed as a productive outcome within social networks, offering insights into the benefits of network embeddedness.

2.2.2.1 The Essence of Social Capital

Initially, social capital was used to describe relational resources in community interpersonal relationships (Jacobs, 2016) and was later widely applied to studies concerning issues within and outside organisations (Burt, 1992; Nahapiet & Ghoshal, 1998). Although a unified definition has not been established, several definitions have been formed (Burt, 1992; Coleman, 1994; Putnam et al., 1993).

The concept of "social capital" was first explicitly introduced by French sociologist Pierre Bourdieu, defined as a collection of actual or potential resources obtained through the possession of "institutionalised social networks." These networks relate to group membership, winning "prestige" by getting membership status and ensuring material or symbolic benefits (Bourdieu, 2011). American sociologist N. Lin discovered that individuals could gain advantageous resources from social networks, proposing the "social resources" theory, defined as the sum of resources obtained through direct or indirect relationships embedded in social networks (N. Lin, 2002), emphasising social capital as social resources based on social network analysis (N. Lin, 1999). James Coleman provided a systematic discussion on social capital, viewing it as offering stability to society, defined as entities conducive to specific actions of individuals within a social structure (Coleman, 1994), proposing social capital as structural factors of society, providing a foundation for theoretical development from micro to macro levels, and noting that actions generating social capital bring resources.

American political scientist Robert Putnam first applied the concept of social capital to a broad social context, viewing it as networks, norms, and trust that promote unity and cooperation among members, reducing opportunistic behaviour. Putnam regarded social capital as the wealth of the entire society, believing that social and democratic development is influenced by it (R. D. Putnam et al., 1993). His views sparked widespread discussion in academia and the public about the relationship between social capital, civil society, and democratic politics. The economic field focuses on the impact of norms and networks in social interactions on the economy. Francis Fukuyama considered the prevalence of trust as social capital, arguing that economic prosperity depends on the degree of social trust (Fukuyama, 1996), with subsequent research exploring changes in social capital and consequences in different countries (Schneider et al., 2000).

2.2.2.2 Dimensions of Social Capital and Functions of Each Dimension

Nahapiet and Ghoshal defined social capital as the sum of actual and potential resources embedded in the network of relationships of individuals or social units, divided into structural, relational, and cognitive dimensions. The structural dimension involves network ties, structure, and appropriable organisation[1]; the relational dimension focuses on trust, norms, and identity; the cognitive dimension includes shared language and stories (Nahapiet & Ghoshal, 1998).

The structural dimension of social capital focuses on the form and structure of relationships between enterprises (Inkpen & Tsang, 2005), varying depending on the network. The position of enterprises within the network determines the amount of social capital they obtain, with central positions and go-between positions being the most advantageous. Studies show that enterprises with rich social relationships are more likely to acquire knowledge, strengthening information processing capabilities (Hansen, 1999). Central positions enable enterprises to quickly obtain and share diversified knowledge (Tsai, 2001). Meanwhile, go-between positions, such as gatekeepers or brokers, help acquire wealth, influence, and resource control rights, connect different groups, and strengthen resource control.

The relational dimension of social capital involves relationship characteristics and the capital within relationships (Tsai & Ghoshal, 1998), including relationship strength and trust. Relationship strength refers to the intimacy and frequency of communication between collaborators (Hansen, 1999), with solid relationships facilitating knowledge transfer, as they encourage enterprises to invest more effort to ensure knowledge understanding and application (Reagans & McEvily, 2003; Rowley et al., 2000a; Hansen, 1999). Trust is the belief in the reliability of collaborators

[1] Appropriable organization refers to a network constructed for a specific purpose, characterized by organizational attributes that enable it to be repurposed or redirected towards other objectives.

(Inkpen, 2000), crucial for knowledge transfer, resource sharing, and exchange (Lane et al., 2001; Szulanski et al., 2004), as trust inspires the willingness to understand and apply external new knowledge (Lane et al., 2001). However, excessive trust may lead to collective blindness, hindering knowledge exchange (Lane et al., 2001; Yli-Renko et al., 2001).

The cognitive dimension of social capital provides resources for shared understanding, interpretation, and meaning systems (Nahapiet & Ghoshal, 1998), manifested as common visions and values, aiding in understanding collective goals and correct actions (Tsai & Ghoshal, 1998). Shared visions, systems, and cultural differences are critical cognitive factors affecting knowledge transfer between enterprises (Inkpen & Tsang, 2005), promoting mutual understanding and knowledge integration. Similarity in organisational structure, compensation policy, dominant logic, and other cognitive factors also facilitate knowledge transfer and sharing (Lane & Lubatkin, 1998; Mowery et al., 1996).

2.2.3 Two Key Perspectives on How Social Networks Generate Social Capital

The discussion on how social networks create social capital centres on two main perspectives: Burt's Structural Hole Theory and Coleman's Social Closure Theory. Structural Hole Theory posits that sparse networks facilitate the creation of social capital, whereas Social Closure Theory values the role of dense, cohesive networks (Gabbay & Leenders, 2001). These viewpoints are not necessarily contradictory, as in sparse networks, value creation can be achieved by intermediaries bridging structural holes, but this requires gaining the trust of the bridged actors/groups, which is ensured by the network's closure. Burt suggested that when trust prevails, network closure creates social capital (Burt, 2007); real-life behaviour often results from "performance is a product of brokerage outside the group and closure inside the group " (Oliver et al., 2007). These perspectives collectively reveal how social networks create social capital through different structural and relational mechanisms.

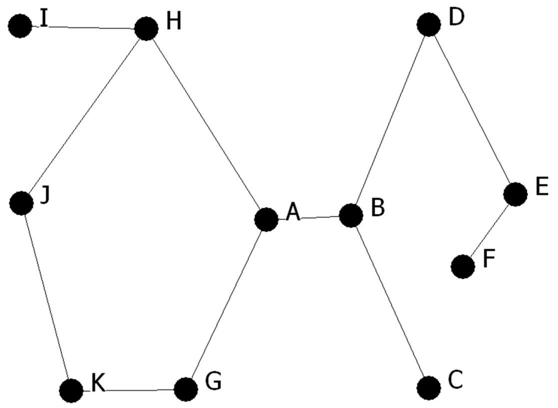
2.2.3.1 Structural Hole Theory

Burt introduced the Structural Hole Theory, highlighting that in sparse networks, specific nodes form structural holes by connecting different influential actors with minimal relational investments, i.e., non-redundant connections between two actors in the network, serving as bridges for acquiring new information and resources (Burt, 1992). These actors occupying structural holes are in advantageous positions by bridging different networks, enabling them to uncover opportunities in competitive environments. Johanson referred to this as the instrumental approach (Johanson, 2001) [2], emphasising its importance in resource acquisition and information circulation. Actors occupying structural hole positions can bridge two disconnected nodes within a network (Figure 2.1), occupying a vantage position. This position allows the actor to exploit opportunities from separate networks in a competitive environment.

2 The theory of social capital differentiates actions into two types: instrumental and expressive. Instrumental actions refer to actions taken to achieve a specific purpose. Networks rich in "structural holes" typically facilitate instrumental actions. Conversely, expressive actions are those taken for one's own interests. "Closed networks" are typical for realizing expressive actions, where the presence of strong ties among actors makes expressive actions more feasible due to the homogeneity in socio-economic characteristics, lifestyles, and attitudes among the actors.

Figure 2. 1

Sparse Network



Note: Self-compilation

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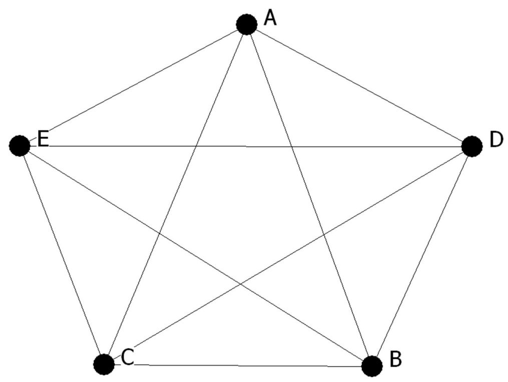
2.2.3.2 Social Closure Theory

Burt introduced the Structural Hole Theory, highlighting that in sparse networks, certain nodes form structural holes by connecting different influential actors with minimal relational investments, i.e., non-redundant connections between two actors in the network, serving as bridges for acquiring new information and resources (Burt, 1992). These actors occupying structural holes are in advantageous positions by bridging different networks, enabling them to uncover opportunities in competitive environments. Johanson referred to this as the instrumental approach (Johanson, 2001), emphasising its importance in resource acquisition and information circulation.

Figure 2. 2

Dense Network



Note: Self-compilation

Coleman argued that trust is critical to developing social capital, which cannot be bought or imposed but must naturally form under network conditions conducive to fostering trust. In dense networks, trust among members promotes the expectation of reciprocal behaviour, enabling enterprises to develop social capital, which aids in forming cooperation norms and trust (Walker et al., 1997). Such dense connections also promote rapid information flow between enterprises and strengthen sanctions against opportunistic behaviour, thereby saving transaction costs (Nooteboom, 2002).

Cohesive networks provide economic benefits by reducing member transaction costs and offering value in social support, providing more resources to eliminate social and psychological stress than non-integrated networks (N. Lin & Ensel, 1989). This social support is also conducive to members creating breakthrough innovations (Monge & Contractor, 2001). In summary, tightly linked networks provide significant value for individual members and add value to the entire network, demonstrating the critical role of Social Closure Theory in creating and sustaining social capital.

Burt's Structural Hole Theory contrasts with Coleman's perspective, which views monitoring, trust, and reciprocal norms among closely connected actors as sources of social capital, implying that densely connected networks are more constraining. Coleman sees Dense connections as beneficial, while Burt views them negatively.

Subsequent research has demonstrated the existence of mechanisms proposed by Burt and Coleman—for instance, the impact of structural holes on dependent variables like career success. Additionally, numerous studies have investigated moderating factors in the relationship between structural holes and dependent variables, such as trust, power and status, culture, and cognitive style. Sometimes, structural holes fail to explain outcome variations, prompting researchers to focus on intermediary behaviours. Obstfeld introduced the concept of tertius iungens, the third party joining others, in contrast to tertius gaudens, the third party separating others (Obstfeld, 2005). Burt found structural holes related to good ideas, while Obstfeld discovered that intermediary tendencies in densely connected networks could predict innovation. Subsequent researchers categorised intermediary behaviours as embedded and non-embedded, adding a short-term and long-term perspective to discussions on intermediary behaviours (Quintane & Carnabuci, 2016) [3]. Other studies propose two forms of intermediary behaviour: arbitrage (creating informational asymmetry by disconnecting from others) and cooperation (sharing information, allying, recruiting, and connecting others). Compared to an arbitrage orientation, a cooperative orientation significantly reduces the positive relationship between structural holes and performance (Soda et al., 2018); Grosser and others further divided the arbitrage/dividing orientation into intermediary and separating (Grosser et al., 2019). Thus, ego-centric intermediary studies were later distinguished between the perspectives of " keep them separated" and " bring them together" (Brass, 2022).

2.2.3.3 Network Position and Social Capital

In various network structures, the position or embedding of enterprises determines the level of social capital they can acquire. Research by Walker et al. indicates that enterprises located in dense areas of a network can obtain higher social capital, while those in looser areas have lower social capital (Walker et al., 1997). The key to enterprises acquiring social capital lies in their position within the network, primarily including central and intermediary positions. Enterprises in central positions may obtain formal or informal social

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3 Brokers often engage in information brokerage through short-term interactions with colleagues outside their long-term relationship networks, a process we refer to as "unembedded brokerage." When engaging in unembedded brokerage, brokers are more likely to mediate information flow between the parties involved than participants in dense network positions, aligning with the tertius gaudens strategy. Conversely, when conducting information brokerage through long-term relationship networks (embedded brokerage), brokers are more likely to facilitate direct information exchange between the parties involved, aligning with the tertius iungens strategy (Quintane & Carnabuci, 2016).

influence due to more frequent contact with other group members (Brass, 2022), better control of the external environment, and reduced uncertainty (Borgatti et al., 1998). Enterprises in intermediary positions, acting as the necessary path between two actors, can manipulate more resources (Burt, 1997, 2004; Burt & Soda, 2021), providing strategic advantages, especially crucial in controlling information flows (Burt, 2004). For example, individuals in intermediary positions in consulting networks can access important information and knowledge (Nahapiet & Ghoshal, 1998). Such information and expertise facilitate transactional conversations and generate trust between exchange parties, further strengthening social capital formation[4]. These studies reveal the importance of network position in acquiring and enhancing social capital, whether through centrality or intermediacy, allowing enterprises to gain competitive advantages and advantages in resource acquisition within their social networks.

2.2.4 Social Network Analysis

2.2.4.1 Development of Network Analysis

Network analysis aids in describing system structures and was initially developed in the 1930s in fields such as psychology and sociology (Wigand, 1988; Wasserman & Faust, 1994). Social networks are viewed as the relational structure between actors. The application of network analysis techniques in sociology, known as social network analysis, includes basic units such as dyad[5] and triad[6], and involves network-level concepts like

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4 Blau (1964) posits that social exchange differs from economic exchange in that, in social exchanges, individuals cannot anticipate immediate returns. Hence, they must rely on the goodwill of others and expect returns in the future. Through a series of successful social exchanges, the parties involved eventually build mutual trust.

5 A dyad consists of two nodes (actors) and their potential relationships. For example, a friendship dyad includes two friends and the relationship between them. Characteristics

density and centralisation (Scott, 2012).

In the 1930s, Jacob Moreno established sociometry, invented the sociogram, and laid the metric foundation for network analysis. Subsequently, the American Harvard School emphasised the importance of interpersonal relationships in social systems and studied factions and group relations, such as Warner and Mayo's Hawthorne experiments (Scott, 2012). Starting with the Manchester school, social anthropologists like John Barnes and Clyde Mitchell transformed the social network metaphor into systematic research, focusing on conflicts and contradictions within social systems (Scott, 2012). By the late 1960s, scholars such as Harrison White at Harvard University researched social structures from a mathematical perspective, propelling new developments in social network analysis. During this period, network analysis methods relied on mathematical approaches, such as applying set theory and multidimensional scaling techniques. Since the 1990s, social network analysis has rapidly developed, with theories such as Burt's structural hole theory and Lin's social capital theory (Burt, 1992, 2004; N. Lin, 2002, 2008).

In summary, social network analysis has become an essential technique in multidisciplinary research, possessing a range of methods, measurements, and tools. Its foundation is graph theory, while the encoding and processing of network data mainly rely on matrix algebra (Burt, 1992, 2004; N. Lin, 2002, 2008). These tools and methods offer researchers great convenience in describing and analysing social networks and structures.

2.2.4.2 Relevant Concepts in Network Analysis

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of dyads typically include reflexivity, symmetry, and transitivity (Wasserman and Faust, 1994).

6 A triad is a point-generated subgraph consisting of three nodes (actors) and the possible relationships among them.

(1) Nodes, Actors

In social network analysis, "nodes" refer to various social actors, while "edges" represent the social relationships between actors. In social network research, any social unit or entity can be considered a "node" or "actor," such as individuals, companies, schools, villages, communities, cities, and nations.

(2) Ego, Alter

From the perspective of a specific actor, that actor is referred to as "ego," and their social network is their ego network. Within the ego network, actors directly connected to the ego are called "alters."

(3) Relation, Tie

Relations can be of various types, including exchange, affective, authority, kinship, etc. "Tie" represents a concrete substantive connection between actors, encompassing real and virtual relationships, and does not belong to any single individual (Wasserman & Faust, 1994).

(4) Path, Walk, Trail

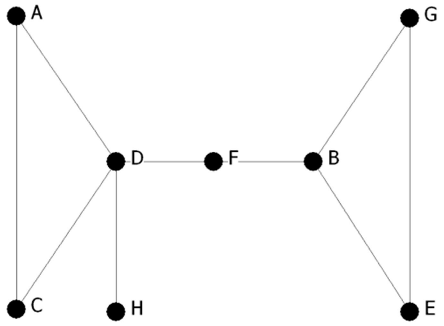
To understand the concept of a path, it is necessary first to comprehend the notions of a route (walk) and a trail. A route comprises nodes and lines, starting at one node and ending at another, with continuous nodes and lines. For instance, in Figure 2.3, A—D—F—D—H—D constitutes a route. A trail is a route that does not pass through repeated line segments. For example, B—E—G—B is a trail where the B node is repeated, but the line is not. Conversely, a path is a route where nodes and line segments do not repeat, such as A—D—H. A geodesic is the shortest path between two nodes, selecting the route with the shortest, non-repeating lines and nodes, like the A—D—H from A to H.

(5) Distance

Refers to the minimum number of lines that must be traversed from one node to another, the total number of lines on the geodesic between two nodes. For example, the distance from A to H is 2.

Figure 2. 3

Path, Walk, Trail



Note: Self-compilation

Distance refers to the minimum number of lines that must be traversed in a path from one node to another. It is the number of lines in the shortest path (geodesic) between two nodes. For instance, as can be discerned from Figure 2.3, the distance from node A to H is 2.

2.2.4.3 Centrality

Centrality is a key indicator for measuring the importance of individuals in social networks, used to assess advantages in network positions, social prestige, and more. This concept has been widely developed since the mid-20th century, becoming indispensable to social network analysis (Everett & Borgatti, 2005). Centrality focuses on the ability of nodes to obtain and control resources/information, with individuals at the network's core having more significant influence and less dependency due to their connections with multiple other individuals (Cook & Emerson, 1978). Centrality not only enhances the opportunity for individuals to access information but also strengthens their ability to control resources. It enables individuals to choose among alternative contacts, reinforcing their social network status (Sparrowe et al., 2001; Wasserman & Faust, 1994).

The main methods of measuring centrality include degree centrality, betweenness centrality, and closeness centrality, reflecting the extent of a node's central position in the network (Wasserman & Faust, 1994). Degree centrality measures the number of direct connections a node has with other actors, reflecting the node's activity level and informal power in the network (Freeman, 1978). For instance, in the star-shaped network shown in Figure 2.4, actor A has the highest degree centrality due to its direct connections with multiple nodes, becoming crucial to information flow. In contrast, in the circular network shown in Figure 2.5, all actors have the same degree of centrality, indicating equal activity levels within the network.

Centrality is related to group efficiency and individual satisfaction. It is used to explain various phenomena in social systems, such as social influence, promotion opportunities (Brass, 1984), decision-making influence (Friedkin, 1998), resource acquisition, and innovation (Ahuja, 2000; Tsai, 2001). These studies suggest that centrality is not only about an individual's position in the network but also affects the formation and utilisation of their social capital.

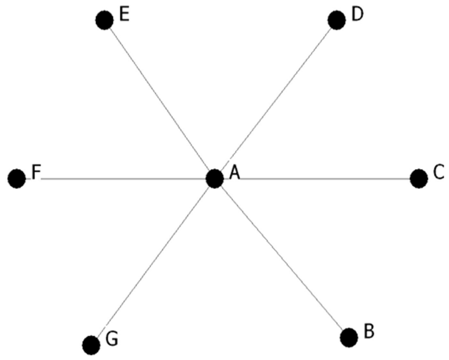
Formula (2-1) shows the degree of centrality calculation.

$$C_D\left(n_i\right) = d\left(n_i\right) = \sum_j X_{ij} = \sum X_{ji} \qquad (2\text{-}1)$$

In this formula, it is either 0 or 1. A value of 1 indicates a relationship between actor i and actor j. In contrast, 0 shows no relationship between actor i and actor j.

Figure 2. 4

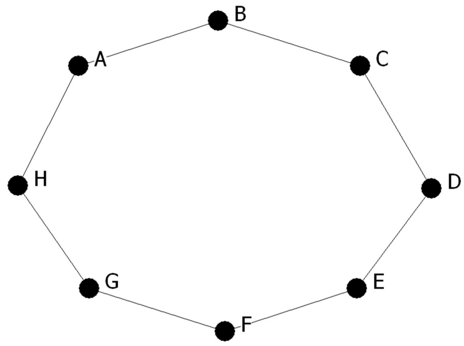
Star-Shaped Network



Note: Self-compilation

Figure 2. 5

Circular Network



Note: Self-compilation

Betweenness Centrality. It measures a node's ability to control the flow of resources in an innovation network, mainly when that node acts as a crucial "broker" on the communication paths between other nodes, preventing exchanges between them (Burt, 1992). This centrality indicator reflects the extent to which a node serves as a bridge for communication between any two other nodes in the network, typically positioned on the shortest path connecting those two nodes (Kilduff & Tsai, 2003) [7]. Betweenness centrality reflects the node's strategic position within the network and reveals its capacity to exert influence by controlling the flow of information and the distribution of resources.

Let g_{jk} be the number of shortest paths connecting two actors, and the probability of using any one of these paths is $1/g_{jk}$, If we consider the likelihood of the shortest paths between two actors passing through actor i, we can define $g_{jk}\left(n_i\right)$ as the number of shortest paths between two actors that

7 Freeman analyzed betweenness centrality based on the concept of "local dependency," noting that if the paths connecting a particular node to other nodes pass through this node, then the latter is dependent on the former. Later, Burt elaborated on this idea with the concept of "structural holes," which he described as existing when two nodes are connected at a distance of 2 (instead of 1). The presence of structural holes allows a third party to play the role of a broker or intermediary.

include actor i. Freeman estimated the probability of passing through actor i as $g_{jk}(n_i)/g_{jk}$. He suggested that if the probability of selecting any of the shortest paths between two actors is equal, then the betweenness centrality index of actor i can be represented as the sum of the probabilities of the shortest paths passing through i among all pairs of actors excluding actor i. The formula is as follows:

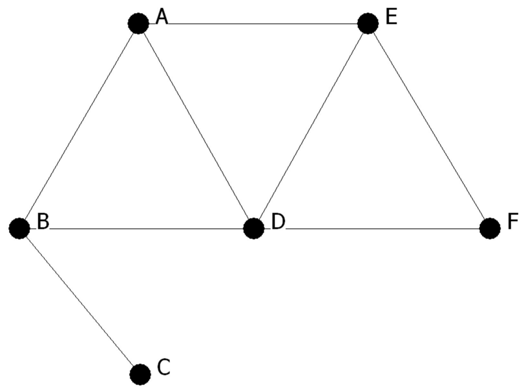
$$C_B(n_i)=\sum_{j<k} g_{jk}(n_i)/g_{jk} \qquad (2\text{-}2)$$

For any actor i different from j and k, this index measures the extent to which the actor plays the role of a broker. When actor i is not on any shortest path between any pair of other actors, the value of this index is minimal, at 0, indicating that the actor cannot control any interactions and is on the network's periphery. The maximum value of this index is $C_{g-1}^2=(g-1)(g-2)/2$, which is the total number of other points' pair combinations excluding n_i. In the star-shaped network (Figure 2.4), the centrally located actor A plays the role of broker and gatekeeper within the network, controlling all paths, and thus possesses high betweenness centrality. This position affords actor A more opportunities to acquire diversified knowledge (Freeman, 1978; Friedkin, 1991).

To illustrate further, let's calculate the betweenness centrality for actor D in Figure 2.6. Firstly, there are two shortest paths from A to F, and D is on one of these paths. Therefore, the estimated probability of the A-F path passing through D is 1/2. Both paths from C to F and B to F must pass through D, so the likelihood for each can be increased by 1. There are two paths, each from E to B and E to C, going through D and A, respectively, so the probability can be increased by 1/2. Thus, the final betweenness centrality for D is 1/2+1+1+1/2+1/2=3.51/2+1+1+1/2+1/2=3.5.

Figure 2. 6

Betweenness Centrality Example



Note: Self-compilation

Closeness Centrality. It reflects the proximity of a node to all other nodes in the network, measuring the ease with which it can facilitate information transmission. This metric indicates the ability of an actor to reach all other actors in the network, serving as an indicator of an individual's capacity to disseminate information autonomously. Positions that are not central are those "that must pass information through others," meaning actors in non-central positions need to relay information through others, whereas actors with high closeness centrality can directly and swiftly reach other nodes in the network (Bavelas, 1950). Consequently, actors with greater closeness centrality are less dependent on others for information transmission and can connect with all other actors in the network through shorter paths.

Let $d(\bullet,\bullet)$ be a distance function, representing the distance between actor i and actor j. The sum of distances from i to all other actors is denoted as $d(n_i, n_j)$. The sum of distances from actor i to all other actors is represented as the sum for all $j \neq i$. Therefore, the Sabidussi index of closeness for an actor, which is the inverse of the sum of distances from actor i to all other actors, is a commonly used to assess closeness centrality (Sabidussi, 1966). The formula is as follows:

$$C_C(n_i)=\left[\sum_{j=1}^{g} d(n_i,n_j)\right]^{-1} \qquad (2\text{-}3)$$

$d(n_i,n_j)$ represents the distance between actor n_i and actor n_j, $C_C(n_i)$ is the inverse of the total distance from a node n_i to all other nodes. The smaller this value, the greater the overall distance from n_i to other points in the network, indicating that the actor n_i is more peripheral and less essential. The maximum value of closeness centrality is achieved only in a star-shaped network. In such a network, if there are g points, the closeness centrality of the "central node" or "core point" is $1/(g-1)$.

Closeness centrality requires the network to be a fully connected graph, meaning each node can reach all other nodes. In graphs that are not fully connected, such as those with isolated points, closeness centrality cannot be calculated because isolation reduces the total distance. Closeness centrality is closely related to degree centrality, and nodes with high degree centrality usually also have high closeness centrality.

2.2.4.4 Structural Holes

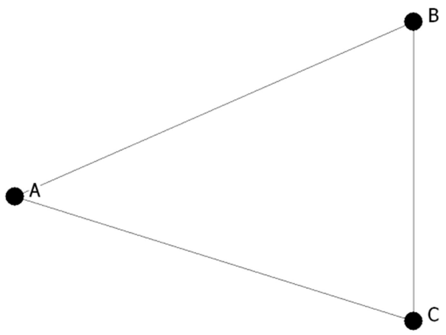
(1) Definition of Structural Holes

Burt defines structural holes as the gaps between two actors or clusters that can be bridged by a third party acting as the sole intermediary (Burt, 2007; Kilduff & Tsai, 2003). Individuals who bridge structural holes possess higher social capital due to their access to a more diverse range of information. Those who span structural holes can gain significant advantages, such as loan officers completing transactions through structural holes (Mizruchi & Stearns, 2001), as well as higher performance evaluations and salary growth (Burt et al., 2000; Mehra et al., 2001). Research on structural holes also relates to individual early promotion, salary, and job performance (Burt, 2004; Podolny & Baron, 1997), and at the organisational level, to total quality management and team performance (Burt, 1997, 2004).

In a network of three actors (as shown in Figure 2.7), if each actor is connected to the other two, actor A may be disadvantaged in negotiations because B and C can choose alternative traders, isolating A for transactions.

Figure 2. 7

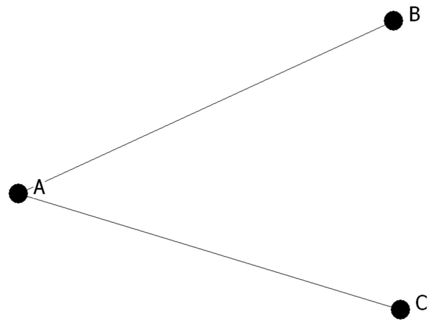
Network without Structural Hole



Note: Self-compilation

Figure 2. 8

Network with a Structural Hole



Note: Self-compilation

Opening a "structural hole" between B and C (as shown in Figure 2.8) eliminates their direct connection, potentially preventing transactions between them due to high transaction costs or a lack of mutual recognition. This structural hole gives A a positional advantage, making A the only actor to transact with both B and C. In more extensive networks, structural holes increase as the scale expands and network density decreases, providing individuals with more positional advantages.

(2) Measurement Indicators of Structural Holes

Burt formalised the concept of "structural holes" and developed various measurement methods, such as the Structure computer program, to explore how structural holes affect individuals' opportunities and actions (Burt, 1992). The measurement of structural holes includes using binary data and valued data[8], with the main indicators being constraint, effective size, efficiency, and hierarchy.

