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Sustainable Innovation of New Area Resident Firms: A Perspective Based on Component Complementarity in Ecosystems

HU Honggen

Doctor of Management

Supervisors:
PhD Renato Lopes da Costa, Assistant Professor,
ISCTE University Institute of Lisbon
PhD SHAO Yunfei, Professor,
University of Electronic Science and Technology of China

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BUSINESS
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I declare that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that to the best of my knowledge it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed:  Date: 2022.03.31

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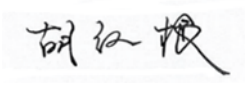
作者签名：  日期：2022.03.31

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Abstract

This study proposes a theoretical framework of ecosystem with radical and incremental innovation of new area resident enterprises. Two sub-studies were designed for exploration and validation.

(1) The first sub-research conducts multi-case approach to explore the relationship between component complementarities and sustainable innovation. It indicates that firms with significant hub and spoke complementarities prefer radical innovation, while firms with significant integrated complementarities prefer incremental innovation.

(2) The second sub-research uses policy capturing to verify the pattern derived from the first sub-research. It indicates that hub and spoke complementarities show a positive correlation with radical innovation and integrated complementarities shows a positive correlation with incremental innovation. Also, we incorporate studies on structural embeddedness to complete the decision-making scenarios. It finds that both hub and spoke and integrated complementarities show positive correlations with radical innovation when centrality is significant.

By exploring and verifying the impact of ecosystem complementarity on sustainable innovation, this study makes a contribution to the study on the sustainable innovation of enterprises in the new area through management interdependence.

Keywords: New area resident enterprises; Sustainable innovation; Radical innovation; Incremental innovation; Component complementarity

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Resumo

Este estudo propõe um quadro teórico assente num ecossistema com inovação radical e incremental para empresas residentes nestes novos distritos. Dois subestudos foram projetados para exploração deste contexto e respetiva validação.

(1) A primeira subpesquisa é conduzida através de uma abordagem multicaso para explorar a relação entre estrutura complementar de componentes e, inovação radical e inovação incremental de empresas nestes novos distritos. Resulta daqui que, que as empresas com complementaridades significativas hub e spoke preferem a inovação radical, enquanto, as empresas com complementaridades integradas significativas preferem a inovação incremental.

(2) A segunda subpesquisa usa uma política de abordagem de captura para verificar o padrão derivado da primeira subpesquisa. Verificou-se que as complementaridades hub e spoke apresentam uma correlação positiva com a inovação radical e as complementaridades integradas apresentam uma correlação positiva com a inovação incremental. Foram ainda incorporados estudos relevantes sobre imersão estrutural para completar os cenários de tomada de decisão. Constata-se que ambas as complementaridades hub e spoke e as complementaridades integradas mostram correlações positivas com a inovação radical das empresas quando a centralidade é significativa.

Ao explorar e verificar o impacto da estrutura de ecossistema complementar na inovação radical e na inovação incremental, este estudo contribui para o estudo sobre a inovação sustentável das empresas em novos distritos através da interdependência da gestão.

Palavras-chave: Empresas residentes em novos distritos; Inovação sustentável; Inovação radical; Inovação Incremental; Complementaridade de componentes.
JEL: L14, Q55

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摘要

本研究在现有生态系统理论以及激进式创新和渐进式创新的研究基础上，提出了生态系统与激进式创新和渐进式创新的理论框架，以揭示功能互补结构与新区入驻企业可持续创新的关系。本研究围绕以上研究目标，设计了两个子研究分别用于探索和验证。

（1）第一个子研究使用多案例研究方法探索了功能互补结构与新区入驻企业激进式创新和渐进式创新的关系。研究指出具有显著的辐射互补结构的新区入驻企业会倾向于进行激进式创新，具有显著整合型互补结构的新区入驻企业会倾向于进行渐进式创新。

（2）第二个子研究使用政策捕获的研究方法验证了第一个子研究得出的规律。政策捕获研究指出，辐射型互补与企业激进式创新呈现正相关关系，整合互补与企业渐进式创新呈现正相关关系。此外，我们结合结构嵌入的相关研究，以完善政策捕获研究理论和决策的情景。研究发现，在中心性显著时，辐射互补和整合互补与企业激进式创新都呈现正相关关系。

本研究通过对生态系统功能互补结构对激进式创新和渐进式创新影响的探索和验证，为新区入驻企业管理相互依赖实现可持续创新的研究做出了贡献。

关键词：新区入驻企业；可持续创新；激进式创新；渐进式创新；功能互补结构

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Acknowledgments

First of all, thanks for the prosperity of the country and the everlasting friendship between China and Europe! Thanks to the international cooperation between two well-known universities, the ISCTE University Institue of Lisbon in Portugal and the University of Electronic Science and Technology of China, I realized my dream of becoming a doctoral student in management, so that I can systematically study international management and business knowledge and master scientific research methods. From the beginning of my doctoral study in 2017 to my graduation, it was also the five years that my company sprinted into the world's top 500. I was fortunate to achieve "learning, thinking, practicing, and integrating knowledge and action" during this period, and transformed theoretical knowledge into enterprise productivity. Contributed the power of youth to the world’s economic development, national rejuvenation, and people's happiness!