Constraint. It measures the degree to which an individual's ties to adjacent actors impose constraints on them, reflecting the scarcity of structural holes. High constraint implies fewer structural holes and information redundancy and is inversely related to performance (Burt, 1992, 1997). Reasons for individuals being constrained in the network include having limited contacts, close connections in dense networks, or sharing information indirectly through central contacts (Burt, 2007).

The formula for calculating constraint is as follows:

$$c_{ij} = \left(P_{ij} + \sum_q P_{iq} P_{qj} \right)^2 \qquad q \neq i, j \qquad (2\text{–}4)$$

$$C_i = \sum_j c_{ij} = \sum_j \left(P_{ij} + \sum_q P_{iq} P_{qj} \right)^2 \qquad q \neq i, j \qquad (2\text{–}5)$$

In formulas (2-4) and (2-5), P_{ij} represents the proportion of investment i makes in the acquaintance j (or the time/energy i spends on j as a percentage of i's total time/energy); P_{iq} is the proportion of investment i makes in the

8 Binary data is used to measure the presence or absence of a certain type of relationship between nodes, where "no relationship" and "relationship" correspond to "0" and "1", respectively. Valued data, on the other hand, involves adding a measure of the strength of the relationship between nodes.

acquaintance q; and P_{qj} is the proportion of investment q makes in the acquaintance j. The sum within the parentheses represents the proportion of i's direct or indirect investment in the acquaintance j. The minimum value of c_{ij} is p_{ij}^2 (i.e., j is not connected to any other points), and its maximum value is 1 (i.e., j is i's only contact). A larger c_{ij} value indicates a network concentrated around many redundant contacts, suggesting that the aggregate constraint imposed on i by all its ties is greater (Fazio & Maltese, 2015; Reagans et al., 2004). In formula (2-4), summing over all contacts j gives the aggregate constraint for actor i in the network (Burt, 1992), as shown in formula (2-5). Thus, $1-C_i$ represents the lack of constraint or the number of structural holes in i's egocentric social network (Zaheer & Bell, 2005).

Effective Size. It measures the number of non-redundant contacts within an actor's network, calculated as the number of other actors directly connected to the actor minus the average degree centrality among these direct relationships. The simplified formula is n-2t/n provided by Borgatti & Halgin (2011), where n is the number of other actors directly connected to actor i (excluding actor i from the network size), and t is the number of direct relationships existing among all other actors directly connected to actor i. For example, if A is connected to three actors who are not connected, the effective size is 3; if these three are mutually connected, A's effective size reduces to 1.

Efficiency. It is the standardisation of the actual size of a self-network by its effective size, reflecting the proportion of "non-redundant" contacts in the network, that is, the influence brought about by each contact's investment. A larger effective size does not necessarily imply higher efficiency, nor does high efficiency directly reflect a large effective size.

Hierarchy. It measures the concentration of constraints, calculated using the Coleman-Theil index of entropy (Burt, 1992), with the formula as follows:

$$H = \frac{\sum_j \left(\frac{c_{ij}}{C/N}\right) \ln\left(\frac{c_{ij}}{C/N}\right)}{N \ln(N)} \qquad (2\text{-}6)$$

In formula (2-6), N is the number of actors directly connected to actor i, and C is the total sum of constraints i receives from all N actors, with C/N being the average constraint each actor imposes on i. The maximum value of hierarchy is 1, indicating that constraints are highly concentrated on a single actor; the minimum value is 0, indicating that constraints are evenly distributed. A higher hierarchy implies that the actor is subject to more restrictions.

2.3 Industrial Agglomeration and Virtual Industrial Agglomeration

2.3.1 Industrial Agglomeration

Industrial agglomeration is a product of industrial development at a particular stage (F. Huang, 2021), referring to complementary clusters of one or several related enterprises that come together due to common interests within a region (W. Han et al., 2019). It is a process where various production factors are clustered, transferred, and reorganised to achieve efficient geographical allocation. Industrial structure influences the agglomeration and diffusion of industries (Guo et al., 2020). External scale economies are the inevitable result of industrial spatial agglomeration (W. Han et al., 2019), leading to a concentrated distribution of firms producing homogenous or related products, thus forming spatial agglomeration characteristics (F. Dong et al., 2020). Moreover, industrial agglomeration is not static; it is a gradual and cyclical evolutionary process with different characteristics at different evolutionary stages (F. Han et al., 2018).

The advantages of industrial agglomeration are primarily manifested in three aspects. First, by facilitating the flow and sharing of resources such as technology, labour, and capital, it strengthens cooperation between enterprises, deepens industrial division of labour, leverages cluster advantages, and forms scale effects, aiding in enhancing industrial competitiveness and productivity (Fazio & Maltese, 2015). Second, industrial agglomeration's knowledge and technology spillover effects are conducive to technological innovation and enterprise progress (J. Liu et al., 2017), encouraging innovation and increasing entrepreneurial opportunities (De Blasio & Di Addario, 2005). Third, industrial agglomeration promotes regional economic coordinated development, optimal allocation of social resources, and sustainable resource utilisation by forming scale economies. However, excessive industrial agglomeration can also have negative impacts on industrial structures and economic development (Broersma & Oosterhaven, 2009; Chi et al., 2022), such as intensified market competition, increased production costs and reduced marginal benefits (Ke, 2010), energy and environmental issues (J. Liu et al., 2017), and substantial regional development disparities.

2.3.2 Virtual Industrial Agglomeration

Traditional agglomeration relies on geography, emphasising the spatial concentration of industries. Integrating formal face-to-face interactions into the digital environment allows industrial clusters to break traditional boundaries, establishing highly dynamic value systems based on knowledge (Fuks & Kawa, 2013). With the burgeoning development of virtualisation and digitalisation technologies, industrial agglomerations crossing spatial boundaries—virtual agglomerations—are emerging, and the connections and interactions between industries are shifting from offline to online (X. Chen et al., 2021; Z. Cheng & Jin, 2022). Virtual agglomeration is internet-based, where the internet's coverage and quality determine the virtual agglomeration's quality (S. Liu et al., 2020). Digital technologies support virtual spaces to expand infinitely, thereby alleviating the crowding effect of geographical industrial agglomeration (Q. Xu et al., 2022). In virtual space, interconnected, geographically dispersed industrial clusters replicate cooperative and competitive dynamics similar to those established in traditional industrial clusters through their members' interactions (Fernandez-Escobedo et al., 2023). Hence, the development of the digital economy not only accelerates the digital transformation of technological innovation, including methods, patterns, management, processes, and outcomes, but also enables manufacturing enterprises to communicate across regions and organisations, reducing the cost of enterprise information search and acquisition, thereby helping to form specialised and diversified virtual industrial agglomerations (Q. Zhang et al., 2023).

Compared to traditional spatial industrial agglomeration models, virtual agglomerations formed by digital development can accelerate knowledge and technology spillovers, optimise resource allocation, promote spatial spillover effects, and reduce crowding effects, creating positive externalities (H. Peng et al., 2023). For instance, Wang & Li believe that virtual agglomeration in the agricultural industry can break the geographical limitations and inefficiencies of traditional agriculture. By establishing agricultural information portals and related institutional virtual platforms, they integrate online and offline operations, enhancing the efficiency of the agricultural industrial chain and value chain. Zhang et al.'s research indicates that the digital economy, accelerating the virtual agglomeration of industry specialisation and diversification, can promote technological innovation output in manufacturing enterprises (Q. Zhang et al., 2023). Concurrently, virtual industrial agglomeration also brings many new challenges, such as managing new business models, network security risks and privacy leaks, and the imperfection of regulatory and legal systems (Fernandez-Escobedo et al., 2023). Therefore, the government, as a crucial guide, maintainer, and arbitrator in the virtual network space, needs to improve corporate digital governance (X. Xie et al., 2019) and continuously refine relevant laws and regulations, providing a favourable business environment for virtual industrial agglomerations.

2.4 Industrial Networks and Industrial Chain Networks

2.4.1 Industrial Networks and Related Research

Industrial networks, organised around the actors, activities, and resources that constitute them (Lowe et al., 2016), are tightly cooperative organisational clusters within industries (Ebers & Jarillo, 1997). The primary features of industrial networks are the technological characteristics based on the industrial chain and the social attributes based on the value chain (Y. Chen & Li, 2014). In such networks, changes within individual firms are closely linked to changes in the entire industrial network. Industrial network theory posits that all activities and changes of firms occur within relationships, central features of business and modern industrial organisation structures

(Paluszak & Wiśniewska-Paluszak, 2016). Firms form industrial network relationships through resource exchange and transfer, encompassing tangible relationships like industrial, service, financial, and technology chains and intangible relationships like knowledge and information chains. The strategic layout of firms is also a collective behaviour based on industrial network connections (Hoyler & Watson, 2019).

The development of Industry 5.0 and the Industrial Internet (IoT, big data, cloud computing) has been crucial in driving the evolution and transformation of industrial networks, significantly enhancing industrial competitiveness. Government policies also play a vital role in the development of industrial networks. Hara's content analysis indicates that changes in Japan's retail industry networks primarily experienced four stages: politicisation, reflection, establishment, and evaluation, with businesses and other actors like governments embedded in industrial networks, triggering transformations (Hara, 2020). Current developments in industrial networks face several challenges and risks. Li et al.'s comparative study of industrial network structures between China and Japan found that China's industrialisation is still in its initial stages (Z. Li et al., 2017). One challenge industrial networks face is coordinating the complex structures and potential conflicts of interest and objectives among network participants (Patala et al., 2014). In the era of intelligence and informatisation, industrial networks also confront issues related to resource sharing and service coordination, platform ecosystem development, and privacy and security protection (Qin et al., 2020; S. Yang & Huang, 2022).

Research on industrial networks mainly focuses on industrial network research methods, corporate strategic formulation and development, business relationships, and innovation. The Industrial Network Approach (INA) has become an independent and viable paradigm, focusing on the relationships between industrial systems firms that produce, distribute, and use goods and services (Axelsson & Easton, 2016). Additionally, researchers are continuously enriching and refining the industrial network approach. For instance, Henneke et al. suggest that the Software-Defined Networking (SDN) approach will significantly impact the future design of industrial networks (Henneke et al., 2016). Li et al., combining industrial network analysis techniques and modern network analysis techniques with the Malmquist Productivity Index (MLI), proposed a new Data Envelopment Analysis (DEA) model, considering the characteristics of interconnection and interaction between various sectors of manufacturing, enabling evaluation of static and dynamic performance (Y. Li et al., 2022). In terms of corporate strategy formulation and development, Gadde et al., from an industrial network perspective, argue that formulating the strategy for a firm means considering resource heterogeneity, interdependence between cross-border activities, and organised collaboration between related companies (Gadde et al., 2003). Park et al. investigated the impact of clustering and subcontracting forms of industrial networks on firm growth, finding that clustering can promote healthy growth and survival. In contrast, subcontracting does not positively impact growth and hinders survival, possibly due to high subcontracting intensity among small firms (Y. Park et al., 2010). From the industrial network perspective, network changes are closely linked to business relationships and the formation of these relationships (Halinen et al., 1999). The field of innovation in industrial networks is vibrant, with innovation being a network phenomenon emphasising inter-organizational interaction processes (Bygballe et al., 2014), and the actual value of innovation lies in its diffusion within industrial networks (Y. Chen & Li, 2014). Shi et al.'s empirical study showed a positive correlation between centrality in artificial intelligence industry innovation networks, network size, and knowledge transfer performance, suggesting that integration into innovation networks and occupying a particular position are critical ways for AI companies to develop and adapt to change rapidly (Shi et al., 2021).

2.4.2 Definition and Related Research on Industrial Chain Networks

The industrial chain is a chain-like organisation comprising multiple related links, with certain upstream and downstream relationships, centred around product transaction activities, oriented towards value-added benefits and supply-demand, and linked by investment and production to meet customer needs (Jin et al., 2014). Each level of the industrial chain represents both industry and individual interests. To achieve industrial adjustment and optimise industrial structure, it is essential to clarify the relationship between individual enterprise development at each level of the industrial chain and the overall development of the industrial chain (L. H. Wang et al., 2014). The development of the industrial chain is closely related to the formation of industrial clusters, with industrial chain relationships within clusters forming the basis for industrial cluster formation (Zheng & Peng, 2019). Cluster coupling not only facilitates procurement, production, and distribution within individual industrial chains but also forms a variety of industrial chain networks with diverse service models (J. Wang, 2009).

With the advent of the digital economy, enterprise boundaries are becoming blurred, and the development model of industrial chains is gradually transitioning from traditional one-to-one chain models to network structures encompassing both horizontal and vertical networks. Enterprises cooperate in pursuing shared interests and forming long-term interactive, cooperative relationships through a specialised division of labour (Bai et al., 2020) and create complete industrial chain networks through horizontal and vertical coupling (G. Lin et al., 2020). Governance of cluster-style industrial chain networks strengthens interconnections and diversified integrated development among industrial clusters, enhancing industrial productivity and promoting sustainable and healthy regional economic development. Research indicates that constructing ecological industrial chain networks significantly improves the ecological efficiency of energy-consuming industrial clusters (Zheng & Peng, 2019). However, challenges still exist in industrial parks, including insufficient horizontal and vertical connectivity and diversity and the inability to meet the demands of cluster development and practical application. For instance, Dong & Li's study on the wind power industry indicates that the interconnection of different types of enterprises along the industrial chain through production and transaction activities is vital. Inadequacies in the industrial chain and poor linkage of critical segments are factors constraining the survival and development of the wind power industry (F. Dong & Li, 2020).

Current research on industrial chain networks mainly concentrates on network structure, digital economy, and innovation. Researchers have conducted extensive studies on the outcomes of industrial chain networks in different industries, with understanding their structural characteristics helping enterprises or countries maintain their advantages in industrial chains or networks and stabilise the industrial chain network. Li & You analysed the distribution of the integrated circuit industry in the Yangtze River Delta, the composition of industrial chains and service chains, proposed associated network analysis and found that both the industrial chain network and service chain network of integrated circuits in the region follow a power-law distribution (S. Li & You, 2018). Ge et al. used big data decision-making to allocate and analyse the overall operational resources of external environments or industrial chain networks for intelligent manufacturing, obtaining control information for optimising operational parameters (Ge et al., 2020). Research on industrial networks and industrial chain network structures often applies network analysis methods, such as Xun et al.'s use of network analysis to visualise and analyse the industrial chain network structure of the fuel cell vehicle industry, demonstrating that China has a large number of manufacturers, the highest centrality, and significant supply risks in the industrial chain (Xun et al., 2021). Guo et al. used complex network analysis to study the evolution and characteristics of trade in the tantalum industry chain, finding that transitivity in network structure plays a foundational role in the tantalum industry chain, i.e., the homogeneity of the tantalum industry chain (Guo et al., 2023). The network structural dependencies among different products in the industry chain are also heterogeneous. Regarding digital economy and innovation research, Zhua & Heb emphasised building digital application platforms to improve overall industrial chain network collaboration capabilities through platform operators to enhance the comprehensive competitiveness of various segments (Zhua & Heb, 2022). Cao et al. divided corporate innovation networks into patent networks, industrial alliance networks, and industrial chain networks. The industrial chain network is mainly represented by the degree of connection with the upstream and downstream of the industrial chain, with results indicating that the industrial chain network significantly impacts innovation (X. Cao et al., 2022).

In summary, the boundaries between industrial networks and industrial chain networks are somewhat blurred, and the academic community has not clearly distinguished these two concepts, both of which are frequently used. Undoubtedly, industrial networks and industrial chain networks are closely related to enterprise innovation. Digital platforms and information technology, cooperation and collaborative capabilities between enterprises, and the flow of knowledge and information among enterprises are all crucial for forming industrial networks and industrial chain networks and enhancing enterprise innovative capabilities. However, industrial chain networks emphasise the connections between upstream and downstream enterprises and the vertical and horizontal coupling relationships between enterprises; industrial networks emphasise the integration, transfer, and exchange of various resources, focusing on complex network relationships such as industrial chains, technology chains, and knowledge chains among enterprises.

2.5 Network Embeddedness Research

2.5.1 Definition of Network Embeddedness

Granovetter conceptualised the idea of embeddedness, explaining its application in economic life. He posited that economic actions are embedded within specific social relations, and the relationships between actors and the entire network influence economic activities (Granovetter, 1985). Network embeddedness is an open system where firms continuously interact with the social system in close, complex, and dynamic ways, eventually forming a network embeddedness model (Moran, 2005). It is also a continuous state of social relations manifested by firms in economic activities (C. Wang & Li, 2023), which can be divided into vertical and horizontal relations. Vertical relations refer to upstream and downstream industry chain relationships between firms in the network. In contrast, horizontal relations refer to non-industrial chain relationships within the same industry or between different sectors, such as university-industry research collaborations (Meng et al., 2021). Firms must embed themselves into industrial networks, facilitating a multi-directional and orderly flow of innovation across departments and fields, thus enhancing market competitiveness.

2.5.2 Definition of Structural and Relational Embeddedness

Most researchers use the two dimensions of structural and relational embeddedness, as defined by Granovetter (1985), to further characterise network embeddedness. Structural embeddedness is reflected in two aspects: the density and scale of a firm's embeddedness in the network, where network density indicates the closeness of a firm with network members, facilitating information sharing and innovation inspiration (Q. Tian et al., 2021), and network scale, representing the total number of connections between network members (D. L. Wang et al., 2022). The second aspect is the number and position of a firm's "structural holes" in the network. According to the structural holes theory, a firm's position in the network reflects its "bridging role" (Burt, 1992; Z. Lin et al., 2009). A higher degree of structural embeddedness enables more accessible access to knowledge and heterogeneous resources (Xiao, 2022).

Relational embeddedness emphasises understanding, trust, commitment, reciprocity, and other relational features between firms (S. M. Lo et al., 2018). As a coordination mechanism, it also fosters trust in the network, where strong relationships help establish deep trust and partnerships. In contrast, weak relationships emphasise loose, non-emotional ties, providing diversified information sources and opportunities for new connections (Burt, 2004). Relational embeddedness is measured by the content, direction, and degree of relational interactions (D. L. Wang et al., 2022).

2.5.3 Research Progress in Network Embeddedness

Network embeddedness theory is often used to study relationships between firms, other organisations, and social systems, with research mainly focused on performance, knowledge management, and innovation and predominantly revolving around relational and structural embeddedness.

Researchers believe relational and structural embeddedness affect firm behaviour and performance (Rowley et al., 2000b). Wang & Li developed a theoretical framework of network embeddedness-financing capability-firm performance, explaining the impact of network embeddedness and financing capability configuration on firm performance using fuzzy set qualitative comparative analysis (C. Wang & Li, 2023). Su et al. explored the influence mechanism of technological firm performance based on network embeddedness theory, finding that structural embeddedness significantly positively affects firm performance, and the interaction between structural and relational embeddedness positively influences entrepreneurial behaviour (Su et al., 2023).

In knowledge management, information transfer and knowledge sharing among firms facilitate access to heterogeneous resources. Peng et al. studied the mechanism of multiple network embeddedness on green supply chain performance in China's ecological industrial parks, revealing that both relational and structural embeddedness significantly promote green knowledge integration, which mediates the relationship between multiple network embeddedness and green supply chain performance (H. Peng et al., 2020).

Xie et al. researched the innovation mechanism of firms based on multi-network embeddedness, showing that firm innovation activities have triple network embeddedness, with management, knowledge, and social networks significantly impacting innovative performance (H. Xie et al., 2021). Liu & Tang systematically reviewed the knowledge evolution structure and research hotspots of open innovation from the perspective of network embeddedness, constructing a comprehensive knowledge evolution system and proposing future research directions for open innovation (T. Liu & Tang, 2020). Cao et al. suggested that in the cooperative innovation process, firms embed themselves in social networks formed by industry-university cooperation relationships and knowledge networks consisting of knowledge nodes (X. Cao et al., 2021). Sang studied the internal mechanism of technological innovative capability in high-tech firms' technology alliances in China, finding that relational and structural embeddedness directly enhance technical innovative capability and can also indirectly promote it through inter-organizational knowledge transfer (Sang, 2021). In summary, network embeddedness is crucial in forming firm knowledge networks and is vital for enhancing firms' innovative capabilities.

2.5.4 Research on the Impact of Network Embeddedness on Corporate Innovative Performance

Network embeddedness has become a strategic choice for corporate innovation and an essential tool in studying corporate innovation dynamics (Wei & Ma, 2016). Scholars have identified diverse relationships between network embeddedness and corporate innovative performance dimensions, including negative, inverted U-shaped, and positive correlations. For instance, Ahuja's research demonstrates that increased structural holes negatively impact corporate innovation. Networks with fewer structural holes may foster trust and diminish opportunistic behaviours, which, from a resource-sharing perspective, are beneficial for inter-corporate collaboration (Ahuja, 2000). Yan et al. found that the relationship between relational embeddedness and exploratory innovation forms an inverted U-shape. As relational embeddedness increases, the benefits derived from knowledge and trust rise at a diminishing rate, eventually stabilising. Additionally, the cost of exploring new expertise for these individuals continuously escalates (Yan et al., 2020).

In a study encompassing 190 companies in the Yangtze River Delta region, Cong et al. discovered that relational embeddedness, structural embeddedness, and resource embeddedness within corporate networks significantly enhance the firm's knowledge management capabilities and markedly boost their technological innovative performance (Cong et al., 2017). Zhang's research identified that structural and relational embeddedness significantly positively impacts the innovative performance of e-commerce enterprises (L. Zhang, 2021). Xiong & Gao, integrating theories of network embeddedness and dynamic capabilities, found through empirical research that dynamic learning capabilities mediate the impact of dual network embeddedness on innovative performance (Xiong & Gao, 2020). Consequently, the direction of the effect of network embeddedness on corporate innovative performance remains uncertain.

2.6 Research on Collaborative Capability

2.6.1 Collaboration Theory

The concept of collaboration, originating from systems theory, refers to the interaction of parts or the whole that results from such interaction (Burton-Jones et al., 2015). It is a dynamic process involving adaptation and learning, creating comprehensive solutions, and represents the joint actions of many, where the overall effect exceeds the sum of individual actions (Harris, 2004). Recent studies have applied collaborative theory to explore collaborative relationships between industry, academia, research, knowledge collaboration, and regional collaborative innovation (F. Fan et al., 2020; Randhawa et al., 2017; Zeng et al., 2023). Collaborative effects arise from cooperative relationships between companies functioning under certain conditions and shared objectives to achieve goals and create collaborative effects (Holubčík et al., 2022). Thus, companies must implement cooperative strategies to establish collaborative relationships with other organisations, enhancing their collaborative capabilities and levels to gain competitive advantage in dynamic and complex environments and achieve sustainable corporate development.

2.6.2 Definition of Collaborative Capability

As interactions and cooperation with other organisations become increasingly frequent for enterprises, leveraging collaborative effects is crucial for accessing innovation resources. Collaborative capability can be defined as the ability of participants to establish and manage network relationships based on mutual trust, communication, and commitment. It is also viewed as an integrated, cross-level concept, explaining much of the knowledge creation and innovation outcomes in networks (Blomqvist & Levy, 2006). Tai Tsou posits that corporate collaborative capability is the ability to promote innovation practices by synergising various resources, primarily manifested as absorptive capacity, coordination capability, and relational capability. Collaboration effectively increases knowledge exchange and allows businesses to acquire knowledge beyond their boundaries (Tai Tsou, 2012). Additionally, corporate collaborative capability can be further subdivided into multiple subsystems like knowledge, relationship, innovation, etc., as Tu et al. divided the industry-university-research collaborative innovation system into four subsystems: knowledge collaboration, relationship collaboration, innovation collaboration, and collaborative performance (Tu et al., 2017). Joint activities are widespread across various industries, with inter-organizational collaborative modes including strategic alliances, supply chains, industrial clusters, industrial parks, and business ecosystems (de Almeida et al., 2021).

2.6.3 Research Progress on Collaborative Capability

Many researchers have studied corporate collaborative capabilities, suggesting that improvements in corporate collaboration levels or capabilities positively impact costs, performance, and sustainable development. Studies show that high-level collaboration between different product teams helps reduce corporate operational costs (Veasey, 2001). Collaboration between businesses and alliance partners lowers transaction costs and forms sustainable competitive advantages in uncertain business environments (M. Cao & Zhang, 2011). Corporate collaborative capability is a means for organisations to enhance competitiveness and achieve knowledge creation (F. Peng et al., 2018). Luzzini et al., from a resource-based perspective, argued that commitment to sustainable development leads to the development of intra- and inter-company collaborative capabilities, enhancing performance and sustainability (Luzzini et al., 2015). Huang et al. used synergetics to comprehensively evaluate the collaborative degree of sustainable logistics enterprises, finding that the higher the collaboration degree in logistics enterprises, the higher the efficiency (J. Huang et al., 2018). Businesses in networks need the collaborative capability to enhance sustainable development (Gonçalves de Almeida et al., 2020). Samad et al. found that collaborative capability moderates the relationship between green supply chain management and environmental and economic performance (Samad et al., 2021). Lo et al. discovered through multiple regression analysis that inter-company collaborative R&D positively impacts technological innovative performance and potential market competitiveness (K. L. Lo et al., 2023).

2.6.4 Research on the Impact of Corporate Collaborative Capability on Innovation

Collaboration encompasses the synergy of internal elements like corporate culture, philosophy, management, and technology and the multi-agent partnership between the business and external entities such as enterprises, universities, research institutions, and government (He & Xu, 2017). Numerous scholars have researched the relationship between collaboration and innovation, finding that collaboration enhances innovation practices. González-Benito et al. found that when businesses innovate through collaboration, the likelihood of success increases, with small businesses more likely to utilise channel collaboration and large companies more dependent on consultancy-based collaboration (González-Benito et al., 2016). At the macro level, Wang et al. showed that the dynamic flow of innovation elements between regions benefits regional innovative performance, with industry-academia-research collaborative innovation positively impacting regional innovative performance (X. Wang et al., 2018). Regional collaborative clustering allows companies to fully leverage the knowledge spillover effect, facilitating the flow of personnel and other elements, thereby promoting regional innovation (Ye, 2021). Dong et al. found that the degree of digital integration and green knowledge collaboration capability in the green building integrated supply chain positively impacts the innovative performance of enterprises in the chain (T. Dong et al., 2023). Therefore, the stronger the collaborative capability of a company, the higher the level of collaboration and trust between enterprises, making it easier to establish efficient network cooperation relationships. In this process, enterprises' information acquisition and learning abilities are continually enhanced, benefiting the innovation output and transformation of achievements.

2.6.5 Research on the Impact of Network Embeddedness on Collaborative Capability

From an inter-organizational relationship perspective, collaboration represents the highest level of interaction (Kapucu & Garayev, 2013), with many researchers suggesting that network embeddedness impacts corporate cooperative relationships and collaborative capabilities. Businesses occupying central positions in network embeddedness have richer collective experiences with other network members, making it easier to derive value from relationships (Gulati et al., 2000). Park et al. showed that information sharing and flexibility influence network embeddedness and collaboration, with embeddedness significantly impacting corporate collaboration (S. T. Park et al., 2014). Based on network embeddedness theory, it is argued that corporate network embeddedness increases inter-enterprise information exchange and interaction, and information accessibility and absorptive capacity significantly enhance the network's collaborative capability (B. Fan et al., 2019). Sun posited that network embeddedness fosters trust, collaboration, and resource sharing between businesses and other organisations, helps gain partner recognition, improves communication efficiency, and enhances corporate collaborative capability (Sun, 2023). Therefore, the higher the structural and relational embeddedness of a business, the more contacts and interactions it has with other organisations, enabling it to establish cooperative relationships, generate trust, acquire and integrate knowledge, and thus enhance collaborative capability.

Chapter 3 Overview of the Development of China's Audio-Visual Industry Parks

This chapter delineates the development trajectory of China's audio-visual industry and its industrial parks by integrating theories from Chapter 2 on networked innovation, social capital, industry focus, industrial chain networks, network embedding, and collaborative capability. It summarises the advantages and pain points of developing China's audio-visual industrial parks and their development paths. Based on four typical development paths, it is proposed that the most advantageous path for innovation is the spontaneously formed industrial chain network-driven park. Additionally, this chapter examines the development overview of Beijing Starpark and representative industrial parks, analysing the current state and challenges of industrial chain network development. It suggests that spontaneously formed industrial chain network-driven parks are the most suitable development path for China's existing audio-visual industrial parks. The content of this chapter provides real-case foundations for the core theoretical questions and hypotheses to be tested in Chapter 4.

3.1 Exploration of the Development Model of China's Audio-Visual Industry Parks

3.1.1 Development of China's Audio-Visual Industry

3.1.1.1 Development Course

The audio-visual industry in China has gone through an extensive developmental phase. Since the era of reform and opening up, the industry has evolved from its nascent stage to robust growth. Appendix 1 organises the development course of China's audio-visual industry:

3.1.1.2 Characteristics of the Optimal Development Path

Following China's reform and opening up, the economy has continuously innovated and developed. Regional management has been identified as one of this process's most successful developmental experiences. Establishing special economic zones, economic development zones, and industrial parks has provided invaluable experiences for economic growth and market-oriented management. As the cultural industry evolved, cultural industry parks have become one of the important physical entities for industry development and management. As a branch of the cultural sector, the audio-visual industry in China has rapidly developed in recent years.

The development characteristics and challenges faced by the audio-visual industry determine that its optimal development path should possess the following features: Firstly, it should be progressive and capable of keeping pace with rapid industry development in technology and business model innovation. Secondly, it should foster open industrial chain cooperation and sharing mechanisms, facilitating resource-sharing collaborative cooperation, reducing resource waste, and decreasing industry costs. Thirdly, it should be inclusive, providing relatively equal development opportunities and incubation growth space for small micro-enterprises and large enterprises. Fourthly, it should have socialised regulation and management mechanisms conducive to industry guidance, communication, and coordination. Finally, it should promote cross-industry integration and talent cultivation, providing an environment for talent training and gathering for cross-domain applications.

Considering the current state of industry market development, audio-visual industry parks are market-oriented cultural and economic organisational forms that can effectively integrate the above characteristics, and they also represent the best path for developing the audio-visual industry. In October 2021, the China National Radio and Television Administration of China released the "14th Five-Year Development Plan for Radio, Television, and Online Audio-Visual," which explicitly stated that strengthening a batch of industrial bases (parks) with aggregation and guiding effects is one of the crucial ways to promote high-quality industry development. The plan proposed supporting the development of existing industrial bases while creating many industry highlands with rich content resources, outstanding technical advantages, apparent industry aggregation effects, and strong integration development guidance to promote the rapid development and growth of the audio-visual industry.

3.1.2 Development of China's Audio-Visual Industry Parks

3.1.2.1 Development History

In China, audio-visual industry parks (bases) generally started construction and development after 2003. The first audio-visual industry park approved by the state was the Zhejiang Hengdian Movie and Television Industries Experimental Zone, approved in 2004, mainly engaged in movie and TV drama location shooting. The second was the Beijing Starpark Television Program Production Base, approved in 2009, which mainly engaged in variety show production. In February 2010, the China National Radio and Television Administration approved the China (Shanghai) Network Audio-Visual Industry Base, which engaged primarily in network audio-visual. In August 2019, the China National Radio and Television Administration approved the renaming of China Beijing Starpark Television Program Production Base to China (Beijing) Starpark Audio-Visual Industry Base, the first national-level base directly named "audio-visual industry" approved by the administration to date.

From the policy development perspective, China has numerous regulations and guidance policies regarding the audio-visual industry, but not many policies and guidance documents regarding audio-visual industry bases (parks). Table 3.1 summarises the relevant contents of policy documents for audio-visual industry bases (parks).

Table 3. 1

Policies and Guidance Documents for Industry Bases (Parks)

Category	Policy Document	Release Date	Key Content
Policies Related to Audio-Visual Industry Parks (Bases)	Notice on Promoting the Construction and Development of National Broadcasting, Television, and Network Audio-Visual Industry Bases (Parks) ([2019] No. 61)	September 2019	Providing clarity on the definition, standards, management attribution, and responsibilities of national-level audio-visual industry bases (parks) from the perspectives of essential requirements, application conditions, and normative management.
	Opinions on Promoting High-Quality Development of Broadcasting, Television, and Network Audio-Visual Industry ([2019] No. 74)	August 2019	Clarifying high-quality development and demonstrative guiding role of audio-visual bases.
	14th Five-Year Development Plan for Broadcasting, Television, and Network Audio-Visual	September 2021	
Policies Related to Cultural Industry Parks (Bases)	14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives Through the Year 2035 of the People's Republic of China	March 2021	Proposing "to standardize the development of cultural industry parks and promote the construction of regional cultural industry belts."
	"14th Five-Year Cultural Industry Development Plan"	May 2021	Specifying the details for the standardized development of cultural industry parks and bases, including cultivation direction, leading role, policy guidance, etc. Proposes "to promote the construction of

	national-level cultural industry demonstration parks (bases) to become advanced areas of the cultural industry with policy integration, enterprise gathering, industry concentration, and leading development."

Note: Self-compiled according to relevant policy documents.

As of the first half of 2022, the China National Radio and Television Administration of China has approved 28 national-level broadcasting, television, and network audio-visual industry bases. However, most of these are invested in, operated, and managed by the government or state-owned enterprises, mainly relying on resources such as provincial development zones and radio and television network groups. For instance, the Malanshan Video Cultural and Creative Park in Changsha, China, relies on Hunan Broadcasting System and is planned and operated by a government agency at the level of a regular office; the Xiamen Intelligent Audio-Visual Industry Base is invested in and operated by the state-owned Xiamen Wenguang Media Group; the China-ASEAN Network Audio-Visual Industry Base is invested in and operated by the state-owned Guangxi Broadcasting and TV Information Network Co., Ltd. In comparison, private or privately controlled audio-visual industry parks are relatively few, such as Beijing Starpark Audio-Visual Industry Base and the Zhejiang Hengdian Movie and Television Industry Experimental Zone. There are mixed-ownership audio-visual parks, like the Hubei Network Audio-Visual Industry Park and the Shanghai Network Audio-Visual Industry Base.

3.1.2.2 Advantages and Challenges

(1) Advantages

Firstly, China's broadcasting, television, and online audio-visual industries possess tremendous potential for development and have the foundation for resource integration. According to the 2021 annual statistical report of the China National Radio and Television Administration of China, as of the end of 2021, there were approximately 60,000 institutions engaged in broadcasting, television, and online audio-visual businesses in China. This number does not include many uncertified and unregistered self-media institutions. Most of these are light-asset creative and service organisations with human advantages. For audio-visual industry parks with a complete system of technology R&D, application, service, policy, regulatory, business docking advantages, entrepreneurial talent and industry collaboration advantages, these audio-visual institutions and entrepreneurial groups bring natural demand.

Secondly, China's audio-visual industry is vast, with enormous market demand. According to the "Digital China Development Report (2021)" released by China's State Internet Information Office, the scale of netizens in China has reached 1.032 billion, among which online video users amount to 975 million. The internet penetration rate has reached 73%. Sixteen sub-industries with prominent characteristics of digital culture generated a business income of 3,962.3 billion yuan in 2021, a year-on-year increase of 18.9%. The market scale of China's audio-visual industry is enormous, and the demand for cultural content creation is continuously growing.

Thirdly, there are policy support advantages. The Chinese government maintains a supportive and promotive attitude towards developing the cultural and audio-visual industries while strengthening cultural regulation and network security monitoring. For audio-visual industry parks and bases, the

China National Radio and Television Administration positions them as leading and exemplary and tends to apply more pilot projects and policies to industrial bases in a prioritised manner. Audio-visual industry parks are resource platforms, information centres, and policy windows for enterprises.

Fourthly, the gap in international competition is narrowing. Due to historical reasons, China's audio-visual industry started late and was relatively backward in software, hardware, and business development models. However, with the integrated development of information technology, artificial intelligence technology, and audio-visual technology, as well as the continuous integration and advancement of resources in China's audio-visual cultural industry, the gap between China's audio-visual cultural industry and its international counterparts is narrowing. The development model of cultural industry parks makes it easier for the industry to achieve synergistic development.

(2) Challenges

First, the industry chain is immature. The modern audio-visual industry is a product of integrating multiple technologies, business forms, and specialities. From the perspective of the industry chain, each link's existence and proportion should conform to market demand and laws. However, in the actual development process, the government's pursuit of specific targets and management indicators for the park's GDP, tax revenue, R&D (patent inventions), and high-tech talents has disrupted the construction of audio-visual industry parks, leading to ineffective synergy and innovation of industry resources. At times, the focus is entirely on data rather than on the perfection of the industry chain, a shortsighted approach that is not uncommon. Fundamentally, this does not favour the industry's overall development and makes it difficult for small and medium-sized enterprises in the audio-visual industry to receive strong policy support, especially in the face of sudden economic situations.

Second, there is a lack of industry synergy. Basic R&D, applied R&D, and industrial practice cannot form effective synergy. The lack of effective communication and collaboration mechanisms between each industry link leads to the difficulty in transforming innovative results into industrial practices, affecting the healthy development of the entire industry chain. In addition, due to the lack of synergy among various segments, the process of industrial development suffers from inadequate resource integration and complementary advantages, resulting in a fragmented state of industrial development. Consequently, it fails to achieve the effects of joint action advocated by the theory of collaborative capability (Harris, 2004). Therefore, developing China's audio-visual industry parks must strengthen synergy and cooperation between various links, promoting the close integration of basic R&D, applied R&D, and industrial practice to drive the healthy development of the entire audio-visual industry.

Third, there is a shortage of innovative talents. A common problem faced by China's audio-visual industry and audio-visual industry parks is the lack of professional skills, especially those who are cross-industry, industry-savvy, and possess both technical foundations and cultural perspectives. Current issues include some individuals understanding art but lacking specialised knowledge and others being technically proficient but lacking artistic capabilities. Similarly, the management of audio-visual industry parks faces similar challenges, where some understand the industry but not park management, and those who understand park management may not be able to grasp management points from an industry perspective. Therefore, talent cultivation is a critical industrial project. Besides having professional venues and facilities, specialised parks and audio-visual industry parks also need professional scientific research capabilities, application scenario development capabilities, talent attraction and coordination capabilities, and industrial ecosystem construction and management capabilities. The current issue is that the planning and construction of many audio-visual industry parks rely mainly on land planning rather than industry demand, leading to a lack of effective industry-driven development. Therefore, enhancing the professional knowledge and industrial operation capabilities of park management and investment attraction departments is necessary to promote parks' professional construction and healthy growth.

3.1.2.3 Development Paths

The primary pathways and driving mechanisms for the development of audio-visual industry parks are as follows:

"Government-led, government-funded, government-operated" planning-type policy-driven parks. Such parks are conceptually broad, often emerging from existing local development zones or high-tech zones through location integration, industrial structure adjustment, and new industrial investments. Managed by the original development zone's administrative committee, their development model resembles economic development zones, mainly relying on policy-based investment attraction for growth. In these parks, the government introduces leading enterprises or large state-owned enterprises, which become the main growth drivers of the park through investment attraction or policy support. However, This type of park is essentially not a pure audio-visual industry park, as its nature is an auxiliary carrier of governmental administrative management, with its core not being the industry.

"Government-led, government-funded, enterprise-operated" planning-type policy-driven parks. These parks typically involve revitalising state-owned land and assets, aligning with policy directions to create industry parks suitable for the current development environment. The investing entities are usually governments or state-owned enterprises, which may lack experience and capability in market-driven industrial development. Therefore, for operations, management committees are often established by the government or state-owned enterprises, transitioning to third-party organisations or establishing subsidiary companies for actual operations. These parks are generally incubator-type, relying mainly on policy-driven strategies, attracting and clustering related enterprises through low rents and policy advantages. Despite many enterprises benefiting from policy-driven incubation with lower rents and developmental privileges, these parks have notable shortcomings. Firstly, most policies are unsustainable, and policy changes may impact the development of these parks. Secondly, although enterprises operate such parks, since these enterprises are not the principal investors in the assets and do not enjoy the long-term benefits of these assets, coupled with the government setting GDP targets for the operating companies, this leads to the enterprises prioritising short-term interests. They pay less attention to constructing industrial chains and ecosystems, lacking the impetus for sustainable development.

"Government-supported, enterprise-invested, enterprise-operated" planning-type economically motivated parks. These parks are usually based on targeted government land planning, transferring land to enterprises at preferential prices for development and operation. Since enterprises undertake significant capital costs in land acquisition and construction, they prioritise rapid cost recovery during subsequent park operations. Audio-visual industry parks, bearing substantial public R&D, application scenarios, and technological platform functions, are not industries that can quickly recover costs. Therefore, such parks often shift towards real estate or other industries, with the audio-visual industry becoming secondary.

"Government-supported, enterprise-invested, enterprise-operated" spontaneously formed, industry chain network-driven parks. These parks typically start from market demands in a segment of the audio-visual industry. With the expansion of the development scale, through increasing production scale and industry clustering, they gradually evolve into spontaneously formed original parks. The planning, investment, and construction of these parks are driven by expanding market demands and industry upgrading. Compared to the first three types of development paths, these parks differ significantly in their economic structure. Their income sources are diversified, including rental income, technical service fees, project investment returns, cooperative profits, comprehensive solution fees, and various consulting and intermediary fees. This spontaneously formed, industry chain network-driven development path is more flexible and diverse, better adapting to market needs and industrial changes. Leveraging the completeness and synergy of the industry chain, they provide comprehensive services and support, attracting more enterprises to settle and achieve substantial economic benefits. Moreover, due to the diversified economic structure, these parks are better equipped to handle market risks, offer broader revenue sources, and enhance the park's sustainability.

The first two of the four development paths of audio-visual industry parks belong to policy-driven development routes. The advantages and disadvantages of these development paths are summarised in Table 3.2.

Table 3.2

Advantages and Disadvantages of Different Development Paths in Audio-Visual Industry Parks

Development Path	Advantages	Disadvantages
Policy-Driven Development Path	- Easy integration and coordination of resources, scale effect; - Government backing and policy support.	- Policy uncertainty and incoherence; - Government management lag and systemic limitations, difficulty in effectively solving unique or historical issues; - Government performance pressure leading to forced growth and over-fertilization; - Issues such as face-saving projects, resource wastage, overstaffing, and rigid operations; - High enterprise reliance on policy, weak risk resistance, poor sustainable development capability.
Economically Motivated (Investment-Driven) Path	- High market sensitivity, flexible operation, strong risk resistance; - Strong profitability, rapid economic growth and revenue generation in a short time.	- Industry development is easily influenced by market and policy; - Resource allocation focused on benefits, the gap between planning and actual operation; - Weak industry foundation, difficulty forming synergy and competitive advantages; - Tendency to blindly follow trends; - Frequent changes in planning, inability to continuously promote overall industry economic development.
Industry Chain-Driven Development Path	- Focused on building industrial ecology, with emphasis on industry development planning; - Strong risk resistance, not prone to low-level competition; - Diversified income	- Large investment scale, long recovery period; - High management and operational costs; - Significant financial and operational pressure and high demands on operating organisations; - Growth space squeezed by policy-driven parks;

	structure, derivative solid and sustainable development capability.	- High costs for professional platform construction and talent development, susceptible to low-level competition from economically motivated parks.

Note: Self-compiled based on the actual development of typical audio-visual industry parks in China.

Based on the above analysis, we recommend that audio-visual industry parks in China adopt an industry chain network-driven model as their development path. This model is more conducive to fostering collaborative capabilities and innovation among enterprises within the park. The specific reasons are as follows:

Firstly, the industry chain network facilitates collaboration and innovation (X. Cao et al., 2022). The nature of the audio-visual industry requires enterprises to collaborate across different segments, from content production to technical support and marketing channels. The industry chain network model can promote close cooperation among these enterprises, driving the entire industry upwards. This tight collaborative relationship will be beneficial for cultivating collaborative capabilities and innovation within the park's enterprises.

Secondly, the industrial chain network model advocates an open and shared development mode. This model aligns with the network embedding theory and industry agglomeration theory research, encouraging open cooperation and resource sharing among enterprises. It facilitates the formation of complementary advantages and improves the overall competitiveness within parks (Fazio & Maltese, 2015; T. Liu & Tang, 2020). In contrast, policy-driven and interest-driven development paths may lead to resource fragmentation and internal consumption, making it difficult to form a healthy industrial ecosystem.

Thirdly, the industrial chain network model encourages innovation driven by market demand (Jin et al., 2014). This model enables enterprises within the park to understand market demands better and respond quickly, promoting continuous product and service innovation. Under this model, enterprises in the park will focus more on the market, accelerating product research and innovation, which is beneficial to the development of the entire industrial park.

Therefore, we chose Beijing Starpark as representative cases to study its industry chain network-driven innovation model. This analysis will help audio-visual industry parks in China achieve collaborative innovation under the drive of industry chain networks.

3.2 Development Overview of Starpark

3.2.1 Positioning of the Park

Starpark aims to create a comprehensive audio-visual ecosystem cultural technology park encompassing all media, formats, industrial chains, and coverage. Its mission is to attract, gather, and lead the joint development of audio-visual program production and related audio-visual culture, technology, and services. The park is also committed to promoting the development of the broadcasting, television, and network audio-visual content production industry chain, advancing the prosperity of the audio-visual science and technology economy, and building a creative, ecological, distinctive, and internationally influential cultural and technological innovation park. The core industry chain of Starpark is always centred around audio-visual content creation and production. According to the park's value map, its industry chain connects creative value zones, auxiliary creative value zones, production value zones, marketing extra value zones, and consumer value zones.

From the perspective of the core product positioning of the industry chain, Starpark has always focused on "content product production" as its core, around which it has built its organisational structure, allocated industrial resources, and attracted investment. On the one hand, this positioning aligns with Beijing's status as a national cultural centre and an international communication hub, fitting well with the city's cultural development and promotional policies and coinciding with the industrialisation process and timely needs of the audio-visual industry. On the other hand, at the peak of growth in the audio-visual equipment field, Starpark needed to explore new domains based on its technological and talent advantages and a highly sticky broadcasting client market. The accumulation of resources, foundational conditions, and multiple business lines have determined that Starpark is destined to develop a comprehensive industrial park.

Looking at the positioning of critical links in the industry chain, in 2009, after in-depth research and analysis of core value companies in the park, Starpark found that these companies' core needs were focused on business requirements satisfaction, professional and low-cost shared technology platforms, and overall brand value development advantages. Hence, in its initial phase, the park positioned key links of its industry chain in the production stages of public service platforms in studios, integration and matchmaking of enterprise supply and demand, and attracting and servicing top enterprises in the cluster growth pole. Starpark allocated internal and external industry resources to these nodal enterprises by investing in platforms, projects, and strategic collaborations.

From the perspective of network growth poles and value nodes, each level of the industrial chain represents both industry interests and pursues individual benefits. Clarifying the relationship between the development of individual enterprises at various levels of the industrial chain and the overall development of the industrial chain is necessary for industry adjustment and optimisation of the industrial structure (L. H. Wang et al., 2014). The development of the industrial chain and the formation of industry clusters are closely related; the industrial chain relationships among enterprises within a cluster form the basis of the industry cluster's formation (Zheng & Peng, 2019). Within the industrial chain network of film and television parks, program channels, large media organisations, and institutions with technological advantages, such as top-tier technical services, play a key role. Their interrelationships are the most active, with strong network connectivity and derivativeness and high value and profit potential. Therefore, the park focuses on introducing or building cluster growth pole enterprises that meet the needs of the park in these fields. Between 2011 and 2013, the park successfully introduced high-value network node enterprises such as Xinhua Net, Central People's Broadcasting Station Shopping Channel, and Zhongshi Qianwei (FO-ZSQW in the questionnaire survey), further perfecting the value chain network structure.

The driving forces behind the development of Starpark stem from multiple resources such as technology, market demand, investment, talent, and investment attraction, which, based on the industry chain network, aggregate and activate to build a diversified, one-stop audio-visual content creative production solution found in the park. This solution fosters collaborative workflows among various professions and coordinates the entire industry chain resources, thus promoting knowledge spillover and value flow, further driving innovation within the enterprises in the park.

3.2.2 Industrial Space Distribution

Starpark is in Daxing District, Beijing, China. It currently has four sub-parks in the east, south, west, and north, covering a total area of 420,000 square meters with a building area of approximately 900,000 square meters. The industrial space layout is as follows:

East District of Starpark: Positioned as an audio-visual technology innovation zone. This area concentrates the core service resources of audio-visual technology in the park, including 6 large studios, 70 small studios, and more than 50 various functional rooms such as directing control rooms, information technology rooms, satellite transmission rooms, post-production rooms, engineering rooms, drama makeup rooms, interview rooms, and audio workspaces. In addition, the area is equipped with a cloud computing centre and other essential supporting equipment and facilities. As the audio-visual technology innovation zone of the park, the East District will focus on developing next-generation audio-visual technologies such as 5G+ ultra-high definition, remote production, virtual production, ultra-high definition + AI/AR, and other new information and fusion technologies. These innovative technologies will bring new opportunities to the park and drive the industry forward.

West District of Starpark is an audio-visual economic development zone. This area concentrates more than 90% of the commercial facilities in the park and has a landmark building for the studio covering 3,600 square meters.

According to the development plans of Starpark and Beijing Municipal Bureau of Radio and Television, the West District is planned to become an audio-visual cultural and economic experience zone, gradually implementing key development projects such as the audio-visual museum, Feitian Theater, and audio-visual cultural district.

North District of Starpark: Positioned as an audio-visual format innovation zone. The feature of this area is small, low-density cultural carriers. As of 2021, part of it has been completed and is expected to be fully completed by 2023. The overall plan aims to create an incubation platform for audio-visual headquarters enterprises and high-quality, innovative startup teams and a platform for format innovation and popular check-in locations. The focus is on introducing audio-visual cultural headquarters enterprises, 5G, 4K/8K, AI, big data, cloud computing, and other high-tech audio-visual enterprises while attracting short and long video production, audio content creation, and live e-commerce innovation and startup enterprises.

South District of Starpark is an audio-visual equipment research and development zone. This area gathers various Starpark series equipment enterprises, covering lighting, projection, giant LED screens, stage machinery, virtual studios, broadcast vehicles, communication vehicles, third-generation semiconductor chips, and other audio-visual equipment. The South District focuses on the research, development, and integration of 5G+ ultra-high definition + AI/AR/XR intelligent audio-visual equipment, committed to promoting research and development in high-tech equipment and achieving the localisation of audio-visual equipment.

3.2.3 Main Business Composition

3.2.3.1 Digital Audio-Visual Intelligent Equipment Sector

This Sector's main factory area is located in the South District of Starpark. The primary business system includes five parts: traditional studio and lighting engineering business, 5G+ ultra-high definition particular vehicle research and customisation business, intelligent stage machinery research and design integration business, significant cultural tourism and performance project design and integration business.

Traditional studio and lighting engineering is Starpark's traditional business, covering all provincial satellite TV stations and major public cultural institutions in China. This business has won multiple awards from the American Newscast Studio and holds more than a hundred professional qualifications and intellectual property rights. It is also the setter of national standards, industry standards, and movie and television LED lighting standards in China's movie and television stage industry. Typical clients include major satellite TV studio projects, Beijing Olympics lighting and movable type, Shanghai Expo China Pavilion, APEC Summit red carpet, People's Great Hall energy-saving lighting, National Theatre lighting project, and Chang'an Theatre lighting project.

The 5G+ ultra-high definition particular vehicle research and customisation business mainly serves various audio-visual institutions (such as TV stations, online video platforms, e-sports and online gaming platforms), providing customised research, development, and integration services for ultra-high definition special vehicles. This business has obtained 29 utility model patent technologies, 5 utility model patents pending, and 1 invention patent. The compartment and some essential equipment have achieved independent research, development, and national production replacement. An average of 42 sets are produced annually, including 21 sets of 5G+8K ultra-high definition broadcast vehicles. Customised research and development projects by enterprises in this area include China's first 5G+8K ultra-high definition broadcast vehicle, the 100th anniversary of the founding of the Communist Party of China CCTV ultra-high definition television broadcast vehicle (which undertook broadcasting tasks at the Tokyo Olympics), iQiyi 8K ultra-high definition broadcast vehicle, and Tencent e-sports broadcast vehicle.

The intelligent stage machinery research and design integration business was established as a joint venture company in collaboration with Show Canada (a Canadian stage industry company) and Mirage Entertainment Inc. (a US entertainment company). The joint venture company integrates Show Canada's advanced stage machinery and control technology and Mirage's unique creative design and performance experience while enjoying its global resources. Combined with Starpark's production, integration, and service systems, the joint venture company provides electromechanical devices, stage settings, hanging systems, control systems, unique architectural structure designs, and customised research and development services for big entertainment or performance projects. Typical clients include Shanghai Disney and Beijing Universal Studios, among other well-known enterprises.

The giant cultural tourism and performance project design and integration business targets cultural tourism parks and large-scale live performance projects, offering a comprehensive one-stop service that integrates creativity, design, integration, construction, and technical services. This business has undertaken several important projects, including Zhang Yimou and Wang Chaoge's Impression series, Return series, and Again series of large-scale live performances, as well as Wanda Dai Show, Han Show series, and other top-level show projects.

3.2.3.2 Digital Audio-Visual Content Production Research and Service Sector

This Sector is located in the East and West Districts of Starpark, and the primary business system includes five parts: studio digital audio-visual service platform, sports digital audio-visual service platform, high-tech digital audio-visual service platform, digital audio-visual application research and development laboratory, and digital cultural asset trading platform.

The studio digital audio-visual service platform focuses on undertaking TV and online audio-visual variety shows and evening party production services. Through business integration and adjustment, it currently mainly cooperates with CCTV brand variety shows, Beijing Satellite TV Spring Festival Gala, and top online audio-visual institutions such as iQiyi, Douyin, and Kuaishou to participate in the production of large-scale evening parties and brand variety shows. Typical cases include Plain Language, Touching China, National Memory, Singing China, Youth Flying, Central Committee of the Communist Youth League Mid-Autumn Festival Gala, Archaeology Conference, Beijing Spring Festival Gala, JD 618 Boiling Night, 618 Pinduoduo Evening Party, Kuaishou National Goods Glowing Live Broadcast, and more.

The digital sports audio-visual service platform mainly undertakes large-scale domestic and international sports events, sports competitions, e-sports competitions, and large-scale event broadcasting and production services. The park has invested in 2 large broadcast vehicles, 4 small satellite communication vehicles, and 3 sports broadcast motorcycles as service carriers. Major projects undertaken include the 2020 Tokyo Olympics, the 2008 Beijing Olympics, the 2013 Guangzhou Asian Games, the PGA Tour China, Running China Marathon, Peace Elite PEC Finals (e-sports), China Tennis Tour, CBA, Men's Basketball World Cup, skiing, table tennis, and many other large-scale sports events, with annual broadcasting mileage exceeding 80,000 kilometres.

The high-tech digital audio-visual service platform includes the 5G+ ultra-high definition remote production centre and the XR virtual production co-innovation centre, mainly undertaking 5G+ ultra-high definition+X (including AI, IP, VR, XR, cloud production, and other new digital production technologies) production service businesses.

The digital audio-visual application research and development laboratory includes the 5G+4K/8K ultra-high definition+X application scenario research and development centre, the XR virtual production visual scene research and development centre, and the 5G+4K/8K ultra-high definition remote production research and development centre. Each centre has established an independent research and development team of over 40 members. As of now, the laboratory has signed research and development cooperation agreements with more than 10 partners, including Huawei, China Mobile, Edipu, Dayang, Xin'aote, Sony, and China Ultra-High Definition Industry Alliance, independently completing 34 intellectual property applications, including 25 software copyrights, 8 utility model patents, and 1 invention patent, and has been approved as a national high-tech enterprise.