Gratitude for the source of benefit；never forget where one's knowledge learns from. Hereon, I must appreciate my doctoral supervisors - Professor Renato Costa of the ISCTE University Institute of Lisbon and Professor Shao Yunfei of the University of Electronic Science and Technology of China. I am deeply impressed by the morality, knowledge and academic rigor of the two professors. What particularly touched me was that the two professors were very patient and serious, and gave me very rigorous and meticulous guidance from the establishment of the research direction of my thesis, the research framework, method data, and writing details. Especially during the global epidemic, both professors often used weekends to guide me, which is why my research can be carried out smoothly!

Then, I would like to thank my friends who supported and helped my research. A lot of interviews and questionnaires have been collected in my research. It is because of your support and help that I can smoothly promote the research process. Thanks to 36 Krypton Sichuan, Chengdu Gaoxin Jiangxi Urban Construction Co., Ltd., Chengdu Yun litchi Technology Co., Ltd. and other units for their strong support. Thanks to IDMgt, Ph.D. Yin Junjie and Ph.D. Jin Yi from Prof. Shao Yunfei's team, good friend Ph.D. Wen Yiding, and Prof. Ma Yongkai, Prof. Du Yifei, Ph.D. Zhang Guojian, Ph.D. Shi Xuanya, master Liu Xian from CICMIB for their collaboration in promoting research.

Finally, I would like to express my special thanks to those around me who have always

supported me. I would like to thank my parents and in-laws, my wife and son. During my Ph.D. study, your understanding and companionship with me was the source of motivation for me to keep moving forward. Studying for a doctoral degree is a painful but happy, confused but firm path. It is because of their silent support and encouragement that I can successfully complete my study and research.

致谢

首先，感谢国家昌盛，中欧友谊常存！得益于葡萄牙里斯本大学和电子科技大学两所知名高校的国际合作，我实现了成为一名管理学博士生之梦，才能更加系统专研国际管理与商业知识及掌握好科学研究方法。从 2017 年开始读博到毕业之际，也正是我所在企业冲刺世界 500 强的五年，有幸我在期间做到“学思践悟、知行合一”，将理论知识转换为企业生产力，为世界经济发展、国家复兴，人民幸福贡献青春力量！

饮其流时思其源，成吾学时念吾师。我必须感谢我的博士导师——葡萄牙里斯本大学 Renato Costa 教授和电子科技大学邵云飞教授。两位教授道德高尚、知识渊博、学术严谨让我深深折服。特别让我感动的是两位教授都非常耐心、认真，从我论文的研究方向的确立、研究框架、方法数据、写作细节等各方面给予我非常严谨细致的指导。特别在全球疫情期间，两位教授还都经常利用周末假期时间指导我，正因为如此我的研究才能顺利开展！

然后，我要感谢对我研究提供支持和帮助的朋友。在我的研究中涉及到了大量的访谈和问卷收集工作，正是由于你们的支持和帮助，我才能顺利推动研究进程。感谢 36 氪四川公司、成都高新绛溪城市建设有限公司、成都运荔枝科技有限公司等单位给予的大力支持。感谢文一丁博士生等朋友给予的帮助。感谢邵云飞教授团队殷俊杰博士、晋邑博士，电子科技大学移动互联商务协同创新中心张国建博士生、史轩亚博士、刘仙研究员等对研究推动的协同。

最后，我要特别感谢一直支持我的身边人。感谢我和夫人的父母亲，感谢我的妻子和儿子，在我攻读博士期间，你们对我的理解与陪伴是我不断前进的动力源泉。攻读博士学位是一条痛并快乐，迷茫却坚定的道路，正是由于他们的默默支持和鼓励，我才能顺利完成学习研究。

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Chapter 1: Introduction

1.1 Research background

1.1.1 The context of new area resident enterprises

The new area is mainly a measure of administrative division adjustment, approved by the central government and has corresponding supporting policies. The geographical scope of the new area is relatively small, usually a certain area within a city. In October 1992, Shanghai Pudong New Area, China's first new area, was established. After nearly 30 years of development, the number and types of new regions in China have changed significantly. As a representative of China's new areas, national-level new areas have gone through a development process from the 'special economic area' model to the 'economic development area' model to the 'new city' model (X. Wu et al., 2020).

The first is Special Economic area model. From 1992 to 2010, new natural-level were similar to particular economic areas (Noori et al., 2020), carrying economic development and social construction components. The Pudong New Area in Shanghai represents this phase. The state's goal in building the Shanghai Pudong New Area was to apply some of the experiences of the Shenzhen Special Administrative Region in terms of reform, opening up, and modernization to the construction of the inland region, achieving a point-to-surface effect. For Shanghai, the development of the Pudong New Area has accelerated the restructuring of the city's industries and has given an excellent boost to the city's economic growth.

The second is Economic Development Area Model. From 2011 to 2016, new national areas began to explore the taking over of particular components. The reasons for this were the high demands on the infrastructure of the former regions and the dependence on national preferential policies that made it difficult for the new SEZ-type national areas to become widespread. In the second phase, the Chinese government, therefore, reoriented the development of new areas towards reforming specialized areas. The Zhoushan Islands New Area in Zhejiang Province, as a representative of the second phase of new national areas, has led to the development of local marine resources and promoted the development of specialized industries.

The third is New City Model. Since 2017, the country's new areas have entered a new city-type construction mode that implements the new development concept. As a representative,

establishing the Xiong'an New Area in Hebei will effectively alleviate a series of significant city diseases such as traffic congestion, high property prices, and resource overload in Beijing while expanding a new space for the development of the Beijing-Tianjin-Hebei region. In addition, the Xiong'an New Area also assumes the component of revitalizing the local economy, promoting sustainable urban development, and driving local innovation. Using the Xiong'an New Area as a model, new areas at all levels in China are beginning to explore new city models that promote sustainable regional economic development.

1.1.2 The condition of sustainable innovation in the new area resident enterprises

As the above shows, the new area resident enterprises are an essential part of the new area and a vehicle for the evolution of the new area's development model. In this new environment, new area resident enterprises need to respond to the recent trends of new area development and seek sustainable innovation to meet the complex and changing needs of new area construction. Currently, there are the following characteristics of sustainable innovation in the new area's resident companies.

First, sustainable innovation in the new area combines radical and incremental innovation. As changes in the external environment accelerate day by day, companies increasingly need to innovate to adapt to their environment continuously. Of course, most innovation, in general, revolves around minor adjustments and improvements to existing products, methods, raw materials to improve the efficiency of the business. For the new area resident enterprise, they, like most companies, will need a great deal of incremental innovation to improve the efficiency of their business operations continuously. However, as the new area’s development model evolves from an economic development area model to that of a new city model, the development path in a new area is no longer confident and clear. As a vehicle for the evolution of the new area development model, new area resident enterprises are tasked with exploring the complex needs of the new area. As a result, sustainable innovation in the new area resident enterprises is radical and incremental.

Second, sustainable innovation in the New Area requires synergy between the innovation outputs of different subjects. On the one hand, sustainable innovation in the new area is to promote the continuous adaptation of the enterprise to the external environment; on the other hand, it is to meet the constant iterative development needs of the new area and to carry the goal of sustainable development of the new area. Therefore, the sustainable innovation of the new area's resident enterprises needs to consider the interdependence with the new area and other new area resident enterprises and collaborate with different entities to achieve the goal of

sustainable innovation.

1.2 Contents of the thesis

1.2.1 Research question

In 2017, the nineteenth national-level new area, Xiong'an New Area in Hebei Province, was announced. This heralds a new exploration stage for developing new areas in China, namely the new city model development stage. As the carrier for developing the new area, the new area resident enterprises are an important driving force in exploring the new development path. Under the new development requirements, the new area resident enterprises need to operate around the new city for further exploration. This is an essential distinction between New Area resident enterprises and other enterprises.

At the same time, due to the highly uncertain development environment and the complex and ambiguous development goals, the new area resident enterprises need to achieve sustainable innovation. This means that not only do they need to improve on their existing foundations, enabling incremental innovation continuously, but they also need to be able to respond to a radically different value proposition, seeking radical innovation.

The new area resident enterprises have rich connections with the new area operators and other new area enterprises and need to work together to carry the overall objectives of the New Area development. Existing research points out that sustainable innovation in the new area's resident firms is not independent and needs to consider the component complementarity in ecosystems. However, there is still a lack of in-depth research on how ecosystem components complementarities contribute to sustainable innovation. Therefore, the following analysis is conducted in this study. Based on this, how does component complementarity in ecosystems affect the sustainable innovation of the new area resident enterprises? To answer this question, this thesis will be developed through two sub-studies, as follows:

Sub-research one explores the mechanisms of component complementarity in ecosystems on sustainable innovation in the new area resident enterprises. To adapt to the rapidly changing development environment and carry the complex requirements of the new area, the companies in the new area must balance radical and incremental innovation. Existing research suggests that innovation is not independent and that the impact of different forms of interdependence on innovation needs to be considered. Compared to the average enterprise, the enterprises in the new area form a closely linked ecosystem with the various subjects in the new area, based on

the development objectives of the new area. In this context, the component complementarity inessentials influence the sustainable innovation of the new area's resident enterprises. Based on this, this research first explores the general patterns of this mechanism of action through a multi-case study approach.