The digital cultural asset trading platform is the core value of the digital movie and television industry. It includes the movie and television works and various artistic, creative and design achievements generated during their production process, such as scenes, virtual characters, props, costumes, etc. These assets, like the works themselves, have intellectual property attributes derivative value, resulting in transformation rights. Given the operation of XR digital asset trading platforms with typical Western cultural characteristics abroad, Starpark plans to accelerate the construction of China's first XR digital asset trading platform, open up industry chain cooperation and industry cultivation, and encourage the creation and intellectual property trading of cultural assets with Chinese cultural characteristics and features, such as digital twin physical landscapes, XR virtual scenes, virtual characters, and props.

3.2.3.3 Audio-Visual Industry Aggregation and Incubation Services Sector

This sector primarily focuses on targeted investment attraction and leasing in the audio-visual industry, public enterprise, public policy, and party services.

The targeted investment attraction and leasing business in the audio-visual industry adopts a precise investment attraction model, mainly positioned for high-end ecological investment in the sizeable audio-visual industry. This business selectively targets enterprises high on the industrial chain, characterised by high positioning, technology, creativity, quality, and potential, to comprehensively enhance the quality of enterprises in the park.

For enterprises that do not meet the park's professional ecology and high-end positioning, a gradual elimination and persuasion to leave strategy is adopted, replaced by high-quality enterprises. Key layouts are in the fields of audio-visual consumption network platforms, top and sub-top digital content production institutions, high-end audio-visual technology research and development and application institutions, well-known consumer performance institutions, digital audio-visual copyright protection and trading institutions, as well as XR virtual production ecological enterprises. The focus is on crucial cultivation and incubation to create a core audio-visual cultural population.

Public enterprise services cooperate with the municipal radio and television bureau and copyright bureau, providing comprehensive services, including offline approval (green channel), audio-visual business consultation, policy training, industry coordination in Beijing-Tianjin-Hebei, and copyright workstations. Twenty-two strategic service cooperation enterprises have been signed, covering investment and financing, technological innovation, entrepreneurship guidance, policy training, creative planning, professional services, and more. More than fifteen public welfare training activities are organised annually, covering commercial finance and taxation, legal finance, policy guidance, professional technology, and other aspects.

Public policy services, from the management level of the base, aim to attract more audio-visual enterprises to cluster and drive the rational flow of resources. The base has introduced preferential policies for the Beijing Starpark, implementing benefits in several areas, including rent reduction, decoration reduction, reduced costs for technical services or upgrades, internal transaction rewards, and talent rewards.

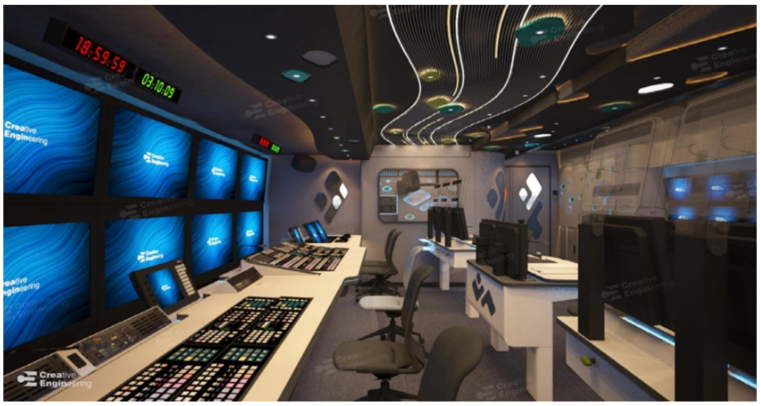
3.3 Current State of Starpark's Industry Chain Network

3.3.1 Building an Industry Chain Network with Platforms

Starpark, established during the initial phase of China's audio-visual industrialisation, has gone through various stages, including the development from solely broadcast television to the integrated evolution of broadcast and online audio-visual media and the diversified integration of audio-visual formats. This aligns with the theoretical evolution from linear to multi-agent network innovation (Baptista & Swann, 1998; Hoffman et al., 1998; Malecki, 2017). Technologically, it has progressed from analogue to Standard Definition (SD), High Definition (HD), and now to 5G+ Ultra High Definition (UHD), achieving an upgrade in quality and ecosystem. Concurrently, lighting technology has evolved from hot to cold light sources. Display technology has continuously improved from plasma and LCD to LED and now OLED. TV transmission technology has also developed from satellite and fibre-optic networks to 5G wireless transmission, and system control has iterated from mechanical to networked and intelligent systems. Starpark has always been a platform for application scenarios and technological innovation testing in China's and Beijing's audio-visual industries. In Starpark's application scenario, collaborative laboratories, breakthroughs in stage lighting technology, LED lighting and large screen technology, stage machinery technology, OB (Outside Broadcasting) van technology, remote production technology, and virtual studio production technology have all been achieved. To date, Starpark has not missed any opportunity for technological progress and iteration. More than a hundred enterprises have emerged within Xing more than a hundred enterprises have emerged. In 2022 alone, over twenty enterprises participated in Starpark's XR virtual production collaborative innovation platform. Starpark is undergoing its fourth comprehensive technological upgrade since the industrialisation of the park, focusing on 5G, UHD, IP-based remote production, virtual production, cloud production, AI intelligent production, and other technological systems. Through the construction of shared experimental platforms and virtual production collaborative innovation platforms, more enterprises are drawn into the industrial chain network system of Starpark.

Figure 3. 1

Real Scene of Starpark's Mobile Production Carrier Platform



Note: Actual scene shooting of Starlight.

3.3.2 Innovation in Industry Formats

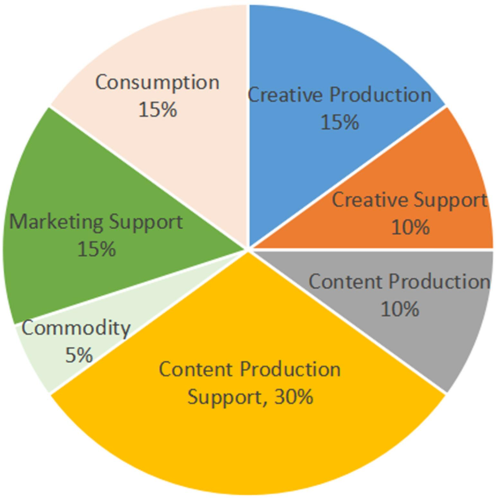
One significant manifestation of industrial value is the spillover value of knowledge, referring to the derivation and recreation of expertise. The audio-visual industry, being a part of the creative economy, possesses characteristics of knowledge spillover. Taking Starpark as an example, its industry format has undergone continuous iteration and upgrading: from the 1.0 version of traditional broadcast television program production to the 2.0 version incorporating broadcast television and online platform program production, and further to the 3.0 version which adds short video and online live broadcast program production. However, post-2021, the COVID-19 pandemic presented new challenges to the industry. To address these challenges, Starpark actively sought innovative breakthroughs in virtual production and established a collaborative innovation platform. XR virtual production, utilising new technologies such as digital twinning, image tracking, rendering, and artificial intelligence, has digitalised and intelligentized most of the industry chain links, revolutionising aspects ranging from scenes, lighting, and props to recording processes, transmission, and editing. The changes brought about by this revolution in terms of cost, efficiency, environmental protection, cultural assets, and regulation have presented significant opportunities for industry development. Through practice, Starpark has affirmed the value of knowledge spillover for industry innovation (J. Liu et al., 2017), utilising knowledge spillover and mutualistic symbiosis as the driving force for forming creative industry space agglomeration in China. Indeed, for audio-visual industry parks, the most significant value of knowledge spillover lies in driving the audio-visual industry's public technology and resource accumulation in a socialised manner, along with derivative innovation in business formats, continuously expanding the depth and breadth of the industry chain.

3.3.3 Evolution and Derivation of the Industry Chain Network

Before 2021, the enterprise organisation of Starpark was mainly based on the ecological needs of related industry organisations upstream and downstream in the industry chain from the 1.0 to 3.0 stages of the audio-visual format. Different modes, such as industrial investment attraction, targeted precise investment attraction, and socialised investment attraction, were adopted to gather enterprises that meet the development needs of the park's industry chain. Currently, the park has amassed more than 500 core value enterprises of the industry chain, distributed in different areas of the value map, as shown in Figure 3.2:

Figure 3. 2

Business Distribution of Enterprises in Starpark Industrial Park



Note: Self-compilation by Starlight Park Management Committee in 2023.

The Movie and Television Park creates conditions for developing and transforming small and medium-sized enterprises (SMEs). Firstly, Starpark, with its rich experience and strong capabilities in technology R&D, market promotion, and resource integration, provides SMEs with technical support, market channels, and resource sharing to help them grow and develop. Secondly, by conducting upstream and downstream industrial chain cooperation and communication, the park builds a broader platform for SMEs, promoting the joint development of the industrial chain and the healthy operation of the entire industrial ecosystem. Additionally, Starpark is committed to continuously strengthening the cluster growth pole ecology, actively introducing core value enterprises at crucial nodes of the industrial chain, thus generating a resource-driving effect on other SMEs.

The park emphasises advancing enterprise cooperation and collaborative innovation. Starpark has consistently maintained a leading position in core and critical technologies in China's audio-visual content production. The park continuously perfects its open, coordinated ecological strategy, ensuring equal opportunities and outcomes in innovation development within the industrial value network through ongoing open acceptance of industrial cooperation, industrial pilots, scenario testing, and industrial collaborative testing. For example, Starpark has established multiple application development centres, including an XR application scenario laboratory, XR virtual technology R&D, XR virtual equipment production, and more, forming an industrial cooperation network in various related fields. Strategic partners or incubated vital enterprises in the Huawei, Mobile, and Sony virtual production industrial chain networks have entered the park. In addition, the park continuously explores and improves audio-visual value-creation concepts and solutions driven by the demands and imaginations of the general public. Through innovative cooperation, business cooperation, industrial forums, new achievement roadshows, capital matchmaking, and other methods, the park maintains the vitality of platforms and projects and advances collaborative innovation among different organizations. Simultaneously, it keeps an investment perspective and sensitivity to development, continuously exploring, evaluating, investing in, and nurturing potential enterprise organisations.

The industrial chain network within the Movie and Television Park is increasingly open. An open industrial chain network not only attracts more partners, promoting innovation cooperation and cross-border integration, thereby driving innovation development upstream and downstream of the industrial chain but also facilitates resource sharing and optimisation, improving overall resource utilisation efficiency, reducing production costs and promoting the coordinated development of organisations in various links of the industrial chain. Starpark, adhering to the concept of open development, create more entrepreneurial opportunities and conditions through open platforms and ecological interfaces, continuously strengthening the knowledge spillover effect brought about by audio-visual technology R&D and cultural creativity. Additionally, the park actively promotes the cross-industry, cross-border, and cross-domain integration development of the industry, breaking down industry barriers, focusing on the integration of the audio-visual industry with retail, tourism, museums, education, and other fields, forming a more open industrial chain network, and driving virtual agglomeration (Fuks & Kawa, 2013), reducing production costs, optimising resource allocation, and creating more development opportunities and growth space for the industry.

3.3.4 Industry Chain Network Gathers Talent Resources

Starpark is committed to building a service platform that integrates all elements of the innovative ecosystem, promoting deep cooperation among scientists, entrepreneurs, investors, engineers, producers, and directors. It aims to fully exploit the diverse values embedded within social capital (Burt, 1992; Nahapiet & Ghoshal, 1998) to address the resource disconnection between original innovation capabilities and the integration of technology and industrial innovation in the audio-visual sector. The core talent needs of

Starpark's digital audio-visual industry mainly include (1) Composite application technology talents with expertise in movie and television technology, information technology, and artificial intelligence; (2) Professional artistic and creative talents in the movie and television industry, including directors, screenwriters, producers, scene designers, visual art designers, animation designers; (3) Digital asset design and production talents with the ability to skillfully use and innovatively combine various production tools; (4) Digital intellectual property operation talents capable of standardising, productising, and marketing different types of digital content, and conducting related transactions and rights protection.

Starpark creates more entrepreneurial opportunities and conditions for various talents through open platforms and ecological interfaces, continuously enhancing the knowledge spillover effect of audio-visual technology R&D and cultural creativity. In addition, the park constantly provides services needed by entrepreneurs, including capital matchmaking, cooperation matchmaking, industry support policy matchmaking, business ecology matchmaking, and talent ecology matchmaking, to smooth entrepreneurial channels, accumulate entrepreneurial resources, and continuously build a sustainable development potential of the entrepreneurial project reserve. In terms of the industrial resource service environment, Starpark actively cooperates with research institutes and well-known large enterprises in the industry, including Communication University of China, South Guangdong College, China Mobile, Huawei, etc., attracting more high-quality, highly skilled talents to the park to jointly carry out new projects and innovative activities.

3.3.5 Formation of Collaborative Innovation Advantage

Collaborative innovation is an internally characterised method with specific managerial planning and leading features. In the audio-visual industry park, collaborative innovation, through the use of scenarios, resources, platforms, and other carriers and experimental venues, adopts strategic cooperation, investment, incubation, mergers and restructuring, etc., to build an innovation R&D and application system of technology, creativity, and models, forming tangible or intangible innovative outcome values. This continuous innovation effort creates innovation points or growth points in industrial development and drives the industry economy to explore more fields. Through collaborative innovation, innovation costs are reduced, and the iteration speed of technology and creativity is accelerated, positively creating industrial value. When the park gradually forms a growth pole led by a particular enterprise, related industrial policies, resources, technology R&D, capital, regional environment planning, etc., will lean towards the park, providing more support and development opportunities.

Starpark has a complete industrial innovation mechanism and a mature industrial collaborative innovation platform in the industrial resource service environment. It has established an efficient innovation mechanism within the park, stimulating and promoting cooperation and innovation activities among different enterprises, research institutes, and other partners. This mechanism allows all participants to share resources, jointly develop projects, and form synergies, enhancing overall innovative capabilities. At the same time, Starpark has built an entire industrial chain value ecological network, covering the whole process from the laboratory to application scenarios to production and consumer scenes. This ecological network allows enterprises and institutions within the park to interconnect and collaborate in different value chain stages, achieving resource sharing and complementarity (Guan & Liu, 2016; Ye, 2021).

Through cross-domain cooperation and innovation, enterprises within the park can better transform scientific research results into practical applications and quickly bring them to market, thereby accelerating the development and maturation of the industry. The establishment of such a collaborative innovation mechanism and a whole industrial chain value ecological network endows Starpark with the capability to advance steadily and form a core competitive advantage. Furthermore, Starpark has developed into a quality incubation carrier, providing security for more light-asset, innovative, and creative enterprises without extensive networks and capital accumulation. Enterprises and institutions within the park jointly carry out innovative projects, optimise production processes, improve product quality, and meet market demands through this incubation carrier. This collaborative innovation model promotes enterprises' development within the park and helps enhance the competitiveness and innovation level of the entire movie and television industry.

3.4 Challenges Faced by Starpark's Industrial Chain Network

3.4.1 Room for Improvement in Industry Collaboration

In developing the audio-visual industry, enterprises in private parks face inherent disadvantages in industrial resource coordination due to the difficulty in completely separating industrial management from business management. In contrast, parks backed by the government or state-owned enterprises and supported by a business management system have advantages. Although private parks have benefits such as market sensitivity, business resource organisation ability, and rapid response mechanisms, allowing them to take the initiative in industry collaboration, their collaborative capabilities can be weakened by various factors once the competition for industrial resources enters a mature stage.

3.4.2 Regional Talent Drain Issue

The overall innovation of industrial parks is inseparable from talent support. Around 2015, Beijing proposed policies to relieve non-capital core functions and industrial retreat, forcing specific segments and groups that play essential service roles in the content production industry chain, such as movie and television location bases, costume props, and stage art companies, to leave Beijing. This caused a disconnect between the production value and the product value in the industrial value network, leading to the simultaneous outflow of enterprises in the production value area and the product value area outside of Beijing, further causing the flow of professional talents in Beijing's audio-visual industry to the south of China. This situation worsened after the COVID-19 pandemic, posing challenges to the development of Beijing's audio-visual industry parks.

3.4.3 Slow Pace of Innovation and Iteration in Projects

The organisation of industrial resources in Starpark mainly includes self-built industrial platforms and those established through investment or joint construction. These platforms often involve high-cost, long payback period projects with high technical barriers and low market investment willingness, requiring continuous innovation iteration and industrial upgrading. However, the park currently faces challenges such as technical barriers and low market investment willingness, lacking the introduction of high-tech and agility to adapt to market demands. Additionally, rigid management systems and a lack of culture that encourages innovation and tolerates mistakes within the park slow the pace of project innovation. With the ever-shortening cycle of innovation iteration, these factors pose significant challenges to developing the industrial park.

3.5 Comparison of Development Models of Representative Audio-Visual Industry Parks in China

As of 2022, the China National Radio and Television Administration has officially approved the establishment of 28 national-level broadcasting, television, and network audio-visual industry bases (Appendix 2). These bases cover multiple fields such as network audio-visual, video, movie and television, TV dramas, documentaries, science and education films, animation, visual technology, etc.. They can be generally categorised into three types: comprehensive, content, and technology.

3.5.1 Key Elements of Park Development Driven by Industrial Chain Networks

3.5.1.1 Core Industrial Chain

An industrial chain refers to the organic connection of various links and participants, forming a complete production process from the supply of raw materials to product sales. An industrial chain network is a vast network formed by the intertwining and interconnection of multiple industrial chains. Parks, leveraging the advantages and resources of their core industries, have developed personalised industrial chains for value creation, production, and transformation. This forms the core industrial chain of the park, with value creation and output as its main body, and expands into related fields around this core. For example, parks focusing on audio-visual application scenario services include primary segments such as application scenario design and development, construction, and service, extending to cultural tourism, entertainment, and other related areas. For parks with content production as the core industry, their industrial chain includes content creative planning, production, and distribution. It extends to the development of cultural derivative products and the commercialisation of intellectual property. The core industrial chain is the carrier of industrial drive in the park, which fully utilises the park's resources and advantages to promote industrial development and expand into related fields to achieve multi-level, multi-field collaborative development, eventually forming a vast industrial chain network. Such a network ensures the healthy operation of the park's industrial ecosystem and promotes sustainable development.

3.5.1.2 Industrial Synergy

Industrial synergy refers to establishing cooperative and coordinated relationships between different enterprises or industries within the park, achieving mutual benefits through resource sharing, technological innovation, and market development. It has become an essential mode in modern industrial development. Enterprises in the audio-visual industry park can establish cooperative and coordinated relationships through industrial synergy, achieving goals such as resource sharing, technological innovation, and market development, enhancing overall benefits and market competitiveness. Economically, enterprises within the park exist in symbiotic business relationships of supply and demand, cooperation, and competition. Different enterprises can complement and collaborate through resource sharing and technological innovation, improving overall efficiency and market competitiveness for mutual development. Organizationally, enterprises in the park can share spaces, platforms, policies, and industrial resources. For example, a company requiring specific equipment or technology can collaborate with others to share resources, reducing costs and improving efficiency. Industrially, enterprises within the park can establish cooperative relationships through collaborative research and development, creative collaboration, joint services, joint production, standardisation, platform building, and channel development. For instance, a film studio and a music production company within the park can collaborate to produce and promote a musical film, achieving mutual benefits. In summary, industrial synergy in the park fosters cooperation and coordination between different enterprises through resource sharing, technological innovation, industrial chain collaboration, market expansion, and talent development, achieving complementary advantages, shared resources, shared risks, and mutual benefits. This cooperative model significantly enhances the park's competitiveness and drives industrial transformation and upgrading.

3.5.1.3 Industrial Innovation Mechanism

Developing industrial parks is closely linked to industrial, social, economic, cultural, and technological advancements, with continuous innovation and industrial upgrading critical to their success. To achieve this goal, eco-industrial chains in parks should establish innovation mechanisms based on the development trends of core industrial chains, with keen market insight and advanced developmental foresight. Firstly, the innovation mechanism must be found in the main business. Reforms deviating from the central business are not innovations but abandoning the original industrial ecosystem. The innovation mechanism of audio-visual industry parks should include technological and scientific research innovation, scene mode innovation, business model innovation, talent system innovation, and operational management innovation, promoting industrial upgrading and building upon the existing industrial chain and value network. Secondly, the innovation mechanism should start from market demand, capturing market dynamics. The common pitfall of policy-driven industrial parks is blind innovation under the stimulus and guidance of policies, deviating from market demand. For instance, the government encourages the development of ultra-high-definition videos, immediately introducing or establishing 8K ultra-high-definition related projects or platforms without seriously considering their actual value in current market demand and application scenarios, leading to significant industrial waste. Therefore, the industrial innovation of audio-visual industry parks should first explore and cultivate market demand and consumption scenarios. Thirdly, the innovation mechanism should be compatible. The audio-visual cultural industry is highly inclusive, covering technology, art, consumption, and other fields. Hence, the innovation mechanism of audio-visual industry parks should fully utilise the industrial ecosystem, leveraging the spillover of knowledge, collaborative innovation, and talent effects to achieve ecological innovation rather than individual innovation. Fourthly, the innovation mechanism should adapt to the political and economic environment. China's audio-visual cultural industry and its industry parks are deeply influenced by policies, with policy risks being one of the main challenges facing the development of audio-visual industry parks. Therefore, the innovation mechanism of audio-visual industry parks should fully consider the current and future political, economic, and policy environments to avoid crossing political red lines and maintain consistency with policy trends. Simultaneously, the innovation mechanism of audio-visual industry parks needs to rapidly respond to the current economic environment, building a reasonable system for innovation collaboration and linkage, seizing market opportunities at the first instance, and gaining the first wave of benefits from industrial innovation and upgrading.

3.5.2 Comparison of Models of Industrial Chain Network-Driven Innovation in Representative Audio-Visual Industry Parks in China

The following section compares four representative audio-visual industry parks with Starpark: Zhejiang Hengdian Movie and Television Industry Experimental Zone, China Huairou Movie and Television Industry Demonstration Base, Hunan Malanshan Video Cultural and Creative Park, and Fujian Xiamen Intelligent Audio-Visual Industry Base, as detailed in Appendix 3. These parks were selected because they include both organically developed and planned parks; they range from the earliest approved to those approved in recent years by the government; they encompass privately (collectively) funded, mixed private and government-funded, and purely government-funded parks; and include both naturally grown and industrially planned integrated parks.

From the perspective of industrial chain networks, Malanshan Video Cultural and Creative Park, established later, has been operating for less than

6 years and has always been under government departments' overall planning and industrial advancement. It lacks a clear industrial chain and ecosystem, with its industrial chain scattered across various fields such as animation, live streaming, and production, more akin to an industrial cluster or economic development zone. Hence, this development model struggles to leverage the innovative driving force of industrial chain networks.

Hengdian Movie and Television Industry Experimental Zone, the first national-level movie and television industry base approved by the China National Radio and Television Administration of China, has been operating for nearly 20 years, primarily focusing on outdoor filming for movies and TV dramas. As a filming base based on natural environments, it possesses inherent environmental advantages in film and television shooting. However, due to its investment policy orientation, the base lacks unified industrial chain management and operation mechanisms, presenting several challenges. Currently, project activation within the base primarily relies on disparate projects. While cost-effective and quick to implement, these projects operate independently, unable to achieve a cohesive industrial chain network effect. Additionally, Its industrial chain is relatively concentrated and primarily confined to location shooting aspects, resulting in a short industrial chain with limited scope for derivative expansion. Being distant from central cities forms the foundation and drawback of its development.

Established in 2014, Huairou Movie and Television Base, a vital industrial resource base in Beijing, backed by a large state-owned enterprise (China Film Group), enjoys strong support. However, with the adjustment of Beijing's industrial positioning and the introduction of prohibited and restricted industry catalogues, the development focus of this demonstration base is facing changes. Owing to a policy-centric orientation, the park primarily comprises dispersed projects such as the China Film project and the Bona project, operating independently without unified industrial chain management and operational mechanisms, failing to form a complete industrial chain network. Meanwhile, as a leading enterprise in the industry, China Film Group's inherent competitive exclusivity limits industrial agglomeration, causing the base to gradually become an appendage of China Film, further weakening the base's capacity for industrial expansion.

Xiamen Intelligent Audio-Visual Industry Base consists of a core and expansion areas. The core area includes intelligent audio-visual content production, technical services, platform operation, education and training, and end-product manufacturing; the expansion area focuses on attracting new intelligent audio-visual enterprises. Similar to Malanshan Park, Xiamen Intelligent Audio-Visual Industry Base, with a short operation time and government leadership, covers multiple areas such as online gaming, animation, and software industries. With its dispersed industrial chain, it struggles to utilise the innovative drive of industrial chain networks.

The comparison of these representative industry parks reveals that Starpark differs significantly from other major Chinese audio-visual industry parks in that it is entirely privately invested, market-operated, and has evolved naturally. In contrast, other parks are supported by powerful state-owned enterprises, corporations, and government organisations. Starpark's ability to operate continuously and hold a place in China's audio-visual cultural industry parks is closely related to its path of driving innovation and development through industrial chain networks. Network maintenance relies heavily on the government's state-owned and central enterprises for other industry parks. For instance, Malanshan Park, backed by Hunan Broadcasting System and Mango TV, two super media platforms in satellite TV and online video, can aggregate massive industrial resources solely based on these two platforms. For the park, the core advantage lies not in the industrial chain network but in the leadership of top enterprises, making their driving force sourced from these leading enterprises. However, this model does not apply to privately owned parks. Hengdian, as a privately owned collective organisation, relies on grassroots government units and has significant advantages in resource integration and scheduling. Hengdian Group's portfolio covers mining, pharmaceuticals, shipping imports and exports, gas, and water supply, a form of resource integration not feasible for a regular private enterprise without government backing.

Therefore, for privately owned, market-operated audio-visual industry parks, it is not feasible to replicate the industrial development paths of the Hengdian Movie and Television Industry Experimental Zone or Malanshan Video Cultural and Creative Park. Instead, they should follow a path that relies on industrial chain network-driven innovation and development of the park.

Chapter 4 Theoretical Hypotheses and Research Model

From the case analysis mentioned earlier, it is evident that industrial chain networks and collaboration can ensure the healthy operation of the ecosystem in audio-visual industry parks, thereby enhancing the competitiveness and innovation level of the entire movie and television industry. Based on this finding, this chapter constructs a theoretical framework of network embeddedness, collaborative capability, and innovative performance from the micro-level perspective of enterprises. It proposes theoretical hypotheses to be tested in this paper.

4.1 Impact of Network Embeddedness on Firm Innovative Performance

Network embeddedness is an open system where enterprises constantly interact closely, complexly, and dynamically, ultimately forming a network embeddedness model (Moran, 2005). Most researchers use the two dimensions of structural and relational embeddedness, divided by Granovetter (1985), to further depict network embeddedness.

4.1.1 Structural Embeddedness and Firm Innovative Performance

Enterprises face a paradox in structural embeddedness, with researchers identifying a negative, positive, and nonlinear relationship between structural embeddedness and innovation. For instance, Ahuja argues that structural holes positively and negatively impact subsequent innovations; in inter-firm collaboration networks, an increase in structural holes negatively affects innovation (Ahuja, 2000). Shi et al. contend that the two main features of structural embeddedness are network centrality and structural holes, finding that a firm's central position in the network positively impacts its incremental innovation ability. In contrast, structural holes have an inverted U-shaped relationship with their radical innovation capacity (Shi et al., 2021). Resource dependence theory posits that organisations lack all the resources and capabilities to achieve expected results, and organisational goals depend on the resources and actions of other organisations. Hence, enhancing a firm innovative capability and performance requires continuous acquisition of external resources (Jajja et al., 2017). The source of innovation lies in the structure of external collaboration networks and the internal capability to leverage network externalities (Helena Chiu & Lee, 2012). According to structural holes theory, firms occupying structural holes act as bridges between two network participants without direct contact, gaining more informational advantages and resource benefits (Guan & Liu, 2016). Therefore, current research shows that structural embeddedness positively impacts innovation. Vasudeva et al. found that structural holes and network embeddedness profoundly influence innovation in the fuel cell industry (Vasudeva et al., 2013). Wincent et al. demonstrate that network embeddedness structure significantly impacts firms' innovative performance (Wincent et al., 2014). Wang et al., through empirical evidence, show that network embeddedness positively impacts the innovative performance of the new generation of employees, with structural embeddedness having a significant positive effect on both process and outcome innovation (J. Wang et al., 2022). Wang et al. find that both relational embeddedness and structural embeddedness significantly positively impact the innovative performance of high-tech enterprises in Guangdong Province (C. Wang et al., 2023).

The variation in the relationship between structural embeddedness and innovation may be related to the type of innovation and the stage of business development. For instance, in the initial stages, structural holes provide firms with new information and diverse thinking, promoting radical innovation. However, when the number of structural holes reaches a certain level, the cost and complexity of coordinating and integrating external information also increase, which may negatively affect innovation. Firms positioned at the centre of networks easily access resources, facilitating sustained incremental innovation. In knowledge-intensive industries such as the audio-visual sector, we posit that the relationship between structural embeddedness and innovation is more likely to be positively correlated. This is because the audio-visual industry heavily relies on innovation and rapid technological changes, including content innovation, technological innovations (such as new media platforms and playback technology), and business model innovation. In such an innovation-driven industry, structural embeddedness, especially links with diverse partners and cross-border networks, is usually positively correlated with innovative outcomes. Additionally, the audio-visual industry experiences rapid changes in market demand with a continuous high demand for innovation. Firms need to constantly adapt to new technologies and shifts in consumer preferences, requiring them to occupy advantageous positions within networks to quickly acquire and apply new knowledge.

Therefore, firms centrally positioned in the network and having more structural holes can leverage resource advantages and linkage roles, facilitating close knowledge, information transfer and exchanges between firms, and a more straightforward understanding of market and customer needs, which is crucial for innovating services and products and enhancing firm innovative performance. Hence, this study proposes Hypothesis 1:

H1: A firm's structural embeddedness positively impacts its innovative performance.

4.1.2 Relational Embeddedness and Firm Innovative Performance

Like the structural paradox, firms face a relational paradox, with the relationship between relational embeddedness and innovative performance still being debated. Some studies indicate that relational embeddedness can adversely affect firms, where decision-makers focus on embedded relationships to mitigate risks and uncertainties in choosing partners. Still, such attention to embedded relationships also limits organisations from forming contacts with other organisations with less or no relational embeddedness, thus reducing organisational adaptability (Meuleman et al., 2010). Furthermore, when environmental dynamics are high, the difficulty in matching internal resources with the external environment increases, and high relational embeddedness requires significant relational maintenance and coordination costs, causing disruptive impacts (H. Zhang, 2021). Yang et al. find an inverted U-shaped relationship between relational embeddedness and innovative performance, suggesting that excessive relational embeddedness can lead to the homogenisation of network knowledge, which is detrimental to firm innovation (B. Yang et al., 2022). However, many studies show that relational embeddedness positively impacts firms' innovative performance. For example, research indicates that higher degrees of relational embeddedness among firms facilitate relationships, overcoming uncertainties and increasing cooperation willingness (Meuleman et al., 2009). Xu et al. explore the mechanism of relational embeddedness's impact on innovative performance in the Chinese context, finding that relational embeddedness in international manufacturing networks positively impacts technical innovative performance through exploratory learning (G. Xu et al., 2012). Benítez-Ávila et al. show that the degree of cooperation with external partners in networks (i.e., the degree of relational embeddedness) positively impacts innovative performance (Benítez-Ávila et al., 2018). Communication and coordination between firms can promote knowledge dissemination and mutual learning, knowledge acquisition, and performance enhancement opportunities (Czernek-Marszałek, 2020).

The existence of a non-uniform relationship between relational embeddedness and innovation indicates that companies need to seek a balance when developing strategies for relational embeddedness to avoid the potential drawbacks of over-reliance on existing networks. In knowledge-intensive industries such as the audio-visual sector, we believe the relationship between relational embeddedness and innovation is more likely to be positively correlated, as these knowledge-intensive companies are generally younger and do not place as much emphasis on relational embeddedness as traditional industries do. Therefore, in the studies of these companies, the latter half of the inverted U-shaped relationship between relational embeddedness and innovation proposed by the academic community is unlikely to appear for the time being, only presenting the first half of the inverted U-shaped relationship, that is, a generally positive correlation.

In summary, the innovation process requires firms to closely connect with other firms to obtain information about technology, customers, suppliers, and markets. A firm's relational embeddedness helps establish partnerships, reduce risks and uncertainties, and acquire knowledge and resources. The higher the degree of relational embeddedness, the stronger the ability of the firm to acquire innovative resources and the willingness of other participants in the network to provide resources (Z. Wang et al., 2020), thereby prompting the firm to transform knowledge and improve innovative performance. Therefore, this study proposes Hypothesis 2:

H2: A firm's relational embeddedness positively impacts its innovative performance.

4.2 Impact of Network Embeddedness on Corporate Collaborative Capability

4.2.1 Structural Embeddedness and Corporate Collaborative Capability

Embeddedness is considered a framework for knowledge exchange and innovation, where structural embeddedness emphasises the participants' positions within the collaborative network (Andersen, 2013). Structural embeddedness aids in playing a 'bridge role' for firms within the network, enhancing inter-firm communication efficiency and increasing collaborative opportunities, providing resource advantages and network positional benefits for the exertion of corporate collaborative capabilities. Scholars have studied the relationship between structural embeddedness and corporate collaboration. Nair et al. assert that structural embeddedness in supply networks provides opportunities for repeated interactions for conditional collaborators, aiding in the collaborative decision-making of supply network members. High structural embeddedness increases the cooperativeness of firms with other network members (Nair et al., 2018). Ofem et al., in their study of economically challenged rural areas, believe that the structural embeddedness of rural economic development organisations increases their coordination ability, allowing partners to utilise shared relationships to provide broader and more comprehensive solutions (Ofem et al., 2018). Network structural characteristics influence not only the outcomes of the focal organisation but also the processes and outcomes of partnerships, where structural embeddedness impacts the success of organisational collaboration through interdependence. Therefore, structural embeddedness can increase cooperation and interaction between firms and other organisational members, aid in joint decision-making, and enable efficient cross-departmental and cross-organizational operations, thus enhancing corporate collaborative capabilities. Hence, Hypothesis 3 is proposed:

H3: Structural embeddedness positively impacts corporate collaborative capability.

4.2.2 Relational Embeddedness and Corporate Collaborative Capability

Relational embeddedness represents the mutual dependency, resource exchange, and resource combination in social relationships (Andersson et al., 2005), enabling firms to establish trust, engage in complementary cooperation, and access heterogeneous resources. Firms with strong social relationships are more likely to enhance mutual understanding of technology and knowledge, which helps establish long-term partnerships within innovation networks (Bonner et al., 2005). Additionally, firms can share responsibilities and risks in collaboration, jointly solve problems, and receive relevant feedback, thereby leveraging comparative advantages and achieving synergistic effects (G. Xu et al., 2012). Establishing cooperative relationships between firms forms social networks, with relational embeddedness more often considered as the closeness and strength of network relationships (García-Villaverde et al., 2018). Firms collaborate through relational network embeddedness to achieve mutual benefits (H. Tian et al., 2021). The higher the degree of relational embeddedness, the closer the connections between firms, the higher the level of trust, the easier it is to establish stable and sustainable cooperative relationships, thereby reducing the costs of information and knowledge flow and exchange between firms, facilitating access to external resources in the social network, and enhancing the collaborative effects and capabilities of firms. Therefore, Hypothesis 4 is proposed:

H4: Relational embeddedness positively impacts corporate collaborative capability.

4.3 The Mediating Role of Collaborative Capability

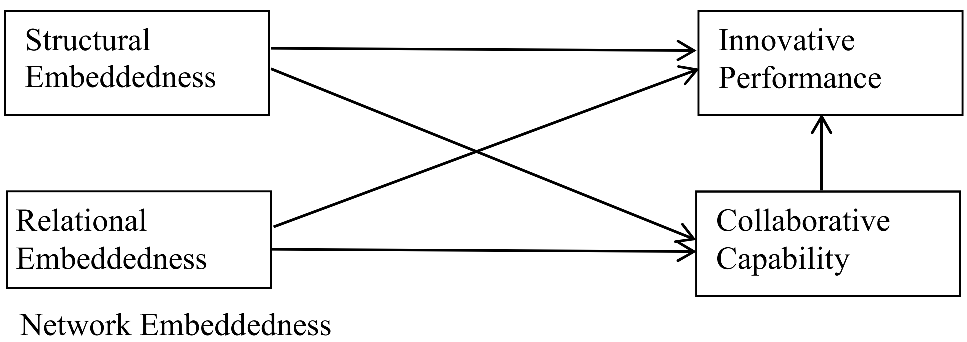
Network embeddedness is a transactional or cooperative relationship with other associated enterprises to achieve resource sharing and value co-creation (H. Zhang, 2021). Structural embeddedness involves an organisation's position within the entire network structure, affecting its interactions and cooperation with other organisations. Relational embeddedness emphasises social contacts, whose intensity impacts the degree of knowledge sharing (Hsueh et al., 2010). Ciabuschi et al. believe that firm embeddedness allows subsidiaries to access existing resources within multinational corporations, making it possible through collaborative integration capabilities (Ciabuschi et al., 2014). Thus, structural and network embeddedness provide firms with resource advantages and interaction opportunities, increasing the frequency and depth of information exchange among enterprises in the network and being conducive to enhancing corporate collaborative capabilities. Firm collaborative capability is closely related to corporate innovation. Extensive communication and interaction between firms and external partners facilitate crossing network boundaries and accessing diversified technological knowledge bases (Rass et al., 2013). The higher the corporate collaborative capability, the higher the degree of information flow and sharing between firms, where information sharing helps achieve business goals, strategies, advanced technology, successful experiences, and ideas, and the absorption, transformation, and utilisation of these, promoting the firm's absorption of knowledge and enhancing its innovation ability (Y. Yang et al., 2022). Corporate network embeddedness influences its innovative performance by exerting corporate collaborative capabilities. Research shows that deep firm embeddedness refers to the increasing collaboration within a specific group of collaborators (e.g., customers or suppliers), allowing firms to create new knowledge combinations through the heterogeneous capabilities of other organisations, increasing the likelihood of finding innovative problem-solving solutions (Leiponen & Helfat, 2010). Additionally, firms' relational embeddedness in external networks outside clusters, or collaboration with partners beyond cluster boundaries, directly impacts the firm's innovation success (Terstriep & Lüthje, 2018). Especially in today's increasingly competitive environment, more firms form alliances to set and disseminate technical standards and improve their innovative performance through network embeddedness (X. Yang et al., 2021). Network embeddedness theory suggests embedding the focal firm into appropriate collaborative innovation networks and establishing sustainable partnerships with collaborators to access scarce resources and increase the success rate of technological innovation (X. Li & Liu, 2023). Therefore, structural and relational embeddedness helps firms establish partnerships and collaborative relationships with other organisations, where partners' heterogeneous knowledge is an essential resource for firm innovation. In summary, firms embedded in networks can leverage their structural and relational advantages, build trust and establish partnerships with other network members, enhancing their collaborative capabilities and synergistic effects. Close collaborative relationships facilitate the rapid and efficient flow of innovative resources such as technology, information, and knowledge between firms and collaborating organisations, enhancing the firm's innovative capabilities or performance. Hence, the study posits that structural and relational embeddedness impact a firm innovative performance through collaborative capabilities and proposes Hypotheses 5 and 6:

H5: Collaborative capability mediates the relation between structural embeddedness and innovative performance.

H6: Collaborative capability mediates the relation between relational embeddedness and innovative performance.

Figure 4. 1

Theoretical Framework



Note: Self-compilation

Chapter 5 Research Design

5.1 Data Collection and Processing Methods

5.1.1 Data Collection Methodology

This thesis adopts a survey method for data collection, particularly leveraging the name-generator technique from social network analysis. The name-generator approach is extensively used and has developed into a mature process with established methods, demonstrating high reliability and validity (Campbell et al., 1986). For instance, the General Social Survey conducted in the United States in 1985 employed this technique, asking respondents, "Looking back over the last six months, who are the people with whom you discussed matters important to you?" This exemplifies a typical name-generator survey form. In management studies, Bell utilised a questionnaire approach to investigate managerial networks. Specifically, chief executives were questioned about their friendship, information, and advisory networks, delineating the company's managerial network (Bell, 2005). Moreover, Tsai's approach of inquiring about departments' positions within organisational networks also falls under the name-generator category. The primary objectives of the name-generator method are twofold: firstly, to obtain a group of names; secondly, to determine the relationships among these individuals (social network diagram), resulting in a network structure (Tsai, 2001). Specifically, in this research, survey participants are asked about "enterprises closely collaborating with your company inside and outside the park," "research institutions closely collaborating with your company inside and outside the park," and "intermediaries closely collaborating with your company inside and outside the park," with a request to nominate as many as possible. The absence of a specific number for nominations is intentional to avoid uniformity in the number of nominations by companies, such as every company naming three, which might lead to the inclusion of less relevant company data. This nomination method allows for collecting company names and information about their collaborative relationships. Furthermore, companies are not asked to nominate government departments, as interactions between enterprises and the government in China are generally confidential. Such exchanges are not as frequent as with state-owned enterprises, especially for private enterprises.

Additionally, the completion time for the questionnaire is controlled to be within 15 minutes (Galesic & Bosnjak, 2009). One method to reduce measurement error in social network analysis is to avoid interview fatigue in respondents. Lengthy questionnaires can cause fatigue, anxiety, and reduced attention in respondents, significantly affecting measurement quality. Conversely, too few items in a questionnaire can lead respondents to be influenced by their answers to previous items, increasing the probability that the response to the current item is affected by previous responses. This reduces the fading of prior responses in short-term memory, thereby increasing the consistency of responses between similar items. In summary, overly long questionnaires can increase the bias due to respondent fatigue and carelessness. In contrast, excessively short questionnaires can increase the likelihood of previous item responses affecting current item responses.

5.1.2 Data Processing Methods

Linton Freeman, an authoritative scholar in social network research at the University of California, Irvine, initially developed the UCINET (University of California at Irvine NETwork) software. Subsequently, Stephen Borgatti and Martin Everett have primarily maintained and updated the software. It is a user-friendly program with general-purpose capabilities, incorporating fundamental concepts of graph theory, positional analysis methods, and multidimensional scaling techniques. The software can calculate various social network characteristic parameters and conveniently analyse data stored in Microsoft Excel spreadsheets. A key advantage of using UCINET software is that the algorithms for measuring the structural embeddedness are built into the software. Moreover, the network construction and analysis procedures in UCINET have been extensively validated, ensuring measurement accuracy. The software versions 6.0 and above have incorporated social network drawing software developed by Krackhardt and Freeman, covering the functionalities of Netdraw. All data are stored, displayed, and described in matrix form in these versions. This paper will utilise UCINET 6.421 software to calculate enterprises' structural embeddedness parameters and draw overall network and ego-centred network diagrams.

In addition to UCINET 6.421, this paper employs SPSS 22.0 software for exploratory factor analysis and AMOS 22.0 software for confirmatory factor analysis. After conducting reliability and validity tests, the PROCESS plugin in SPSS 22.0 software performs hypothesis testing for mediating effects and calculates effect ratios.

5.2 Measurement of Variables

5.2.1 Dependent Variable

In measuring an enterprise's innovative capability, the academic community often refers to Feldman's definition of innovation, which is the adoption of new technology in the production process and the creation of new products or services (Feldman, 2000). In empirical research, there are various methods for measuring enterprise innovative performance: some studies use the number of new product releases to measure innovation (Acs & Audretsch, 1988); some use R&D expenditure as a proxy for enterprise innovative capability (Henderson & Cockburn, 1994). However, due to the long latency period of new product releases, it is difficult to examine the current innovation situation of enterprises through the number of new product releases in cross-sectional studies. Additionally, China's R&D statistical system is immature, especially for small and medium-sized private enterprises, making obtaining data on R&D investment difficult.

Many scholars also use the number of patents to measure a company's innovative capability (Ahuja, 2000; Jaffe & Trajtenberg, 2003) because patents are directly related to the ability to invent and innovate. Empirical studies have shown that patents are highly correlated with indicators such as new product development, innovation and invention numbers, and sales growth. However, patent numbers have certain drawbacks to measuring innovative performance. First, some inventions may not meet all the conditions for patent application, and some of these conditions have no necessary connection with the innovativeness of the product/technology. Secondly, some inventions may not wish to apply for patents for strategic reasons (e.g., to avoid attracting competitors' attention). Thirdly, companies vary in their propensity to apply for patents; for instance, companies that value intellectual property rights place more emphasis on patent applications, while those with a weaker sense of intellectual property protection or who believe the cost of patent protection outweighs the benefits naturally hesitate more in patent applications. Prioritising scientific and technological achievements while neglecting patent protection is still a common issue in China. Therefore, this study believes that using the number of patents as a measure of innovation is also inappropriate in the Chinese context.

Therefore, this study measures innovative performance according to the research of Bell, Ritter, and Gemünden (Bell, 2005; Ritter & Gemünden, 2004), and this method of measuring innovative performance has been recognised by a series of scholars (J.-H. Cheng et al., 2014; Song et al., 2006). A five-point scoring method is used, where 1 point indicates strong disagreement and 5 points indicate strong agreement. Specific measurement items are shown in Table 5.1.

Table 5. 1

Innovative Performance Measurement Scale

Measurement items
Compared to peers, my company often takes the lead in introducing new products/services in the industry.
Compared to peers, my company often pioneers the application of new technologies in the industry.
Compared to peers, my company's product improvements or innovations receive very positive market responses.
Compared to peers, my company's products incorporate top-notch advanced technologies and processes.
Compared to peers, my company has a very high success rate in developing new products.

5.2.2 Independent Variables

Structural Embeddedness is measured based on network position and social capital theories considering centrality and structural holes to calculate the structural embeddedness of companies within industrial chain networks (Burt, 2007; Goodwin et al., 2009; Zaheer & Bell, 2005) and depicting the network map of company cooperation. The questionnaire design method for cooperation network data refers to the name-generator method in social network analysis. It asks the surveyed companies to nominate companies or institutions they closely cooperate with.

5.2.2.1 Degree centrality

Typical indicators used to measure centrality include degree centrality, betweenness centrality, eigenvector centrality, and closeness centrality. Among them, degree centrality is the most widely used. In a directed graph, it can be distinguished into in-degree centrality and out-degree centrality. An undirected graph represents the sum of the ties between the surveyed firm and other firms without indicating the direction. For example, if A is the focal firm and nominates B, its degree centrality increases by 1. If C nominates A, A's degree centrality increases by another 1. However, if A also nominates C, the centrality does not increase further because when both parties nominate each other, the degree of centrality of the focal firm in an undirected graph is counted only once.

5.2.2.2 Constraint

The "constraint" index is the most focused and widely used index for measuring structural holes. Constraint is a highly summarising index that can effectively measure the scarcity of structural holes. The higher the constraint, the fewer structural holes the actor has, so "constraint" usually has an inverse relationship with performance (Burt, 2007). Also, as the maximum value of the "constraint" index is 1, for convenience, scholars often use the difference between 1 and the "constraint" value to measure the abundance of structural holes (Zaheer & Bell, 2005). In this study, we calculate the constraint values of each surveyed company using UCINET 6.421 software and then calculate the abundance of structural holes for the corresponding companies by computing the difference between 1 and the "constraint" values.

5.2.2.3 Relational Embeddedness

Relational embeddedness is measured based on the research of scholars (Granovetter, 2018; McEvily & Marcus, 2005; Uzzi, 1997; G. Xu et al., 2012b), designing 5 measurement items, using a five-point scoring method, where 1 point indicates strong disagreement, and 5 points indicate strong agreement.

Table 5. 2

Relational Embeddedness Measurement Scale

Measurement items
My company attaches great importance to providing and receiving information from partners.
My company and partners help each other in problem-solving.
My company and partners alert each other about possible issues or changes.
My company has frequent interactions with partners overall.
My company maintains stable collaboration with our partners.

5.2.3 Mediating Variable

Referring to the research design of scholars (Mishra & Shah, 2009; Nieto & Santamaría, 2007; Vuola & Hameri, 2006), the collaborative capability is divided into collaboration with related enterprises, research institutions, government departments, and intermediary agencies, using a five-point scoring method, where 1 point indicates strong disagreement and 5 points indicate strong agreement.

Table 5. 3

Collaborative Capability Measurement Scale

Measurement items
My company and relevant companies trust each other in research and development activities.
My company engages in strategic collaborations with relevant companies regularly.

Measurement items
My company and relevant companies closely collaborate in innovation activities.
My company frequently obtains valuable information or knowledge from relevant companies.
Employees from my company and relevant companies often exchange and learn from each other.
My company and research institutions trust each other.
My company has close collaborations with research institutions.
My company frequently establishes cooperative relationships with other organisations through research institutions.
Research institutions are essential partners for our company's innovative activities.
My company has received funding or rewards from the government for research or innovation.
My company's innovation often receives support from the government.
My company can timely grasp the latest policies related to R&D areas from the government.
My company frequently establishes cooperative relationships with other organisations through government departments.
My company and intermediary organisations trust each other.
My company frequently establishes cooperation relationships with other organisations through intermediary organisations.
Intermediary organisations are indispensable partners for my company's innovation activities.

Note: Intermediary agencies include training centres, accounting firms, law firms, industry associations, chambers of commerce, and other intermediary agencies.

5.2.4 Control Variables

5.2.3.1 Enterprise Age

Henderson argues that incumbent firms possess a set of mature information processing norms or procedures, which are very useful for these firms to achieve incremental innovations along existing technological trajectories (Henderson, 1993). Therefore, as time passes, the foundational knowledge of enterprises accumulates, and thus, organisational innovation is strengthened with increasing age. Shan et al. suggest that older enterprises have more time to develop products and, therefore, have more innovative outputs (Shan et al., 1994). Other scholars believe that the age of enterprises affects their rate of patent applications, thereby impacting their innovative performance (Salman & Saives, 2005; Sørensen & Stuart, 2000).

In this study, we consider that enterprise age may influence innovative performance, but it is not the focus of this paper. Therefore, enterprise age is treated as a control variable. Following common academic practice, we use the difference between 2023 (the year of questionnaire collection) and the year the enterprise was founded as the enterprise age.

5.2.3.2 Enterprise Size

According to the tradition of Cohen and Levin, it is necessary to control enterprise size when analysing innovative performance (Cohen & Levinthal, 1989). Studies have found that enterprise size significantly impacts innovative output (Shan et al., 1994) because larger enterprises have more resources to strengthen innovative performance and are more likely to receive support from the government and other institutions in innovation. Large enterprises may have more extensive industry contacts, leading to broader personal networks and more opportunities for knowledge alliances (Stuart, 1998) [9]; additionally, size may affect an enterprise's attractiveness as an alliance partner, as larger enterprises have broader market coverage and access to large user groups (Stuart, 1998). This study considers that enterprise size may influence innovative performance, but it is not the main focus of this paper. Therefore, enterprise size is treated as a control variable.

For specific measurements, annual sales are used as a proxy for enterprise size (Stuart, 1998), and sales revenue and the number of employees

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9 Professor Rolf Sternberg from the Department of Economic and Social Geography at the University of Cologne conducted a comprehensive survey of the Hanover-Braunschweig-Göttingen research triangle, Saxony, and Baden in Germany. He found that with the expansion of company size, the external contacts of the company strengthened. Among the manufacturing companies with innovation activities surveyed, 80% of small companies with fewer than 20 employees had external contacts related to product or process innovation, while this figure was 95.8% for large companies with more than 500 employees. The same conclusion holds when using the stricter measure of “joint research and development projects” to assess a company's innovation connections, namely, the external contacts of a company increase with the expansion of its size, regardless of its location.

are used as variables to measure size (Tsai, 2001). The number of employees and sales revenue may fluctuate significantly due to seasonal and market volatility, making it challenging to compare enterprise sizes intuitively. In contrast, total assets are more stable, comparable, and less affected by market fluctuations. Therefore, the study uses total assets as a proxy variable for enterprise size, considering that larger enterprises usually have more assets.

5.3 Sampling Method

Among the numerous scholars in social network sampling research, Frank is considered one of the most influential (Wasserman & Faust, 1994). His classic works and comprehensive literature reviews (Frank, 1971, 1981, 2005) provide fundamental solutions for situations where complete network data is unavailable in social network sampling. Erickson and Nosanchuk summarised the potential issues in network sampling based on a network of over 700 actors (Erickson & Nosanchuk, 1983). Notably, Goodman was the first to propose a clever network sampling technique – snowball sampling (Goodman, 1961) [10]. In recent years, other scholars have also reviewed the application of snowball sampling methods in the context of "respondent-driven sampling" (Heckathorn & Cameron, 2017; Winton & Sabol, 2022). The development of these sampling techniques undoubtedly provides theoretical references and methodological guidance for our research.

Reviewing recent studies utilising social network analysis methods on enterprise networks, we find that most research employs convenience or

10 Snowball sampling is a method where a group of selected respondents reports other actors with whom they have specific relationships, known as nominees. These nominated actors form a first-order network. Researchers then survey each actor in this first-order network to collect another group of actors (excluding those in the first-order network and the initially surveyed actors), which constitutes a second-order network. This process can continue to multiple orders of networks, depending on the researcher's interest.

random sampling methods to obtain sample data. For instance, Bell used convenience sampling to analyse the relationship between management network centrality, institutional network centrality, and innovation in 77 Canadian mutual fund companies (Bell, 2005). Ahuja employed archival research methods, collecting data on the cooperative relationships of 97 leading pharmaceutical companies in Western Europe, Japan, and the United States to study the impact of the richness of structural holes on innovation (Ahuja, 2000). Badi et al. used convenience sampling to examine the relationships in the ego networks of four small and medium-sized Chinese construction enterprises in value creation (Badi et al., 2017). Based on their work, the current study adopts the principle of convenience sampling, selecting larger and more well-known enterprises within the Starpark for questionnaire distribution rather than surveying all enterprises in the park. These enterprises typically have more extensive cooperative networks, and the number of enterprises they nominate is more comprehensive, depicting a more extensive industrial chain network with more cooperative ties, better reflecting the structure of the entire movie and television park's industrial chain network.

Chapter 6 Data Collection and Preprocessing

6.1 Questionnaire Distribution and Collection

We adopted a one-on-one approach for distributing questionnaires, with all responses recorded on paper.

In August 2023, a preliminary survey was conducted in the park with ten enterprises, most of which were larger businesses. The primary purpose of this pre-survey was to solicit any issues these businesses faced while filling out the questionnaire. Ultimately, these ten enterprises raised no objections to the questionnaire.

From September to October 2023, we invited 140 enterprises within the park to participate in the survey and distributed paper questionnaires, achieving a 100% response rate. After data entry and verification, two enterprises found noticeable omissions in their scoring responses. The investigators recontacted these businesses, confirmed the omissions were due to oversight, and filled in the missing options with the enterprises' consent. Ultimately, 150 valid questionnaires were collected in the first and second rounds.

After collecting the questionnaires, we first anonymised the names of the surveyed enterprises and their nominated enterprises, following these steps:

Input the handwritten names of the surveyed enterprises and the nominated enterprises.

To ensure the accuracy of the enterprise names, we verified each enterprise and its partners on Chinese websites such as Qichacha and Tianyancha. This step involved confirming the existence of the legal entity and correcting any apparent typos or multiple or missing characters. For example, "天码" was mistyped as "天马", "五颗柠檬" as "五颗柠檬树", and "菲尔斯乐器" as "菲尔乐器", among others.

Extract abbreviations from the names of the surveyed and nominated enterprises. We used the initials of the 3-6 Chinese characters' Pinyin for easily recognisable abbreviations. For example, Beijing Xinggang Weixun Technology Development Co., Ltd. was abbreviated as "XGWX". We used their official English abbreviations for enterprises with ambiguous abbreviations or repeated initials. For instance, the "China Radio and TV Equipment Industrial Association" was abbreviated as "CRTA".