Sub-research two verifies how component complementarity in ecosystems affects the sustainable innovation of the new area resident enterprises. Based on a multi-case study exploring the general pattern of component complementarity in ecosystems on sustainable innovation in the new area, this research uses a policy capturing method to test the above pattern quasi-experimentally. This study advances the spiritual understanding of sustainable innovation in new areas and develops quantitative analysis on ecosystems by placing the subjects in a full decision-making context. Considering that networks are carriers of resources and information; the network structure can have an impact on the innovation activities of enterprises. For this reason, this study designs a decision scenario questionnaire based on ecosystem theory and integrates the structure of social networks to verify the mechanism of the influence of component complementarity in ecosystem the sustainable innovation of enterprises located in the new areas.

1.2.2 Overview of research methods

With the goal of exploring and verifying the mechanism of component complementarity in ecosystems on the sustainable innovation of the resident enterprises in the new area， this study was customized with the following research method.

First, multi-case study. The case study method is the primary way of understanding the objective reality and has an irreplaceable advantage in the social sciences, being suitable for answering the questions of 'what' and 'why' (R. K. Yin, 2018). The main reasons for choosing the case study approach in this research are as follows. The core objective of this study is to investigate the impact of component complementarity in ecosystems on sustainable innovation in the new area. The study first needs to explore the mechanism of action by which component complementarity in ecosystems influences sustainable innovation in firms. The case study approach is therefore appropriate.

On the other hand, compared to single-case studies, multi-case studies using replication logic have a stronger theoretical foundation and better generalizability and replicability (Volmar & Eisenhardt, 2020). This study aims to use multiple cases to generalize the role of the component complementarity in ecosystems on the sustainable innovation of enterprises in the

new area and to build on this foundation to expand and explore contexts in greater depth. Therefore, a multi-case study approach that can be generalized and replicated is appropriate for the purpose and needs of this study.

Second, policy capturing. Policy capturing is a quasi-experimental research method that provides managers with a series of contexts and allows them to make decisions and judgments by assessing Contextual factors (Zhu et al., 2021). This approach bridges the macro and microdomains of research and can represent overall trends or patterns in decision-making at the organizational level across many individuals.

In addition, different researchers can focus on specific factors or combinations of factors depending on their focus, thus allowing them to control the influence of other factors effectively. The method not only restores details that are easily overlooked when making strategic decisions but also allows the researcher to exercise some necessary control over the decision-making behavior of managers by designing contexts. In addition, it can avoid memory bias and other influences in questionnaires and interviews and overcome the subjective effect of managers on the factors of the decision scenario (Jensen & Raver, 2020).

This study explores the sustainable innovation options of companies facing different component complementarity in ecosystems. It requires the construction of decision contexts through a combination of critical influencing factors and the testing of senior managers of companies with experience in the new area. This is a complex research process in a conventional questionnaire and interview format. Therefore, this study uses a quasi-experimental approach to test the decision making of senior managers of companies with experience in the new area resident enterprises and to analyze their influencing contexts and factors, to verify the general patterns of the impact of the multi-case study approach on the mechanisms of sustainable innovation in companies with complementary ecosystem components.

Third, theoretical deduction approach. The basic idea of the theoretical deduction is hypothesis testing logic. Through logical construction, deduces the speculative hypothesis to be tested and then uses the collected empirical data to verify the theory's truth. In the process of trying an idea, the researcher does not directly use the empirical data collected to test the concept to be tested but needs to apply the abstract idea to deduce concrete, testable propositions, reducing the abstraction level of the idea. This deductive logic, like inductive logic, draws on the research method of the natural sciences to apply to sociological research (Lakatos & Ji, 1980).

Theoretical testing in this research is to draw on deductive logic to obtain relatively

concrete hypotheses from abstract theories and then test them through the testing of hypotheses. Therefore, this research takes the research question as its guide and explores the mechanisms by which different ecosystem complementary structures influence sustainable innovation in the new area's resident enterprises based on a multi-case exploration through searching, reading, and collating literature, as well as a moral selection of theoretical perspectives in the literature.

1.3 Significance of the research

1.3.1 Theoretical significance

This research is based on theoretical analysis and focuses on how component complementarity affects sustainable innovation in the new area. First, a multi-case study is conducted to explore the general patterns of how the complementary structure of ecosystem components affects sustainable innovation. Then, based on the findings of the multi-case study, the research is tested using the quasi-experimental approach of policy capturing.

By examining the above issues, this research has the following theoretical significance:

First, this study uses theory and case studies to show that sustainable innovation in the new area requires both radical and incremental innovation to be considered. Existing research suggests that radical innovation disrupts the current innovation ecosystem by breaking out of existing technology paths to build a unique competitive advantage and technological barriers (Ardito et al., 2020; Gomes et al., 2019).