We added prefixes to all enterprise names other than the surveyed enterprises based on the type of partner and whether they were located in the park. The specific prefixes are as follows:

Table 6. 1

Prefixes for Enterprise Name (Excluding Surveyed Enterprises)

Enterprise Abbreviation Code Prefix	Meaning of Code Prefix
FI-	Firms in the park
FO-	Firms outside the park
RI-	Research institutions in the park
RO-	Research institutions outside the park
I I-	Intermediaries in the park
IO-	Intermediaries outside the park

6.2 Descriptive Statistics of the Sample

Table 6. 2

Descriptive Statistics

Variable/Dimension	Label	Sample Size	Minimum	Maximum	Mean	Standard Deviation
age	age	150	1	25	8.47	5.232
Main business①	EquipmentRD	11				
	AppliedTechnology	44				
	ApplicationScenarios	5				
	ContentProduction	32				
	AudiovisualMarketing	31				
	Other	54				
Total_Assets	Total_Assets	150	3	15000	1139.36	2351.72
Relation	infor	150	3	5	4.31	.770
embeddedness	interac	150	3	5	4.29	.805

Variable/Dimension	Label	Sample Size	Minimum	Maximum	Mean	Standard Deviation
	collabra	150	3	5	4.21	.832
	solv	150	3	5	4.13	.830
	alert	150	3	5	4.40	.751
Collaboration with other companies	trust	150	3	5	4.27	.791
	inform	150	3	5	4.11	.824
	strategy	150	3	5	4.09	.806
	exchange	150	3	5	4.16	.828
	collab	150	3	5	4.03	.814
Collaboration with research institutions	collab1②	150	3	5	4.17	.798
	relation	150	2	5	3.98	.871
	essential	150	2	5	3.93	.833
	trust1	150	2	5	4.22	.818
Collaboration with government	support	150	1	5	3.26	.699
	policy	150	1	5	3.23	.743
	fund	150	2	5	3.69	.706
	relation1	150	1	5	3.37	.710
Collaboration with intermediaries	relation2	150	1	5	3.85	.915
	indispens	150	1	5	3.89	.894
	trust2	150	2	5	3.85	.817
Innovative Performance	lead	150	2	5	3.75	.770
	pioneer	150	2	5	3.73	.783
	marketres	150	2	5	3.79	.805
	advanced	150	2	5	3.75	.785
	success	150	3	5	3.78	.759

Note: ① Company's primary business categories include Equipment Research and Development, Applied Technology, Application Scenarios, Content Production, Audio-Visual Marketing, and Others. This item is a multiple-choice question; therefore, the total frequency of all options selected for this item exceeds 150. ② The numerical suffixes following variables such as collab, trust, and relation are used because the items designed for collaboration with different institutions are similar. The suffixes serve to differentiate these similar items by assigning them distinct labels.

Table 6.2 shows that the enterprises surveyed are generally relatively young, with an average establishment year of 8.47 years. Most are small-scale but capital-intensive businesses, with an average employee count of 11.60 and an average total asset amount of 1139.36 ten thousand yuan. Regarding primary business operations, the enterprises participating in the survey mainly engage in applied technology, content production, and audio-visual marketing. Regarding the scoring items on the scale, the average scores of each item range between 3.23 and 4.40. Overall, the degree of collaboration with the government is the lowest, followed by intermediary organisations, with the highest level of collaboration observed between enterprises.

6.3 Scale Reliability and Validity

6.3.1 Reliability

Tables 6.3—Tables 6.5 present the reliability tests for some of the measured variables. The reliability coefficient of the relational embeddedness scale is 0.927, and deleting any item will not increase the reliability of the relational embeddedness measurement scale. The reliability of the collaborative capability scale is also good, with subscale reliability coefficients for the four dimensions being 0.912, 0.904, 0.856, and 0.910, respectively. Deleting any item will not increase the reliability of the collaborative capability measurement dimensions. The reliability coefficient of the innovative performance scale is 0.943, and deleting any item will not increase the reliability of the innovative performance measurement scale.

Table 6. 3

Reliability of Relational Embeddedness Scale

Item	Label	Scale Mean (if Item Deleted)	Scale Variance (if Item Deleted)	Corrected Item-Total Correlation	Cronbach's Alpha (if Item Deleted)	Cronbach's α
provide informaiton	infor	17.03	8.160	0.814	0.910	0.927
problem-solving	solv	17.21	7.860	0.813	0.910	
interaction	interac	17.05	7.863	0.846	0.903	
collaboration	collabra	17.13	7.762	0.836	0.905	
alert each other	alert	16.94	8.540	0.736	0.924	

Table 6. 4

Reliability of Collaborative Capability Scale

Item	Label	Scale Mean (if Item Deleted)	Scale Variance (if Item Deleted)	Corrected Item-Total Correlation	Cronbach's Alpha (if Item Deleted)	Cronbach's α
Company	trust	16.40	8.282	0.722	0.902	0.912
	inform	16.55	7.886	0.785	0.890	
	strategy	16.57	7.951	0.792	0.888	
	exchange	16.51	7.795	0.804	0.886	
	collab	16.63	7.979	0.773	0.892	
Research	collab1	12.13	5.150	0.766	0.882	0.904

Item	Label	Scale Mean (if Item Deleted)	Scale Variance (if Item Deleted)	Corrected Item-Total Correlation	Cronbach's Alpha (if Item Deleted)	Cronbach's α
	relation	12.32	4.568	0.869	0.843	
	essential	12.37	5.026	0.761	0.884	
	trust1	12.08	5.134	0.743	0.890	
Government	support	10.29	3.374	0.720	0.809	0.856
	policy	10.32	3.199	0.738	0.801	
	fund	9.86	3.598	0.603	0.856	
	relation1	10.17	3.299	0.741	0.800	
Intermediary	relation2	7.73	2.626	0.806	0.883	0.910
	indispens	7.70	2.574	0.865	0.831	
	trust2	7.74	2.959	0.793	0.894	

Table 6. 5

Reliability of Innovative Performance Scale

Item	Label	Scale Mean (if Item Deleted)	Scale Variance (if Item Deleted)	Corrected Item-Total Correlation	Cronbach's Alpha (if Item Deleted)	Cronbach's α
takes the lead	lead	15.06	8.030	0.862	0.926	0.943
pioneers the application	pioneer	15.07	8.028	0.844	0.929	
positive market responses	marketres	15.01	8.067	0.802	0.937	
advanced technologies and processes	advanced	15.05	7.849	0.891	0.921	
high success rate	success	15.03	8.227	0.823	0.933	

6.3.2 Exploratory Factor Analysis (EFA)

Table 6.6 presents the results of exploratory factor analysis for each variable or dimension. It is evident that all sub-scales have Kaiser-Meyer-Olkin (KMO) values ranging between 0.758-0.883, and Bartlett's test of sphericity chi-square values are significant, suggesting that the sub-scales are suitable for exploratory factor analysis. Using principal component analysis and based on eigenvalues greater than 1, these sub-scales successfully extracted one factor in their respective dimensions, indicating that all items measure the same dimension. The percentage of variance explained by the factors extracted for each dimension, as shown in the last column of Table 6.6 is very high, indicating good construct validity of the sub-scales (Stapleton, 1997).

Table 6. 6

Exploratory Factor Analysis of Sub-Scales

Sub-scale	Kaiser-Meyer-Olkin	Approximate Chi-Square of Bartlett's Test of Sphericity	Sig.	Variance Explained (%)
relational embeddedness	0.875	584.775	0.000	77.477
collaboration with companies	0.881	481.555	0.000	73.875
collaboration with research institutions	0.813	397.522	0.000	77.640
collaboration with government	0.797	269.779	0.000	70.007
collaboration with intermediaries	0.758	418.668	0.000	84.840
innovative performance	0.883	685.207	0.000	81.400

6.3.3 Confirmatory Factor Analysis (CFA)

The measurement model describes the relationship between observed variables and latent variables, assessing the effectiveness of manifest variables in measuring latent variables. Confirmatory factor analysis is commonly used for validity analysis of measurement models, where, ideally, significant loadings of variables on theoretically related latent variables can be observed through confirmatory factor analysis. Table 6.7 shows standardised factor loadings for the relational embeddedness measurement scale range is 0.753-0.903, the collaborative capability measurement model is 0.744-0.928, and the innovative performance measurement model is 0.831-0.923. In all three measurement models, all item standardised factor loadings are greater than 0.6 and significant at less than 0.01.

Additionally, the paper calculated the Construct Reliability (CR) for each measurement scale to reflect the internal consistency of the items on the scale; the CR value uses the squared sum of factor loadings, indicating that the stronger the correlation between items, the stronger the latent variable's explanatory power, leading to a larger squared sum and better internal consistency. The Average Variance Extracted (AVE) was also calculated for each measurement scale to reflect the convergent validity; the AVE value uses the sum of squared factor loadings, representing the comprehensive explanatory power of the latent variable for all measured variables. The higher the AVE value, the stronger the ability of the latent variable to simultaneously explain its corresponding items, and vice versa, the stronger the items' ability to manifest the latent variable's nature, indicating better convergent validity (Farrell & Rudd, 2009). As seen in Table 6.7, CR values for the latent variables of relational embeddedness, collaborative capability, and innovative performance range between 0.6043-0.7779, all greater than 0.6[11] and AVE values range is 0.8581-0.9431, all greater than 0.5, indicating strong explanatory power of the latent variables for these items, with good internal consistency, and also suggesting that the items manifest the nature of the latent variables well, with good convergent validity.

Table 6. 7

Standardised Regression Weights, AVE and CR for scales

			Estimate	SE.	CR.	P	AVE	CR
infor	<---	RE	0.869				0.7187	0.9272
interac	<---	RE	0.903	0.071	15.376	***		
collabra	<---	RE	0.874	0.075	14.462	***		
problemsolv	<---	RE	0.832	0.078	13.229	***		
alert	<---	RE	0.753	0.076	11.179	***		
trust	<---	Company	0.744				0.6728	0.9111
inform	<---	Company	0.818	0.112	10.237	***		
strategy	<---	Company	0.857	0.109	10.773	***		
exchange	<---	Company	0.857	0.112	10.781	***		
collab	<---	Company	0.820	0.110	10.260	***		

11 Some scholars argue that the Composite Reliability (CR) value should be greater than 0.7, but many also consider a CR value of 0.6 to be acceptable (Meilani et al., 2020; Suryani & Tentama, 2020).

			Estimate	SE.	CR.	P	AVE	CR
collab1	<---	Research	0.854				0.7094	0.9067
relation	<---	Research	0.921	0.077	15.334	***		
essential	<---	Research	0.811	0.080	12.315	***		
trust1	<---	Research	0.776	0.081	11.495	***		
support	<---	Governm	0.773				0.6043	0.8581
policy	<---	Governm	0.843	0.113	10.220	***		
fund	<---	Governm	0.647	0.109	7.758	***		
relation1	<---	Governm	0.831	0.108	10.111	***		
relation2	<---	Intermed	0.867				0.7779	0.9130
indispens	<---	Intermed	0.928	0.069	15.214	***		
trust2	<---	Intermed	0.849	0.065	13.444	***		
lead	<---	IPerf	0.880				0.7685	0.9431
pioneer	<---	IPerf	0.831	0.062	15.993	***		
marketres	<---	IPerf	0.923	0.069	14.109	***		
advanced	<---	IPerf	0.849	0.059	17.896	***		
success	<---	IPerf	0.897	0.063	14.776	***		

注：*** $p < 0.001$

Table 6.8 presents the overall fit of the measurement model. In SEM, one should not rely on a single indicator to judge whether the measurement model fits the implied theoretical model and should conclude based on multiple indicators. As can be seen from the table, RMR, GFI, and CFI indicators in the three measurement models all meet the threshold requirements, but some measurement models do not meet the threshold requirements for CMIN/DF, AGFI, and RMSEA indicators. Considering the good performance in Table 6.7, this paper believes there is no sufficient reason to reject the measurement model.

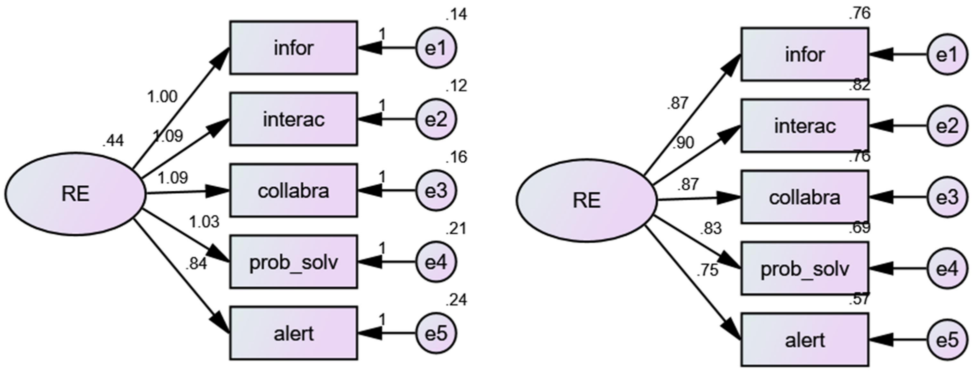
Table 6. 8

Confirmative Factor Analysis Model Fit Summary

	CMIN/DF	RMR	GFI	AGFI	CFI	RMSEA
Threshold	1-3	< 0.05	> 0.9	> 0.9	> 0.9	< 0.08
Relational embeddedness	4.842	0.020	0.933	0.800	0.967	0.161
Collaborative capability	2.244	0.035	0.856	0.800	0.932	0.091
Innovative performance	4.271	0.013	0.949	0.847	0.976	0.148

Figure 6.1

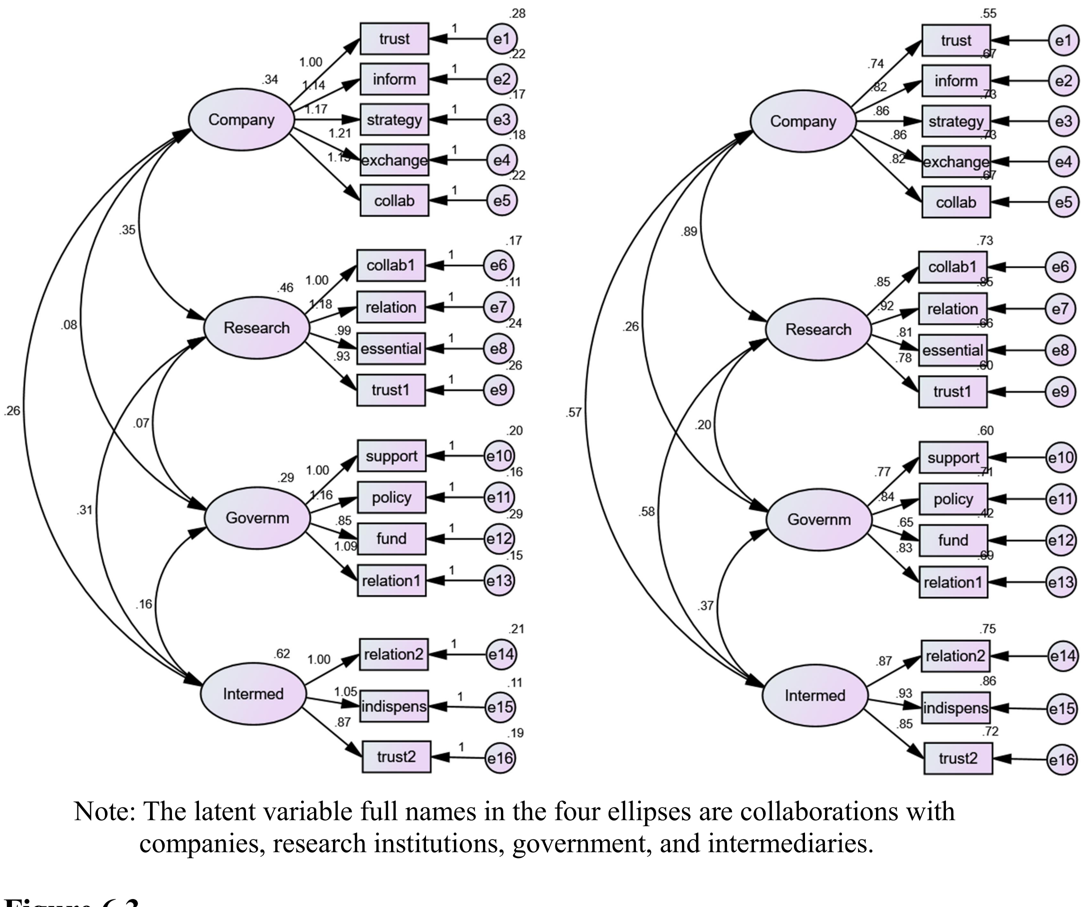
Non-standardised and Standardised Results of Confirmatory Factor Analysis of the Relational Embeddedness



Note: The latent variable full names in the two ellipses are both relational embeddedness.

Figure 6.2

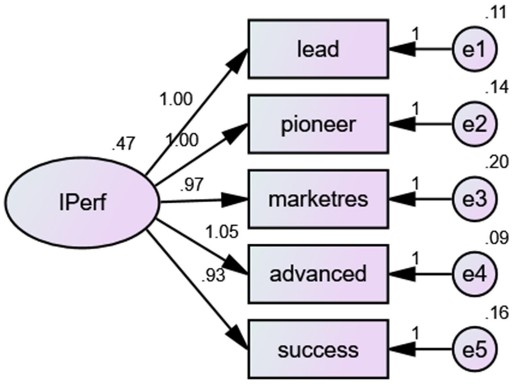
Non-standardised and Standardised Results of Confirmatory Factor Analysis of the Collaborative Capability

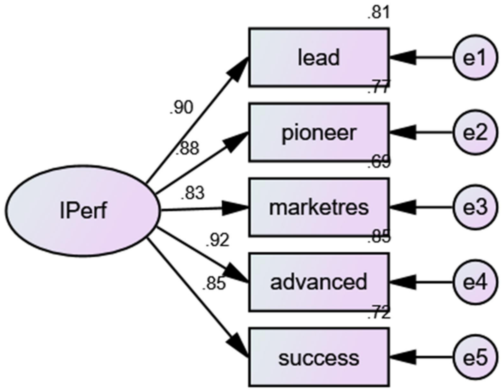


Note: The latent variable full names in the four ellipses are collaborations with companies, research institutions, government, and intermediaries.

Figure 6.3

Non-standardised and Standardised Results of Confirmatory Factor Analysis of the Innovative Performance





Note: The latent variable's full name in the ellipse is innovative performance.

6.4 Network Characterisation

In the effective questionnaires collected, following the nomination generation method[12], the surveyed 150 enterprises nominated 3815 partners (including repeated nominations of enterprises and cases where surveyed enterprises were nominated by others). Ultimately, the network generated 709 unique nodes, with 559 non-surveyed yet nominated institutions. Based on whether there is a cooperative relationship among the 709 enterprises, a 0-1 coding was applied, where 0 represents no cooperative relationship between enterprises, and 1 indicates the existence of such. After coding, we obtained a 0−1 matrix comprising 709 nodes. The original asymmetric matrix and the symmetrically processed matrix[13] were used to calculate network indicators for each enterprise in directed and undirected graphs using UCINET 6.421 software.

6.4.1 Whole Network Indicators

12 The nomination generation method not only allows for the identification of a group of enterprises but also provides insights into the relationships among these entities, thereby revealing a network structure.

13 To symmetrize the data matrix, the Transform→Symmetrize function in the UCINET software can be used. This is achieved by setting xij= xji = 1 only when at least one of xij = 1 or xji= 1 holds; otherwise, they are set to 0. This approach is based on the convention of interpersonal interactions where the relationship between cooperative parties is usually mutual. If A considers B a close friend, typically B would also regard A as a close friend. This concept can be similarly applied to corporate relationships.

See Appendix 5—8 for different scale network diagrams and Table for whole network indicators of various scale networks.

Table 6. 9

Whole Network Indicators of Different Networks

Indicator	150		283（150+133）		576（150+426）		709	
	Asymmetric	Symmetric	Asymmetric	Symmetric	Asymmetric	Symmetric	Asymmetric	Symmetric
# of ties	1126	2120	2013	3894	2882	5632	3769	7406
Avg Degree	7.50667	14.13333	7.11307	13.75972	5.00347	9.77778	5.31594	10.44570
Deg Centralization	0.31199		0.32942		0.12953		0.13535	
Density	0.05038	0.09485	0.02522	0.04879	0.00870	0.01700	0.00751	0.01475
Fragmentation	0.02662	0	0.48115	0	0.74497	0	0.79258	0
Transitivity or Closure	0.14204	0.15421	0.19551	0.15794	0.11128	0.09685	0.14673	0.10568

Note: The number of ties in the symmetric undirected graph network is not double the number of ties in the asymmetric directed graph network, as some enterprises have already nominated each other in the asymmetric directed graph, so the number of ties does not increase in the symmetric undirected graph.

As shown in Table 6.9, drawing a network graph with the surveyed 150 enterprises as the focal point, there are 1126 ties in the asymmetric directed graph and 2120 ties in the symmetric undirected graph. When the focus of the network graph extends to the partners within the park, the network scale increases to 283 enterprises. When it expands to partners outside the park, the network scale is 576 enterprises, and when it extends to both within and outside the park, the network scale is 709 enterprises. As the network scale expands, the number of ties in the network also increases.

Avg Degree measures average centrality in the network, indicating the number of edges directly connected to each focal enterprise. This indicator typically has higher values in symmetric networks than in asymmetric networks. Considering within and outside park cooperating institutions (709 enterprises), the average degree of enterprises in the directed and undirected graphs is 5.32 and 10.45, respectively.

Deg Centralization, or network centralisation, is calculated based on centrality. It calculates the difference between the centrality of the most central point and other points. Then, it compares the sum of these actual differences to the sum of the maximum possible differences. This indicator represents the graph's overall "cohesiveness" or "integration" of the graph, " describing to what extent this cohesion is organised around specific points. A network has only one centralisation. As shown in Table 6.9, the centralisation of the cooperation network among institutions within the park (0.329) is greater than that after including institutions outside the park (0.130). This indicates that cooperation among institutions within the park is more intimate than cooperation with institutions outside.

Density is the overall network density, the ratio of the number of connections to the total possible connections. The greater the network density, the closer the relationships between nodes. As shown in Table 6.9, the network density among institutions within the park is more significant than that after including institutions outside the park, similar to the trend in the Centralization indicator. This also indicates that cooperation among institutions within the park is more intimate than cooperation with institutions outside.

Fragmentation measures the dispersion or partial separation of connections in the network from another angle, often used to describe the connection status between subgroups in the network. The fragmentation index ranges from 0 to 1, with a higher value indicating weaker connections or more separation among subgroups in the network. In other words, the network has many isolated or less interconnected subgroups. This may lead to limited information flow, uneven information dissemination, and restricted cooperation or information exchange between different subgroups. Therefore, a highly fragmented network may complicate cross-group information transfer or collaboration. A fragmentation value of 0 indicates no fragmentation or separation, and the network is fully connected, with all nodes directly or indirectly connected, forming a whole. Such a situation usually occurs in a highly dense or globally connected network, where each node is directly or indirectly connected to other nodes. In this case, information can freely propagate and flow throughout the entire network, with no obstacles between parts, and cooperation and communication are smoother. In this study, there are no isolated points, and the network becomes a global network after symmetrical processing; hence, the index value is 0.

Transitivity or closure measures the transitivity or the likelihood of friends of friends in the network potentially connecting. This indicator measures the probability that if node A is connected to node B and node B is connected to node C, node A is also likely to be connected to node C. The range of transitivity values is from 0 to 1, where 0 indicates that the connections between nodes in the network do not have transitivity, even if there are connections between A and B, B and C, but not necessarily between A and C. 1 indicates that the connections between nodes in the network have very strong transitivity, if there are connections between A and B, B and C, then A and C are also likely to have a connection. Higher values typically indicate stronger transitivity and closure of connections between nodes in the network, i.e., nodes are more likely to form transitive connections or closed group structures. As shown in Table 6.9, the nodes among institutions within the park have stronger connection transitivity, possibly because these enterprises are more familiar.

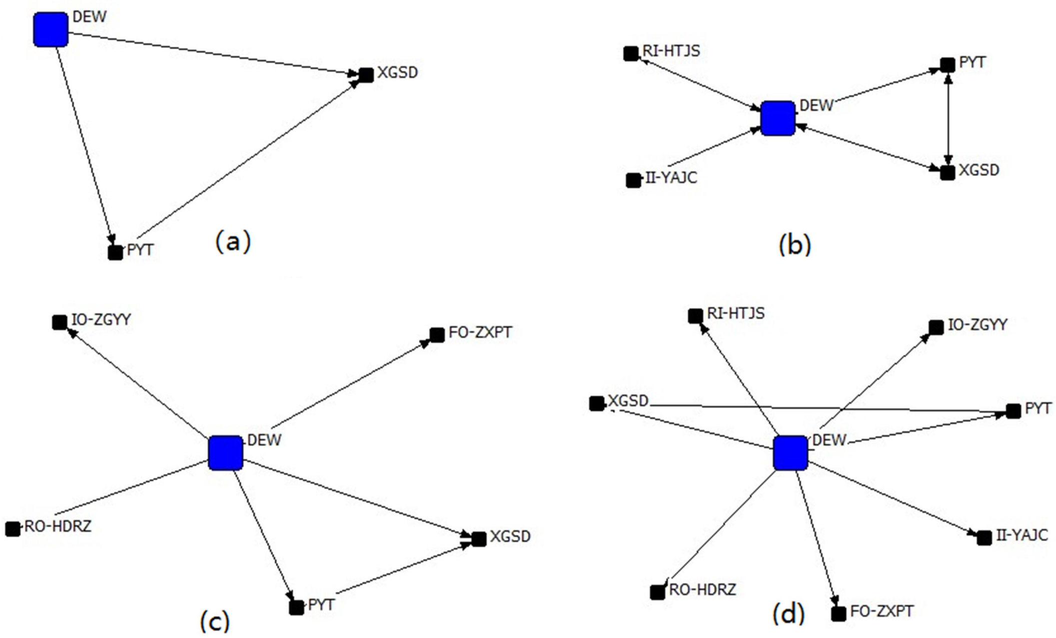
6.4.2 Ego Network Indicators

An Ego network, also known as a self-centred network, consists of a unique central node (ego) and its neighbours (alters), including only the edges between ego and alters and among alters.

Taking Figure 6.4 as an example, for the enterprise DEW, considering this enterprise and its associated institutions as nodes, and only considering this enterprise, its directly connected institutions, and the connections among these institutions, we can obtain a network centred around DEW, i.e., DEW's ego network.

Figure 6. 4

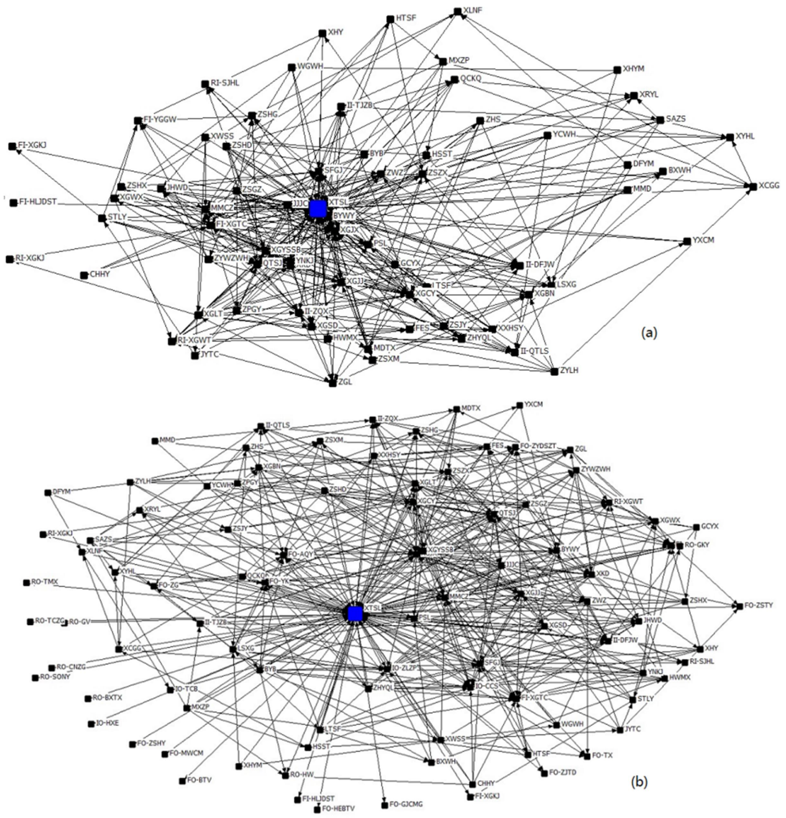
DEW's Ego Network



Note: The blue square node is the central node, the centre of the ego network, surrounded by black square nodes directly connected to this node, which are the alters. (a)-(d) represent DEW's ego-network diagrams in directed graphs of 150, 283, 576, and 709 scales, respectively.

Figure 6. 5

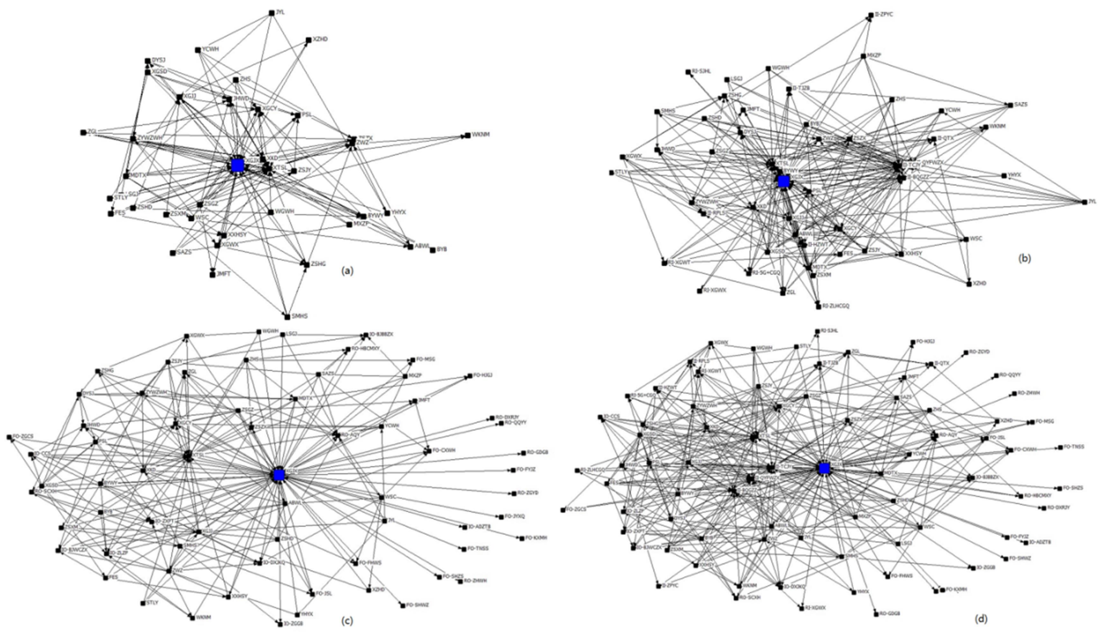
XTSL's Ego Network



Note: (a)-(b) represent XTSL's ego-network diagrams in directed graphs of 283 and 709 scales, respectively.

Figure 6. 6

XGJX's Ego Network



Note: (a)-(d) represent XGJX's ego-network diagrams in directed graphs of 150, 283, 576, and 709 scales, respectively, with networks of 150 and 576 scales omitted.

Table 6.10

Main Indicators of the Ego Networks of Three Surveyed Enterprises in the 709×709 Network

Network Indicator	DEW		XTSL		XGJX	
	Value	Ranking	Value	Ranking	Value	Ranking
OutDeg	7	150	48	4	**53**	**1**
Indeg	0	150	**70**	**1**	28	3
Degree	7	150	**107**	**1**	80	2
Closeness	**2351**	**1**	1469	150	1591	148
Between	3525	34	24585.832	1	14300.551	2
Constraint	0.194	2	**0.039**	**150**	0.044	148
EffSize	6.714	150	**87.612**	**1**	72.521	2
Efficiency	0.959	4	0.922	34	0.918	39
Hierarchy	0.040	150	0.089	58	0.085	71

Note: ① Degree and all other indicators below are calculated from the symmetric network. ② OutDegree refers to the number of other enterprises mentioned by the enterprise in the questionnaire; InDegree refers to the number of times other surveyed enterprises mention the enterprise. ③ The sum of OutDeg and InDeg does not necessarily equal the Degree in the symmetric network, as if two enterprises mutually nominate each other, the nomination count is not duplicated.

Degree indicates the number of degrees on a node and is the most classic indicator of centrality in an ego network. A node that directly contacts many other nodes occupies a central position and has a high degree. In directed ego networks, degree can be divided into InDegree and OutDegree. OutDegree refers to the number of institutions mentioned by the enterprise in the questionnaire, while InDegree refers to the number of times other institutions cite the surveyed enterprise. As shown in Table 6.10, XGJX nominated the most institutions, reaching 53, while DEW nominated the least, only 7. The enterprise most mentioned by other institutions is XTSL, which was mentioned 70 times. Including both nominations by the enterprise and mentions by others, XTSL still ranks first, reaching 107 times.

Freeman et al. (1991) proposed Closeness as a centrality measurement method based on the "closeness" between points. Closeness centrality considers the average length of the shortest paths from each node to other nodes; the closer a node is to others, the higher its Closeness, and the closer it is to the centre of the graph. As shown in the table, the enterprise with the largest Closeness among surveyed enterprises is DEW, but its degree is the smallest. Therefore, multiple indicators must be combined to determine whether an enterprise occupies a central position in the network.

Freeman also proposed Between, describing the extent to which a point lies between other points in a graph, playing a significant "broker" or "intermediary" role, controlling others to some extent. Egos with high betweenness typically control more resources in the network. The table shows that XTSL and XGJX have very high Between values, ranking first and second among surveyed enterprises, indicating their prominent roles as intermediaries.

Similar to the Between indicator, other indicators derived from Burt's Structural Holes concept (Burt, 2004) include constraint, effective size, efficiency, and hierarchy. Intuitively, when two points are connected at a distance of 2, a Structural Hole is said to exist between them. Constraint, the most important indicator for measuring structural holes, indicates the extent to which an enterprise's contacts are redundant; high constraints around a node imply higher network density and fewer structural holes. Thus, enterprises with smaller constraints, like XTSL and XGJX, face fewer restrictions in the network and are usually the authorities or "stars" of the park. EffSize, contrary to constraint, measures the non-redundant part of relationships, i.e., the effective size of a node's ego network; the more interconnected a node's contacts are, the smaller and more redundant its ego network's EffSize. Efficiency measures the non-redundancy of a node's relationships by dividing its effective size by its degree, standardising the non-redundant measure of a node's relationships. Network effective size represents overall influence, while efficiency represents the impact gained per investment in each tie. An extensive network effective size does not imply high efficiency, and vice versa. The efficiencies of the three enterprises in Table 6.10 are very high, close to 1, indicating that they gain considerable impact from each partner, with a lower likelihood that their partners bypass them and connect directly[14].

14 In a multi-stage snowball survey, this conclusion may not necessarily hold true. For instance, although partners A and B of DEW show no direct connections in the current round of the survey, if we have the opportunity to further investigate either A or B, it is possible that a connection between them may indeed exist.

Chapter 7 Hypothesis Testing

7.1 Multicollinearity Test

Before conducting multiple regression analysis, it's necessary to perform a correlation analysis among the independent variables to determine the presence of multicollinearity issues preliminarily. Table 7.1 presents the Pearson Correlation Coefficients among the variables of the study. Except for the slightly higher correlation coefficients between degree and constraint and relational embeddedness and collaborative capability, the correlation coefficients among other variables are insignificant. Furthermore, in regression analysis, degree and constraint are used as proxies for structural embeddedness and are not included in the regression models simultaneously. Therefore, although their correlation coefficients are relatively high, they do not affect the regression results. Even though relational embeddedness and collaborative capability have a relatively high correlation, it has been suggested that severe multicollinearity arises only if the correlation coefficient is more significant than 0.8 (Gujarati & Porter, 2022). Moreover, Hypothesis 4 inherently assumes an influential relationship between these two variables, so a higher degree of correlation is expected and normal. Based on these considerations, there is no significant correlation among the selected independent variables of the study.

Table 7.1

Correlation Coefficients among Independent Variables

Independent variables	1	2	3	4	5	6
1.age	1					
2. total_Assets	0.137	1				
3.degree	0.106	0.435**	1			
4.constraint	-0.082	-0.170*	-0.737**	1		

Independent variables	1	2	3	4	5	6
5. relational embeddedness	0.212**	0.064	0.251**	-0.015	1	
6. collaborative capability	0.145	0.054	0.320**	-0.189*	0.739**	1

Note: ** p < 0.01, and * p < 0.05. The data for the two structural embeddedness indicators, degree and constraint, are based on values from the 150 companies in the 709-sized network. The correlation coefficients for other sized networks were significantly similar to those in this table and are not repeated.

7.2 Mediating Effect Test

The study used PROCESS version 3.0 developed by Andrew F. Hayes, to test the mediating effect (Hayes, 2012), with 5000 Bootstrap samples. In the regression model of the mediating effect test, the values for relational embeddedness, collaborative capability, and innovative performance were based on the average scores of their respective dimensions.

Table 7.2 shows the mediating effect analysis of structural embeddedness on innovative performance when the surveyed 150 companies cooperate with internal and external institutions. The table indicates that the two leading indicators of structural embeddedness, degree and constraint, have a significant direct impact on companies' innovative performance, with regression coefficients of 0.0304 (p<0.001) and -9.9098 (p<0.001), respectively, supporting Hypothesis 1. Notably, a negative coefficient for constraint implies that lower constraints or larger structural holes enhance innovative performance. Structural embeddedness significantly impacts collaborative capability, with coefficients of 0.0143 (p<0.001) and -3.6118 (p<0.05), supporting Hypothesis 3. Collaborative capability partially mediates (see columns 3 and 6 of Table 7.2), supporting Hypothesis 5, with effect ratios of 14.14% and 14.72%.

Table 7.2

Mediating effect test of structural embeddedness on innovative performance when cooperating with internal and external institutions (Partial Mediating)

	Y=	Y= innovative	Y=	Y= innovative

	collaborative capability	performance		collaborative capability	performance	
constant	3.4208***	2.7810***	1.7552***	4.2409***	4.7481***	3.0356***
degree	0.0143***	0.0304***	0.0261***			
constraint				-3.6118*	-9.9098***	-8.4513***
collaborative capability			0.2999***			0.4038***
R^2	0.1024***	0.2796***	0.3282***	0.0356*	0.1615***	0.2562***
indirect effect	0.0043			-1.4585		
total effect	0.0304			-9.9098		
effect ratio	14.14%			14.72%		

Note: ① All coefficients are non-standardised. Duncan (1975) argues that non-standardised coefficients are more statistically significant for mediating effect tests (Baron & Kenny, 1986). ②The conclusions remain unchanged after including control variables such as company age and size in the regression model. ③ *** p < 0.001, ** p < 0.01, and * p < 0.05. ④ Each node's constraint and structural hole values sum to 1, meaning a smaller constraint value indicates a larger structural hole, and a negative constraint coefficient implies a positive impact of structural holes on innovative performance.

Table 7.3 analyses the mediating effects of structural embeddedness on innovative performance in collaborations between the surveyed 150 enterprises and institutions within the park. According to the table, the two leading indicators of structural embeddedness, degree and constraint, have a significant direct impact on the enterprises' innovative performance, with regression coefficients of 0.0366 (p<0.001) and -5.7902 (p<0.001), respectively. This supports Hypothesis 1, indicating that the more centrally an enterprise is positioned in the network, the more it plays a mediating role (when the constraint value is small or the structural hole value is significant), the higher its innovative performance. Structural embeddedness significantly influences collaborative capability, with regression coefficients of 0.0176 (p<0.001) and -2.8658 (p<0.001), supporting Hypothesis 3. Collaborative capability partially mediates (see columns 3 and 6 of the regression results in Table 7.3), supporting Hypothesis 5, with effect ratios of 16.40% and 18.14%, respectively.

Table 7.3

Mediating effect test of structural embeddedness on innovative performance when cooperating with internal institutions (Partial Mediating)

	Y= collaborative capability	Y= innovative performance		Y= collaborative capability	Y= innovative performance	
constant	3.5211***	3.0105***	1.7994***	4.3820***	4.7731***	3.1670***
degree	0.0176***	0.0366***	0.0306***			
constraint				-2.8658***	-5.7902***	-4.7398***
collaborative capability			0.3440***			0.3665***
R^2	0.0822***	0.2153***	0.2807***	0.0729***	0.1793***	0.2543***
indirect effect	0.0060			-1.0504		
total effect	0.0366			-5.7902		
effect ratio	16.40%			18.14%		

Note: ① All the above are unstandardised regression coefficients. ② The study's conclusions remain unchanged After including control variables such as enterprise age and size in the above regression models. ③ *** $p < 0.001$, ** $p < 0.01$, and * $p < 0.05$.

Table 7.4 analyses the mediating effects of structural embeddedness on innovative performance when the surveyed 150 enterprises collaborate with external institutions. According to the table, the two leading indicators of structural embeddedness, degree and constraint, have significant direct impacts on the enterprises' innovative performance, with regression coefficients of 0.0313 ($p<0.001$) and -5.7637 ($p<0.001$), respectively. This supports Hypothesis 1, indicating that the more centrally an enterprise is positioned in the network, the more it plays a mediating role (when the constraint value is small or the structural hole value is significant), the higher its innovative performance. The degree significantly impacts collaborative capability, with a regression coefficient of 0.0159 ($p<0.001$). However, the impact of constraint on collaborative capability is not significant, with a regression coefficient of -2.1239 ($p=0.1173$), partially supporting Hypotheses 3 and 5. It means that when structural embeddedness is measured as degree, collaborative capability plays a partial mediating role. However, when structural embeddedness is measured as constraint, the mediating effect does not exist. A possible reason for this is that in a first-order nomination network, information about 'whether nominated enterprises are related to each other' is usually difficult to obtain, especially when cooperating with enterprises outside the park, making it more challenging to acquire this information and may underestimate the constraint index for some enterprises, thereby disturbing the regression coefficients and their significance levels of constraint to other variables.

Table 7.4

Mediating effect test of structural embeddedness on innovative performance when cooperating with external institutions (Partial Mediating)

	Y= collaborative capability	Y= innovative performance		Y= collaborative capability	Y= innovative performance	
constant	3.4624***	2.9356***	1.7893***	4.1146***	4.3946***	2.5438***
degree	0.0159***	0.0313***	0.0261***			
constraint				-2.1239	-5.7637***	-4.8084**
collaborative capability			0.3311***			0.4498***
R^2	0.0951***	0.2228***	0.2825***	0.0165	0.0732***	0.1930***
indirect effect	0.0053			-0.9553		
total effect	0.0313			-5.7637		
effect ratio	16.93%			16.57%		

Note: ① All the above are unstandardised regression coefficients. ② The study's conclusions remain unchanged After including control variables such as enterprise age and size in the above regression models. ③*** $p < 0.001$, ** $p < 0.01$, and * $p < 0.05$。

From the mediating effect tests in Table 7.2 to Table 7.4, it is evident that whether the surveyed enterprises collaborate only with internal institutions, only with external institutions, or with both, structural embeddedness significantly influences their innovative performance. More centrally positioned enterprises have higher innovative performance, and this influence is partially mediated through collaborative capability.

Table 7.5 analyses the mediating effects of relational embeddedness on innovative performance when the surveyed 150 enterprises collaborate with internal and external institutions. According to the table, relational embeddedness has a significant positive direct impact on enterprises' innovative performance, with a regression coefficient of 0.3683 ($p<0.001$), thereby supporting Hypothesis 2, indicating that the more an enterprise values the maintenance of relationships, the higher its innovative performance. Relational embeddedness significantly impacts collaborative capability, with a regression coefficient of 0.5748 ($p<0.001$), thereby supporting Hypothesis 4. When relational embeddedness and collaborative capability are simultaneously included in the regression model (Table 7.5, column 3), the regression coefficient of relational embeddedness is 0.1946 ($p=0.0855$). Therefore, collaborative capability completely mediates, supporting Hypothesis 6, with an effect ratio of 47.16%. The conclusions remain unchanged after adding control variables of enterprise age and size in the first three columns of the regression models in Table 7.5.

Table 7.5

Mediating effect test of relational embeddedness on innovative performance (Full Mediating)

	Y= collaborative capability	Y= innovative performance		Y= collaborative capability	Y= innovative performance	
constant	1.4282^{***}	2.1893^{***}	1.7577^{***}	1.4301^{***}	2.1909^{***}	1.7647^{***}
relational embeddedness	0.5748^{***}	0.3683^{***}	0.1946	0.5765^{***}	0.3690^{***}	0.1972
collaborative capability			0.3022^{*}			0.2980^{*}
age				-0.0014	-0.0067	-0.0062
size				0.0000	0.0000^{*}	0.0000^{*}
R^2	0.5461^{***}	0.1351^{***}	0.1601^{***}	0.5463^{***}	0.1587^{***}	0.1829^{***}
indirect effect	0.1737			0.1718		
total effect	0.3683			0.3690		
effect ratio	47.16%			46.56%		

Note: ① All coefficients are non-standardised. ② *** $p < 0.001$, ** $p < 0.01$, and * $p < 0.05$. ③ This table does not involve network indicators and values because relational embeddedness is a scoring item unrelated to the surveyed enterprise's network position. Therefore, whether the cooperation partners of the surveyed enterprise are from within or outside the park does not affect the conclusions of this table.

Chapter 8 Conclusions and Discussions

8.1 Conclusions

By conducting a detailed analysis of the Beijing Starpark case and combining data and empirical analysis results from other representative audio-visual industry parks in China, the thesis finds that adopting a model driven by industrial chain networks and building collaborative platforms is in line with the fundamental development realities of the audio-visual industry in China, including the Starpark.

8.1.1 The Model of Innovation Driven by Industrial Chain Networks Aligns with the Development Trends of China's Audio-Visual Industry

China's audio-visual industry is in a phase of rapid development, where representative audio-visual industry bases like Beijing Starpark highlight the crucial role of industrial chain networks and collaborative development. This model emphasises cooperation and interaction between various segments of the industrial chain, aiming to form a more cohesive and efficient industrial ecosystem. This model is significant in China's audio-visual industry, firstly reflected in the formation of industrial chain networks. Collaboration among parks and enterprises promotes deep integration of segments from content production, technology R&D, and marketing and promotion. For example, in Beijing Starpark, inter-company technological exchanges, resource sharing, and cross-industry collaboration have driven the tight linkage of each segment of the industrial chain, allowing rapid iteration and application of innovative outcomes.

Regarding building collaborative industry platforms, representative audio-visual industry parks provide enterprises with more cooperation opportunities and resource support. Platforms like startup accelerators and technology incubators not only help resolve issues related to funding and technology but, more importantly, create a space for innovative exchange, promoting cross-boundary cooperation and exploration of innovative models.

This innovation model driven by industrial chain networks emerged due to the development realities of China's audio-visual industry. This sector's rapid growth and transformation require more cooperation and win-win scenarios among enterprises rather than isolated development. This concept of cooperative win-win has become the mainstream trend in developing China's audio-visual industry, with various parks and bases responding by constructing industrial chain networks and collaborative platforms to adapt to rapid market changes and emerging innovative technologies.

8.1.2 Structural Embeddedness is Beneficial for Corporate Innovation

Empirical research finds that the higher the centrality of a company's structural embeddedness, the larger the structural holes, the lesser the constraints, and the greater the innovative benefits obtained from the network. This finding aligns with the research conclusions of Guan & Liu (2016), Wang et al. (2022), and Wang et al. (2023).

Another important finding is that structural embeddedness affects corporate innovative performance by influencing collaborative capability. This indicates that companies rely not only on their positions in the network but also must combine collaborative capability to utilise resources acquired from their positions effectively and integrate them into the innovation process.

Notably, these conclusions remain consistent across different cooperation contexts, i.e., when companies only collaborate with enterprises within the park, only with those outside the park, or both within and outside. This demonstrates the reliability of the theoretical framework and conclusions of this research.

These findings provide important insights for companies in choosing positions within the network and cultivating collaborative capabilities. Companies need to actively build their structural embeddedness while enhancing their collaborative capability to utilise better the advantages brought by their positions and convert them into actual innovation value.

8.1.3 Relational Embeddedness is Beneficial for Enhancing Corporate Innovative Performance

The research finds the critical role of corporate relational embeddedness in innovative capability, i.e., the more a company values and maintains relationships, the higher its innovative performance (Benítez-Ávila et al., 2018; Z. Wang et al., 2020; G. Xu et al., 2012). Relational embeddedness refers to the extensive contacts a company establishes in its network, covering partners and other stakeholders. These close relationships provide information, resources, and support for companies, thereby promoting the occurrence and spread of innovation. In China's audio-visual industry, extensive networks among enterprises often mean more cooperation opportunities, resource sharing, and innovative collaborations, providing a rich ground for innovation.

Collaborative capability plays a full mediating role in this process. It links relational embeddedness and innovative performance and is critical to ensuring that relational networks are transformed into innovation advantages. Excellent collaborative capability enables companies to fully utilise their established extensive relationships, integrate resources and information from the relational network, and effectively convert them into actual innovative outcomes.

Moreover, this conclusion remains unchanged even after considering control variables like company age and size. This indicates that regardless of the size or age of the company, its emphasis on and maintenance of relationships has a stable and significant impact on innovative performance.

This conclusion provides significant insights for guiding corporate development strategies in China's audio-visual industry. Companies should value establishing and maintaining extensive relational networks while focusing on enhancing collaborative capability. Such an approach helps companies better utilise their relational networks, converting them into a driving force for innovation and supporting the industry's sustainable development.

8.1.4 Collaborative Capability is Beneficial for Enhancing Corporate Innovative Performance

Collaborative capability is seen as a critical factor for internal and external collaboration and cooperation, essential for promoting innovation activities, integrating resources, and accelerating innovation (González-Benito et al., 2016; X. Wang et al., 2018; Ye, 2021). This capability enables companies to integrate better and utilise various resources, promote information and experience sharing, and accelerate the occurrence and dissemination of innovation. The characteristics of China's audio-visual industry determine its need to constantly adapt and lead in technology, content, and market changes. In this context, collaborative capability becomes essential for companies to gain innovation advantages. This capability manifests within the company and includes collaboration with external partners. For example, companies work closely and collaboratively with technology providers, creative teams, and market channels in movie and television content production.

This conclusion has been fully confirmed in the practice of China's audio-visual industry. Companies with higher collaborative capability in the industrial chain often can release innovative products more quickly and better meet market demands. Therefore, companies should focus on cultivating and enhancing collaborative capability in the audio-visual industry.

8.2 Discussions

8.2.1 Perspective of Park Managers

Developing Carriers for Innovation in the Audio-Visual Industry. Industrial park managers are committed to constructing a comprehensive audio-visual industry innovation ecosystem. They promote the construction of interdisciplinary and cross-sectoral R&D platforms, integrating resources from engineering, design, content creation, and more. Utilising advanced technologies such as 5G, AI, AR, and VR, they drive innovation in video content creation and dissemination methods, fostering the integration of technology and the application of emerging technologies. Moreover, they advocate for close cooperation along the industrial chain by establishing open collaboration mechanisms and sharing resources and information to promote collaborative innovation across the entire industrial chain.

Creating Incubation Carriers for the Audio-Visual Industry. Some audio-visual industry parks in China emphasise incubator construction, such as the Starpark North Area, Malanshan Video Cultural and Creative Park, Tencent Cloud Qi Smart Film and Television Industry Base, etc. Incubators help promote knowledge sharing, industrial collaboration, and network building. Therefore, industrial park managers should focus on creating incubation carriers for the audio-visual industry, providing specialised services and facilities, such as high-quality recording studios, editing suites, VR/AR laboratories, etc. These resources are challenging for startups to access on their own, and the support from incubators enables them to use these advanced tools and technologies at a lower cost. Parks can also connect with financial institutions to help businesses attract angel investors, venture capital, and other financing channels, providing financial support for developing the audio-visual industry. Through incubators, parks can offer businesses mentorship, market insights, and business support, helping startups achieve greater success in innovation.

8.2.2 Perspective of Enterprises

Valuing Network Cooperation and Innovation along the Industrial Chain. Innovation is a network phenomenon that emphasises the interactive process between organisations (Bygballe et al., 2014). Formulating a strategy for enterprises means considering the heterogeneity of resources, the interdependence between activities across company boundaries, and organised collaboration among related companies (Gadde et al., 2003). Audio-visual industry enterprises should break the traditional isolated development pattern through cross-border cooperation, reproducing the dynamic process of industrial chain network-style cooperation and competition that transcends traditional industrial cluster boundaries (Fernandez-Escobedo et al., 2023). Enterprises should actively participate in open collaboration mechanisms, share resources and information, and achieve collaborative innovation in technology, market, management, and other fields. This enhances the enterprises' innovation performance and achieves collaborative development with platforms, content providers, advertisers, and others through content linkage and IP derivative development.

Focusing on Talent Cultivation and Introduction. Based on the conclusions, we believe that while network embeddedness is beneficial for enhancing enterprises' collaborative capabilities and innovation performance, enterprises should not focus solely on building good network positions and maintaining relationships. Theoretical research has found that excessive focus on relational embeddedness can reduce organisational adaptability (Meuleman et al., 2010) and lead to the homogenisation of network knowledge, which is not conducive to innovation (B. Yang et al., 2022). Therefore, enterprises must also focus on the fundamental element that promotes innovation—talent. Enterprises can collaborate with universities to establish talent cultivation projects in professional directions and jointly hold professional training courses with industry associations to provide industry talents with practical skill training and further education opportunities. At the same time, enterprises should actively introduce top international talents, strengthen international exchanges and cooperation, introduce new thinking and advanced experience, and promote the global development of enterprises and the entire audio-visual industry.

8.2.3 Perspective of Policy Makers

Policymakers encourage the audio-visual industry to establish an innovation service system covering the entire industrial chain and to strengthen resource sharing and complementary advantages. From a policy perspective, encourage and guide enterprises to form industry alliances, aggregate stakeholders with common interests through joint resources and information sharing, encourage open cooperation, and promote win-win for the entire industry. In addition, the government designs policies to guide and support internal and external cooperation and exchange in the audio-visual industry, establish special funds or reward mechanisms for cooperative innovation, and promote industry collaborative development and network-style innovation. For example, Tencent Video cooperates with numerous production companies and self-made drama teams to create a content ecosystem jointly. Through content linkage, IP derivative development, and other forms, collaborative development among platforms, content creators, and advertisers has been achieved.

To perfect and standardise policies or laws for corporate cooperation, the model of innovation driven by industry chain networks has played a significant role in enhancing the innovation capability and overall competitiveness of the industry but also faces some challenges. The cooperation and collaboration between different enterprises require more trust and resource-sharing mechanisms (Sun, 2023). Therefore, as policymakers, it is necessary to improve policies and laws to regulate the cooperative relationships between enterprises to avoid resource wastage or disputes. Specifically, the Chinese government should further perfect policies or laws regulating enterprise harmonious relations in the future. First, formulate policies supporting the development of the audio-visual industry, encourage inter-enterprise cooperation and innovation, and provide financial support, tax incentives, and other incentive measures. Second, promote cross-border audio-visual industry cooperation, formulate policies conducive to cooperation and investment, and encourage international sharing of technology, resources, and markets. Third, improve the anti-monopoly legal framework, prevent monopoly behaviours and unfair competition, ensure a fair market competition environment, and encourage inter-enterprise cooperation while avoiding monopoly formation. Fourth, strengthening intellectual property protection encourages enterprises to engage in technological exchanges and innovative collaboration while ensuring the lawful rights and interests of intellectual property. Fifth, perfect the contract legal framework, regulate the contract signing and execution process, and ensure the principles of equality, voluntariness, fairness, and good faith in contract rights and obligations. Sixth, enterprises must disclose information during cooperation, ensure transparency, and prevent information asymmetry and unfair competition.