Incremental innovation, on the other hand, enhances the competitive advantage of the current innovation ecosystem by continually improving existing processes and continuously strengthening relationships with players in the innovation ecosystem. Focusing on the long-term development goals of the new area, sustainable innovation by the new area's resident companies is based on the innovative synergy of the various members of the ecosystem (Sebastian et al., 2018). This requires new area resident enterprises not only to innovate gradually to meet the existing needs but also other subjects to respond to the radical innovation initiated by enterprises (Z. Liu & Stephens, 2019).

Sustainable innovation requires the coordination of both radical and incremental innovation and cannot rely on one but is the result of both. Firms evolve with incremental innovation based on improvements to existing businesses and radical innovation for new value creation, coordinating both behaviors to achieve sustainable innovation. This research strengthens our understanding of the profound and essential role of corporate innovation in the ecosystem and

expands and deepens the application of innovation theory.

Second, this study integrates a multi-case and policy capturing research approach to explore and test the general patterns of component complementarity in ecosystems on the mechanisms of sustainable innovation. This fills a gap in research on the influence of ecosystems as Contextual elements on firms' innovative behavioral choices. Ecosystems and social networks are two of the most important manifestations of external interdependence in business management (Shipilov & Gawer, 2020). Many studies have focused on the impact of different dimensional characteristics of social networks on sustainable innovation in firms (Najafi-Tavani et al., 2018). However, as the dimensional characteristics of ecosystems are still in the exploratory stage, existing studies on ecosystems focus on the process of ecosystem formation and evolution. Still, there is a lack of research on the mechanisms of ecosystems as contextual variables affecting sustainable innovation (Sant et al., 2020).

By systematically reviewing the existing literature, this study classifies ecosystems according to different components complementary structures into Hub and spoke complementarities and Integrated complementarities and summarizes the general rules of the mechanism of action of other components complementarities on sustainable innovation exploring multiple cases. This study uses a quasi-experimental research method, policy capturing, to test the general pattern of ecosystem components complementarities on sustainable innovation, inspiring quantitative research on ecosystems.

1.3.2 Practical significance

The sustainable innovation of enterprises resident in the new area is built on the background of sustainable development and changing the external environment of the new area, which requires synergistic innovation output of different subjects. Based on this context, this research analyses the impact of the complementary structure of ecosystem components on sustainable innovation in enterprises, which has important implications and guidance for enterprises to realize sustainable innovation better. Therefore, this research presents the practical implications at the following levels respectively.

First, sustainable innovation in the new area's resident enterprises requires synergy between radical and incremental innovation. As a core component of the new area, the area resident enterprise is an essential vehicle for its development and paradigm shift. As an important driving force in the development and reform of China's economic system, the new areas have assumed crucial historical tasks in the latest round of deepening reform and sustainable economic and social development in China. As a result, there is a need for the new area residents

to improve their efficiency through incremental innovation and achieve radical innovation in the context of new sustainable development requirements. In general, sustainable innovation in the new area is a synergistic radical and incremental innovation process.

Second, innovation in the new area's resident enterprises is not independent and needs to consider the component complementarity in ecosystems. With the continuous development of the economy and society, the various subjects in the business community are increasingly characterized by mutual integration and interdependence. Therefore, the sustainable innovation of enterprises is not accomplished by a single force but also requires careful consideration of other subjects and the interdependence between them. Different components complementarity structures have implications for radical and incremental innovation in firms from an ecosystem perspective. Specifically, hub and spoke complementarities promote radical innovation, while integrative complementarities promote incremental innovation. These patterns explored and tested through this study provide essential references for firms in their innovation.

Third, the social networks of the new area resident enterprise provide a good support for the component complementarity in ecosystems. The social networks of enterprises carry the transmission of resources and information and significantly impact their operations and innovation. Existing research has explored the relationship between the different dimensions of social networks and sustainable innovation. This study examines the correlation between the component complementarity in ecosystems and sustainable innovation through a policy capturing in a decision-making context of social networks and ecosystems. At the same time, this study finds that integrated complementarity promotes both radical and incremental innovation when the centrality of firms is significant. This implies that the supporting role of social networks for the ecosystem needs to be considered in achieving sustainable innovation by the new area resident enterprises.

1.4 Overview of the structure

The overview of the structure is shown in the diagram below. From the technical framework diagram of this study, this research is divided into six chapters. The details of each are as follows.

Chapter 1 is the introduction. This chapter mainly clarifies the background of the research proposed in this res study, the significance, the main study, the research method, and the study's main framework and technical line.

Chapter 2 is a literature review. This chapter compares the relevant literature on sustainable innovation, the component complementarity in ecosystems, and the structural embedding of

social networks, finding theoretical support from existing research as well as theoretical innovations. And then, it introduces the contextualization of the theories. It focuses on the theories and reviews previous research on similar issues from these theoretical perspectives.

Chapter 3 is the research approach and method. This chapter presents the research questions and their basis on the literature review. Then, this chapter focuses on clarifying the research methods and concepts used in this study and how the material was collected and processed under these methodologies to present a complete and authentic research process.

Chapter 4 is sub-research one. This chapter chooses three typical case studies of 36 Krypton Sichuan (from now on referred to as "36 Krypton Sichuan"), Chengdu Gaoxin Jiangxi Urban Construction Co., Ltd. (from now on referred to as " Jiangxi Urban Construction "), Chengdu Yun Litchi Technology Co., Ltd. (from now on referred to as " Yun Litchi"), to explore the general patterns of different component complementarity in ecosystems on the sustainable innovation performance of enterprises.

Chapter 5 is sub-research two. This chapter uses a policy capturing approach to collect data on firms' sustainable innovation choices under different component complementarities. It conducts a regression analysis to verify how different component complementarities in ecosystems affect the sustainable innovation of firms in the new area and expand the study’s contexts.

Chapter 6 is the conclusion of this study. This chapter summarizes the study and discusses the contributions and implications of this study. Finally, this chapter discusses the limitations of the study and future literature.

Figure 1.1 presents the research roadmap.

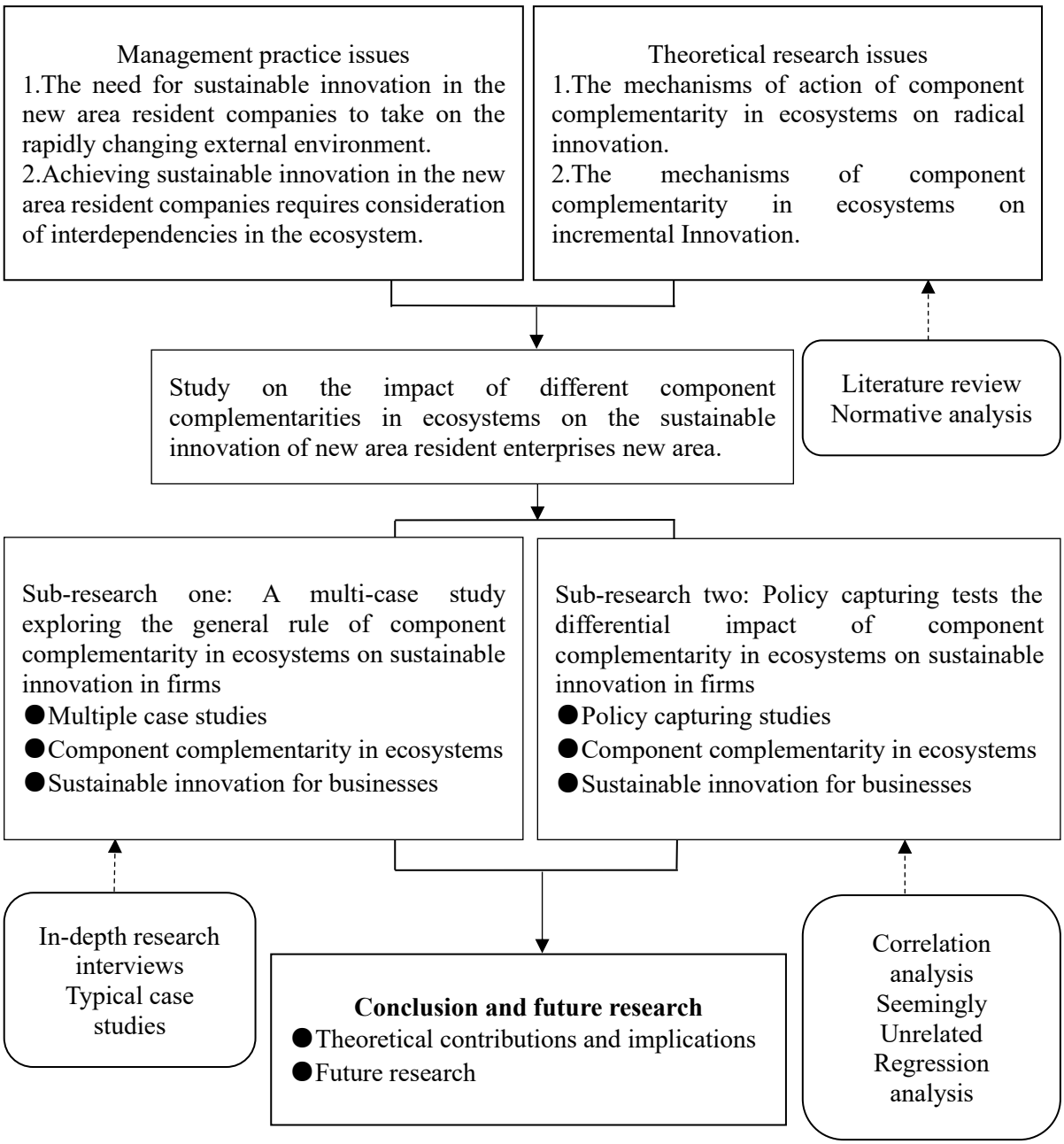


Figure 1.1 Technical roadmap

Chapter 2: Literature Review

By reviewing, sorting out and summarizing sustainable innovation research, ecosystem theory and social network theory, this chapter realizes the theoretical inheritance between this thesis and existing research results, and explains the relationship between each theory in this thesis.