8.3 Limitations and Prospects

Future research on this issue needs to expand the sample size of enterprises further. Since the thesis used structural equation modelling to verify the reliability and validity of the scale, structural equation modelling has high requirements for sample size (Kline, 1998). If the sample size is small, it may lead to inadequate representation or limit the in-depth analysis of various variables and associated factors, hindering our deep understanding of industrial chain networks and their collaboration. Future research can expand the sample size and analyse the theoretical framework covering structural embeddedness, relational embeddedness, collaborative capability, and innovative performance.

The thesis was conducted using only first-order nominations, capturing only the surveyed firms' direct connections and neglecting the network's broader social contacts and indirect relationships. This might lead to researchers having an incomplete or biased understanding of the structure and dynamics of social networks. If conditions for research permit in the future, it would be possible to implement multiple rounds of snowball sampling, extending first-order nominations to second-order and beyond, thereby more accurately depicting the cooperative states between network participants.

The data collection method of the thesis is a questionnaire survey. Survey questionnaires may be subject to response biases; for instance, due to social desirability bias, companies generally wish to be perceived as successful in innovation, leading to potentially inflated scores for innovation; recalling the number of partners and the interactions with them might also be subject to memory bias. Additionally, the constructs measured in this paper, such as relational embeddedness and collaborative capability, currently lack mature scales widely accepted by the academic community after multiple rounds of reliability and validity testing. Therefore, the scales that were developed by referencing other scholars' theories might not perfectly fit the measured constructs. This area of measurement still requires further deepening and exploration by future researchers.

The research conclusions need to be cautiously extended to other knowledge-intensive industry parks. There are differences between different industry parks, including industry characteristics, market demands, technology levels, etc., and various industry parks may have different management modes, affecting the ways of cooperation and collaboration. Therefore, the research conclusions may not necessarily apply to other fields. Future research on extending research conclusions needs to conduct in-depth research and compare different knowledge-intensive industry parks, obtain sufficient data support, and understand their unique characteristics and similarities.

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Appendix 1: The Development Course of China's Audio-Visual Industry

Stage	Time	Development Content
Initial Stage	1978	- The audio-visual industry in China commenced in 1978 following the Third Plenary Session of the 11th Central Committee of the Communist Party of China. Before this, its precursor, the Chinese Broadcasting, Movie, and Television Industry, served as a tool for ideological propaganda and lacked independent economic attributes and industrial functions; hence, it could not be termed an industry.
Broadcasting and Television Industrialization Stage	1979-2009	- Implementing the reform and opening-up policy deepened the information dissemination and cultural value demands of the broadcasting, movie, and television industries. - From the birth of the first commercial advertisement in 1979 to Zhang Junshan's explicit statement of the ideological and economic attributes of broadcasting and television at the National Broadcasting Industry Planning Conference in 1980 and the National Radio and Television Administration's 2003 release of "Opinions on Promoting the Development of the Broadcasting and Movie Industry," marked the actual industrialization of China's broadcasting and television business. - During this period, there was continuous debate over the broadcasting business versus the broadcasting industry, which was resolved by issuing "Several Opinions on Deepening Cultural System Reform" in 2005, clarifying the boundaries between industry and business and ultimately resolving policy bottlenecks. - Subsequently, China's broadcasting industry rapidly developed and expanded. By 2007, there were over 2000 private companies in China's broadcasting industry, with personal capital accounting for over 80% of the capital share in the movie and television content production field. - Concurrently, China's movie industry actively explored and attempted marketization and industrialization.
Network Audio-Visual Industry Industrialization Stage	1999-2009	- In 1996, establishing China Central Television's international internet site marked the start of China's network audio-visual industry. - Subsequently, the National Radio and Television Administration issued relevant management documents promoting the development of the network audio-visual industry. - The issuance of "Measures for the Administration of Internet and Other Information Network Dissemination of Audio-Visual Programs" in 2003 further boosted the development of the network audio-visual industry. - During this period, leading platforms such as Youku, Bilibili, iQiyi, and Tencent Video were established and launched. The number of video websites in China grew from 30 to over 300, driving rapid growth in China's online video industry. - By 2011, the development pattern of China's network audio-visual industry was essentially established.
Integration Development Stage of Broadcasting and Network	2010-2022	- In 2010, the National Radio and Television Administration issued the "Regulations on Internet TV Content Services" and the "Regulations on Internet TV Integrated Business." - Subsequently, the traditional broadcasting and television industry began integrating with the network audio-visual industry. - Broadcasting organizations ventured into the network audio-visual field, accelerating content innovation and

Stage	Time	Development Content
Video		solidifying audience and viewership ratings. Local broadcasting organizations achieved remarkable results in reforms, gradually forming a development pattern of station-network cooperation, content stratification, and shared distribution. - Network video institutions also accelerated their pace in survival of the fittest and integration, gradually forming a pattern with iQiyi, Youku, and Tencent as the leading platforms and various small-scale speciality video platforms co-developing. - Simultaneously, the National Radio and Television Administration intensively issued network cultural content management policies to guide and regulate the development of the network video industry, including aspects such as entry and exit. Diversified Integration Development
Stage of Network Live Broadcasting, Long and Short Videos	2016-2022	- The rapid development of short videos and network live broadcasting in the Chinese market has driven the diversified integration of the audio-visual culture market. - Kuaishou and TikTok are the leading institutions in China's short video market, with the former exceeding 700 million registered users by 2017 and the latter rapidly capturing a significant market share. - The network live broadcasting industry surged in 2016, reaching a user scale of 422 million with a yearly growth rate of 22.6% in 2017. Management institutions issued relevant regulations and management measures to regulate the market, incorporating diversified audio-visual formats into the overall management system. - Since the outbreak of COVID-19 in 2020, China's audio-visual industry has combined with the e-commerce economy, giving birth to new formats like network live-stream selling, variety show selling, and e-commerce live-stream selling. - The industry seeks comprehensive industry catalysis in technology, culture, metaverse social interaction, and the digital economy, exploring new formats and development paths.

Appendix 2: List of China National Broadcasting, Television, and Online Audio-Visual Industry Bases

Number	Name
1	China(Beijing) Starpark Audio-Visual Industry Base
2	China(Beijing) High-Tech Audio Visual Industrial Park
3	China (Hubei) Network Audio Visual Industrial Park
4	China (Chengdu) Network Audio Visual Industrial Base
5	China (Chengdu) UHD Innovation Industrial Park
6	China (Guangzhou) UHD Video Innovation Industrial Park
7	China (Zhejiang) Audio Visual Innovation and Venture Industry Base
8	China (Xiamen) Intelligent Audio-Visual Industry Base
9	China (Changsha) Malanmount Video Cultural and Creative Industrial Park
10	China Broadnet•Qingdao 5G High-Tech Video Test Park
11	China Asean Network Audio-Visual Industry Base
12	China (Shanghai) Network Audio-Visual Industry Base
13	Hefei National Radio, Movie and Television Technology Innovation Experimental Base
14	Hengdian Movie and Television Industry Experiment District
15	Jiangsu Cultural Future Cultural and Creative Industrial Park
16	China(Zhejiang) Movie and Television Industry
17	China(Huairou) Movie Industry Demonstration Base
18	National Production Base for Major Revolution and Historical Theme Movie and TV Dramas(China Television Production Center)
19	National Production Base for Major Documentary Film(Central Studio of News Reels Production)
20	National Scientific and Education Film Production Base(Beijing Scientific Education Film)
21	China International Television Corporation(Chinese Animation Industrial Base)
22	Hunan Sunchime Cartoon Group
23	Hangzhou High-Tech Development Zone Animation Industrial Park
24	Shenzhen Animation Production Center
25	Suzhou Industrial Park Sis Park（Sis Park）
26	Nanjing Software Park(Nanjing Animation Industrial Base)
27	Chongqing Nan'an District Tea Garden New Area Animation Industrial Base
28	Tianjin Binhai New Area National Film and Television Network Animation Experimental Park

Appendix 3: Comparison Table of Representative Chinese Audio-Visual Industry Parks

item	Comparison Element	Beijing Movie and Television Park	Beijing Huairou Movie and Television Industry Demonstration Base	Zhejiang Heng Dian Movie and Television Industry Experimental Zone	Hunan Malanshan Video Cultural and Creative Park	Fujian Xiamen Intelligent Audio-Visual Industry Base
1	Industry Planning and Positioning	Audio-visual Content Production	Movie and Television Location Base, Post-production	Movie and Television Location Base, Cultural Tourism District	Video Cultural Creation, 5G High-Tech Video Applications in Multiple Scenarios	Animation, Gaming, Audio-Visual Technology
2	Establishment Method	Industry-derived Development, Corporate Investment	Industry-derived Development, State-Owned Enterprise Investment	Industry-derived Development, Private Collective Investment	Policy Planning, Government Investment	Policy Planning, Government Investment
3	Approval Time	November 2009	May 2014	April 2004	June 2018	December 2020
4	Location	Beijing Daxing	Beijing Huairou	Zhejiang Jinhua	Hunan Changsha	Fujian Xiamen
5	Area	0.4 square kilometres	6.99 square kilometres	365 square kilometres	15.75 square kilometres	0.33 square kilometres
6	Number of Clustered Enterprises	>1500	> 600	>1500	>3600	>229
7	Annual Revenue in 2021	7.5 billion yuan	N/A	21.124 billion yuan	51.981 billion yuan	5.4 billion yuan
8	Organizational Management Mode	Private Limited Liability Company	Government + Private Sector	Government + Collective + Private Sector	Government + State-Owned Enterprise Integration	Government + State-Owned Enterprise Integration
9	Management Institution	Beijing Starpark Tuocheng Investment Co., Ltd.	Huairou District Government, Beijing	Administration Committee of Zhejiang Hengdian Movie and Television Cultural Industry Experimental Zone (Government	Malanmount (Changsha) Video Cultural and Creative Industrial Park Commission; Malanshan(Changsha)	Steering Group of Xiamen Intelligent Audio-Visual Industry Base (Coalition Government)

item	Comparison Element	Beijing Movie and Television Park	Beijing Huairou Movie and Television Industry Demonstration Base	Zhejiang Heng Dian Movie and Television Industry Experimental Zone	Hunan Malanshan Video Cultural and Creative Park	Fujian Xiamen Intelligent Audio-Visual Industry Base
				Agencies)	Video Cultural and Creative Industrial Park Regulatory Commission (Government Agencies)	
10	Operation Institution	Beijing Starpark Tuocheng Investment Co., Ltd. （Private Company）	Huairou District Cultural Industry Development Promotion Center; China Film Group Corporation (State-Owned Enterprise); Xingmei Jinsheng(Private Company)	Hengdian Group (Private and Collective Joint-Stock Enterprises)	Hunan Broadnet Group (State-Owned Enterprise)	Xiamen Wenguang Media Group (State-Owned Enterprise)
11	Core Industrial Resource	Studios and Audio-Visual Technology Innovation, Service Resources	Movie and Television Production, China Film Group Resources	Movie and Television Location Resources	Hunan Broadcasting and Television Group	Xiamen Broadcasting and Television Group
12	Industry Chain Layout	Audio-Visual Content Production Industry Chain	Movie and Television Production and Cultural Tourism Industry Chain	Location Shooting and Cultural Tourism Industry Chain	Movie and Television Content Industry Chain	Animation and Video Industry Chain
13	Industry Value Ecological Network	Content Production Ecological Network Centered on Variety Shows, Evening Parties, etc.	Policy Attraction Network Focused on Movie, Television Shooting, and Post-production	Cultural Tourism Industry Ecological Network Centered on TV Series, Movie Shooting	Enterprise Cluster Network Centered on Hunan Broadcasting (Mango TV)	Enterprise Cluster Network Centered on Meitu and Xiamen Wen Guang
14	Value Output Mode	Non-directional Channels and Modes: Broadcasting, Network, Short Videos, Live Broadcasting, etc.	Directional Channels and Modes: Movie, Television Series Distribution Channels	Directional Channels and Modes: Movie, Television Series Distribution Channels	Directional Channels and Modes: Broadcasting and Network Audio-Visual as the Core Output Channels	Directional Channels and Modes: Broadcasting and Network Audio-Visual as the Core Output Channels

item	Comparison Element	Beijing Movie and Television Park	Beijing Huairou Movie and Television Industry Demonstration Base	Zhejiang Heng Dian Movie and Television Industry Experimental Zone	Hunan Malanshan Video Cultural and Creative Park	Fujian Xiamen Intelligent Audio-Visual Industry Base
15	Industry Chain Derivative Development Mechanism	Market Demand-oriented Derivative Development Mechanism	Depending on China Film Group, Deriving to Mass Consumption Field	Depending on Traffic, Deriving to Pan-Culture, Cultural Tourism, Lifestyle Fields	Depending on Provincial Satellite TV Resources, Developing Resource Integration Fields	Depending on Provincial Satellite TV Resources, Developing Resource Integration Fields
16	Driving Mode	Innovation-Driven	Policy-Driven	Consumption-Driven	Leading Enterprise-Driven	Policy-Driven

Appendix 4: Qestionnaire

Dear Madam/Sir,
Thank you for participating in this survey! This questionnaire aims to study the relevant conditions of the Starpark Movie and Television Industrial Chain Network. We will strictly keep the information you provide confidential. Except for the researchers and survey collectors, no one else will have access to the original questionnaire you fill out. Please feel free to complete it.
We kindly ask you to carefully answer each question. Thank you!
Contact Person: Phone: Email:

Background information

1. Company establishment date:___________
2. Number of employees:___________
3. Company's main business category:
A - Equipment Research and Development B - Applied Technology C - Application Scenarios D - Content Production E - Audio-Visual Marketing F - Others
4. Total assets of the company (in 10 thousands of RMB) :___________
5. Company's Full Name:___________________________________ (Very Important, Please Make Sure to Fill in)

Please mark "√" on the score box, the higher the score, the more approval

Relational Embeddedness						
1	My company attaches great importance to providing information to partners and receiving information from them.	1	2	3	4	5
2	My company and partners help each other in problem-solving.	1	2	3	4	5
3	My company and partners alert each other about possible issues or changes.	1	2	3	4	5
4	My company has frequent interactions with partners overall.	1	2	3	4	5
5	My company maintains stable collaboration with our partners.	1	2	3	4	5
Collaboration with Relevant Companies						
1	My company and relevant companies trust each other in research and development activities.	1	2	3	4	5
2	My company engages in strategic collaborations with relevant companies on a regular basis.	1	2	3	4	5
3	My company and relevant companies closely collaborate in innovation activities.	1	2	3	4	5
4	My company frequently obtains valuable information or knowledge from relevant companies.	1	2	3	4	5
5	Employees from my company and relevant companies often exchange and learn from each other.	1	2	3	4	5
Collaboration with Research Institutions						
1	My company and research institutions trust each other.	1	2	3	4	5
2	My company has close collaborations with research institutions.	1	2	3	4	5
3	My company frequently establishes cooperative relationships with other organizations through research institutions.	1	2	3	4	5
4	Research institutions are essential partners for our company's innovative activities.	1	2	3	4	5

Collaboration with Government						
1	My company has received funding or rewards from government for research or innovation.	1	2	3	4	5
2	My company's innovation often receives support from government.	1	2	3	4	5
3	My company can timely grasp the latest policies related to R&D areas from the government.	1	2	3	4	5
4	My company frequently establishes cooperative relationships with other organizations through government departments.	1	2	3	4	5
Collaboration with Intermediary Organizations						
1	My company and intermediary organizations trust each other.	1	2	3	4	5
2	My company frequently establishes cooperation relationships with other organizations through intermediary organizations.	1	2	3	4	5
3	Intermediary organizations are indispensable partners for my company's innovation activities.	1	2	3	4	5
Innovative Performance						
1	Compared to peers, my company often takes the lead in introducing new products/services in the industry.	1	2	3	4	5
2	Compared to peers, my company often pioneers the application of new technologies in the industry.	1	2	3	4	5
3	Compared to peers, my company's product improvements or innovations receive very positive market responses.	1	2	3	4	5
4	Compared to peers, my company's products incorporate top-notch advanced technologies and processes.	1	2	3	4	5
5	Compared to peers, my company has a very high success rate in developing new products.	1	2	3	4	5

Partners Nomination

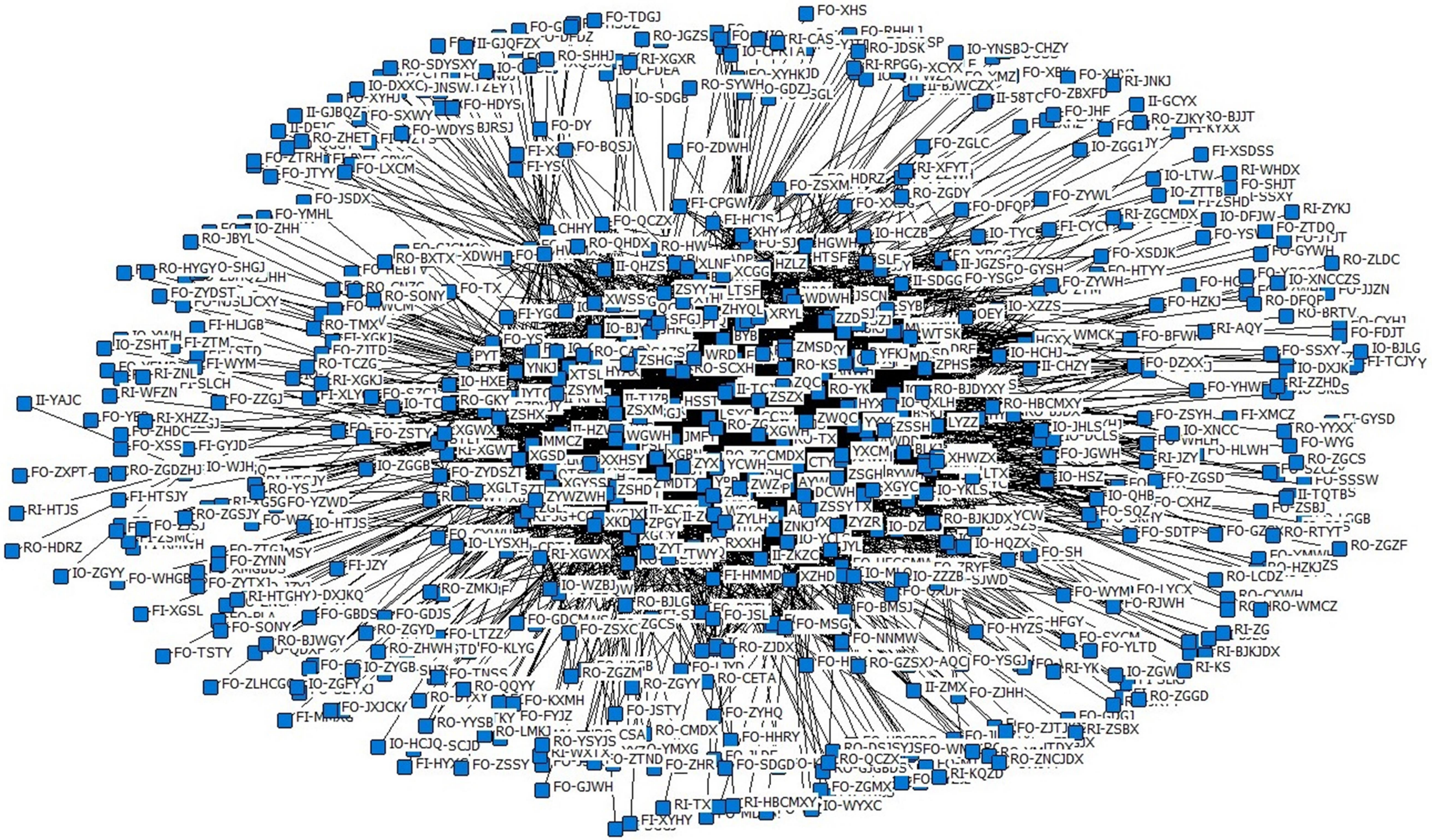
Please ensure to fill in the full and clear names of the companies or organizations you have close collaborations with.

Relevant companies	
Inside the park	**Outside the park**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

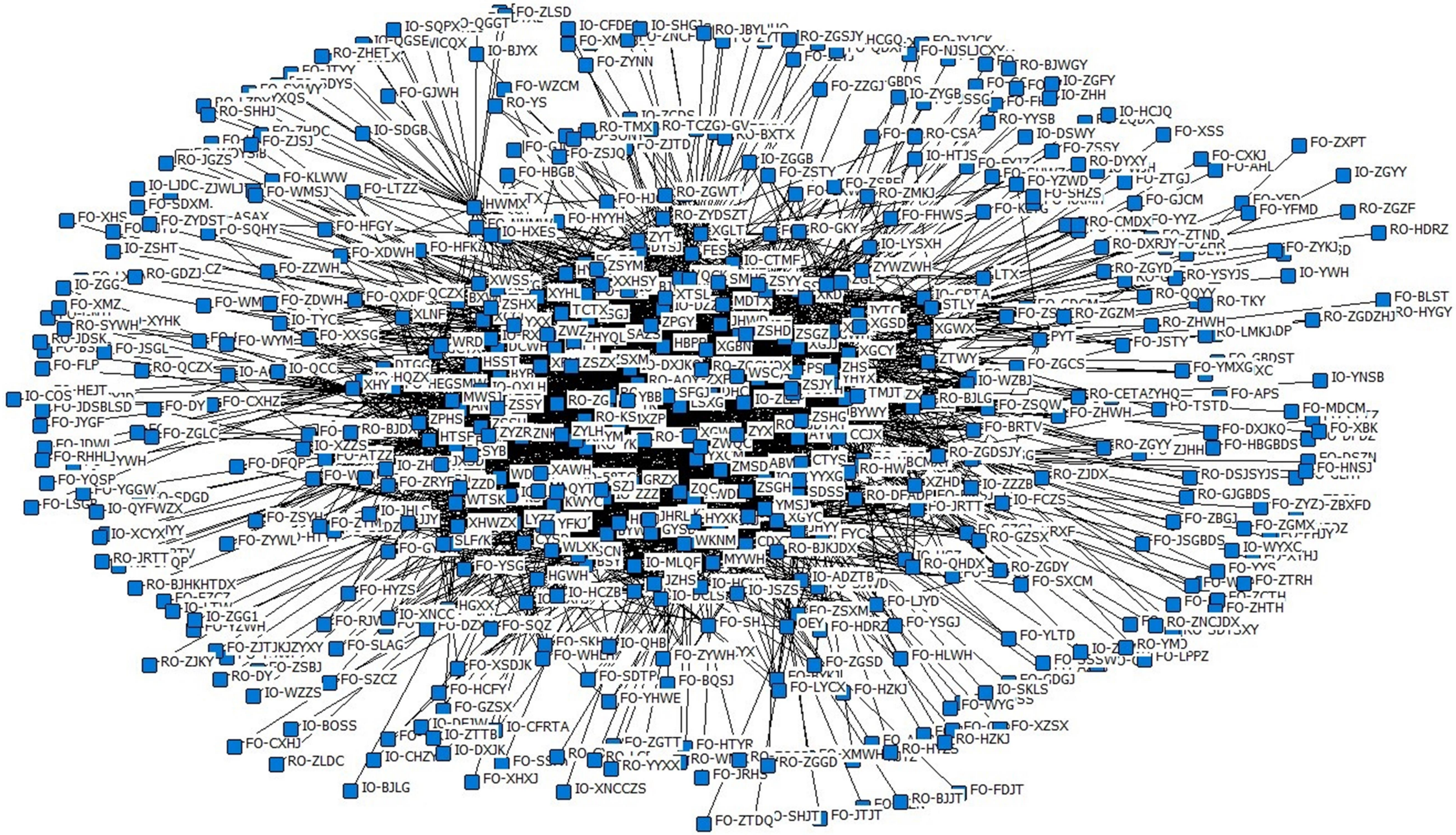
Research institutions	
Inside the park	**Outside the park**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.
Intermediaries *	
Inside the park	**Outside the park**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

* Note: Intermediary organizations include training centers, accounting firms, law firms, industry associations, chambers of commerce, and other intermediary organizations.

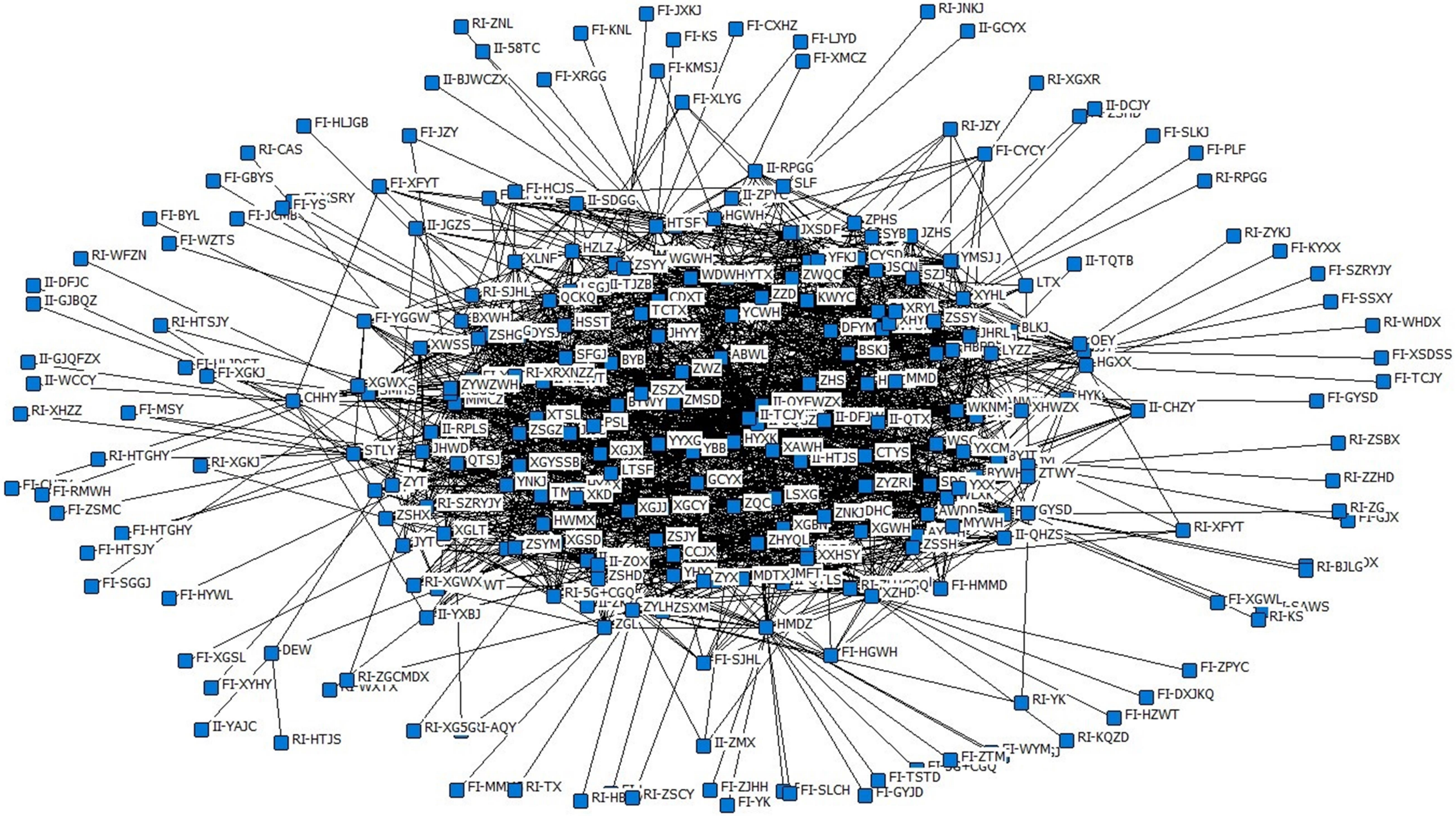
Appendix 5: 709 Network



Appendix 6: 576 Network



Appendix 7: 283 Network



Appendix 8: 150 Network