2.1 Sustainable innovation

2.1.1 Evolution of innovation theory

Kalr Marx’s discourses influenced Schumpeter and others to a certain extent and provided material for scholars in the field of innovation at this stage to interpret the Marxist idea of innovation (Kline, 2010; Lee et al., 2020; Marx, 1875). Marx's views on innovation are as follows.

Marx analyzed human practice from the perspective of historical materialism, pointing out that "history is created by the masses, and the development of historical activities is accompanied by the expansion of the masses." This means that the main body of innovation is the people, and human is the noumenon factor in the process of innovation.

According to the different objects of innovation, Marx divides innovation into three categories: scientific innovation, technological innovation and institutional innovation. Scientific innovation refers to the use of physical science, chemistry and other scientific forces; Technological innovation refers to the improvement of production tools brought by human beings with the help of new processes and technologies, such as the application and improvement of production equipment. Institutional innovation refers to the improvement or reform of human division of labor, cooperative organizational forms and management methods, or the superstructure of the underlying production relations and political and legal systems. For the relationship between the three, Marx believed that three kinds of innovation is indispensable, from the point of view of promoting the level of human productivity. To be specific, science is the foundation, technology is the core, and institutions are the guarantee.

As something that does not exist in nature, innovation is created by producing according to human needs. Marx believed that as the subject of innovation, people need to give play to their subjective initiative and innovate according to the law of the development of things. Engels

adds that "the demands of society are more capable of advancing science and technology than ten universities". This means that social needs are the most important source of innovation.

After Max, the most influential innovation schorlar is Schumpeter. The concept of innovation is generally considered to have originated with the work of Joseph Alois Schumpeter on economic growth. According to Schumpeter et al. (1934), innovation is the activity of regrouping factors of production to obtain a profit. According to the object of innovation, innovation can be divided into five categories: product innovation, market innovation, innovation in raw materials, innovation in production processes or manufacturing methods, and innovation in organizational systems and their diffusion and spread within the firm.

Schumpeter et al. (1934) also pointed out the differences between the two common concepts of invention and innovation. He argues that inventions precede innovations. Specifically, an invention represents the creation of a new process or tool, while innovation means that the new procedure or device is implemented. The most crucial step in an invention becoming an innovation is to obtain economic value. Schumpeter sees innovation as a form of creative destruction. Innovation reorganizes the factors of production and destroys old capital. This process of "destruction-creation" is the driving force behind economic development. In summary, Schumpeter's innovation theory is a theoretical tool for analyzing economic development and understanding the cycle of economic growth driven by technological innovation.

In Schumpeter's innovation theory, the subject of corporate innovation is the entrepreneur. He believes that innovation is the most critical competency of an entrepreneur and is even a necessary condition for an entrepreneur to be an entrepreneur. Specifically, the entrepreneur must have the following attributes: an eye for potential value, the ability to grasp opportunities, a particular appetite for risk, and good organizational skills. This view highlights the innovative capabilities required of entrepreneurs and reflects the central role of entrepreneurs in innovation.

Since the 1980s, there has been a growing consensus in economic management circles on the concept of innovation, which has led to the examination and exploration of the scope of its application and the development of the National Innovation System (NIS) theory. Although there is no consensus on when the NIS concept was first developed, most scholars in innovation prefer (Dosi & Soete, 2022), who first used the idea in his work. Towards the end of the twentieth century, more and more scholars conducted in-depth research on NIS.

Freeman sees the national innovation system as a structural network between the public and private sectors. The role of this network is primarily to provide a vehicle for activities that trigger, introduce, transform and diffuse new technologies. According to the available literature,

not all scholars share this view.

Regional Innovation System (RIS) was studied later than National Innovation System (NIS). In contrast to the NIS, the regional innovation system emphasizes geographical factors. Specifically, a regional innovation system comprises industries, higher education institutions, and scientific research institutions. At present, scholars at home and abroad have not yet reached a consensus on the concept of the regional innovation system.

Based on relevant studies at home and overseas, point out that the idea of regional innovation system mainly includes the following four parts: (1) participating subjects, including governments, industries, higher education institutions, and research institutes in the region; (2) resource inputs, including human resources, financial resources, technology; (3) innovation objects, including technological innovation, management innovation；(4) Innovation results, including new products, new markets, new industries.

Li et al. (2021) argue that the regional innovation system has six components: research and development system, enterprise technology innovation system, innovation results diffusion system, education and training system, regional macro-control system, and social service support system. In addition, he divides these six systems into two levels: innovation operation and innovation support. The scientific research and development system, the innovation diffusion system, and the enterprise technology innovation system belong to the innovation operation level; the education and training system, the regional macro-control system, and the social service support system belong to the innovation support level.

At this point, the study of innovation has gradually expanded from the firm to the system in which the firm is embedded. We need to use theories to analyze and sort out the phenomenon under study. In this study, we have adopted social network and ecosystem theory.

2.1.2 Evolution of sustainable innovation

Currently, companies are faced with an increasingly turbulent and complex environment. Innovation has become the way to break through the bottleneck of development, but a single innovation can hardly support the long-term development of a company. Both practitioners and academics are beginning to focus on achieving sustainable innovation. As one of the most central and essential concepts in this study, it is necessary to review the development of sustainable innovation and its connotations.

Theoretical research on sustainable innovation began in 1991 with a study by Japanese scholars Nonaka and Takeuchi. Nonaka and Takeuchi (1991), conducted pioneering research

on sustainable innovation in companies from knowledge management in the text (Spanellis et al., 2021). In 1997, Arthur D. Little, a leading US management consulting firm, published a survey on continuous innovation, exploring ways to achieve sustainable innovation in innovative firms and providing insights into the pathways to increased learning capacity in innovative firms.

In 1998, the European Union conducted a study on continuous innovation policy for the 21st century. Participants included universities and academic institutions from 10 European countries, including Sussex University in the UK and leading technology innovation research institutions. The Green Industry Network and the governments of the USA and Canada co-organized an international conference on continuous innovation, which addressed topics such as continuous learning and innovation at organizational, corporate, national, and regional levels.

In 1999 POSTI gave two definitions of sustainable innovation: a. innovation where the innovation process or output has the goal of sustainability; b. innovation where the innovation process or production has the goal of improving the quality of the environment. This means that sustainable innovation from the beginning encompasses concepts such as green innovation and sustainable innovation, which are higher dimensional requirements for innovation.

In 2008, the European Commission defined eco-innovation as "the production, absorption or utilization of novelty in the production process of products, services or management and business methods which aim to prevent or significantly reduce environmental risks, pollution and other negative impacts of resource use throughout their life cycle". Interestingly, elsewhere, the European Commission links eco-innovation to sustainable development and states that "eco-innovation is any form of innovation that aims to make significant and demonstrable progress towards the achievement of sustainable development objectives by reducing its impact on the environment".

There are also multiple levels of academic understanding of the concept of sustainable innovation, and Table 2.1 summarizes the principal terms used and scholars represented. According to Carrillo-Hermosilla et al. (2010) concise overview of eco-innovation, sustainable innovation can be defined as innovation that improves performance, where sustainability innovation performance includes ecological and economic, and social criteria. As these criteria are difficult to quantify, sustainable innovation has different meanings and characteristics in different contexts.

Table 2.1 The notion of sustainable innovation

Concept formulation	Presented by
Sustainable innovation	Cillo et al. (2019); Fu et al. (2020)
Continuous improvement	R. Wang et al. (2018)
Eco-innovation	Kuo and Smith (2018)
Green innovation	H. Sun et al. (2019)
Corporates sustainability	Nilashi et al. (2019)

Source: According to Cillo et al. (2019), Fu et al. (2020), R. Wang et al. (2018), Kuo and Smith (2018), H. Sun et al. (2019), Nilashi et al. (2019) and related literature.

Specifically, there are three broad understandings of the concept of sustainable innovation in existing research.

First, some scholars view sustainable innovation as the persistence of competitive advantage resulting from innovation (Scott et al., 2019). Specifically, in his discussion of sustainable innovation and firm heterogeneity, Knott (2003) argues that sustainable innovation refers to the long-lasting competitive advantage that innovation can bring to a firm. This formulation focuses more on the role of innovation in the firm's development. It ignores the fact that sustainable innovation needs to be aligned with the development of the external environment.

Second, some researchers' view, is that sustainable innovation is ecologically green innovation, for example, that an essential measure of sustainable innovation performance is whether it is sufficiently beneficial to the ecological environment in which humans live or whether it minimizes the degree of harm to the environment (Ramkumar et al., 2021). Scholars who hold to this philosophy consider sustainable innovation as the innovation that aims to reduce negative impacts on the environment, innovate products and processes by introducing new ideas and behaviors to achieve ecologically sustainable goals, introduce ecological thinking into economic strategies, and innovate in products, services, and processes driven by green under the concept of sustainable development, which can be seen as an innovation that follows the laws of natural development (Truong & Berrone, 2022).

Unlike other practices that meet minimum environmental standards, sustainable innovation emphasizes ecological protection at the source to prevent pollution from occurring. Green technology innovation is about making products cleaner through innovation that helps to reduce resource waste. As a pragmatic definition, it should not aim to reduce the environmental burden but rather to produce significant environmental benefits (Huang & Chen, 2022). Carrillo-Hermosilla et al. (2010) take a broader view that any technological innovation that reduces negative environmental impacts is sustainable.

Third, researchers see sustainable innovation as sustainability-oriented innovation. In an

era where firms face an increasingly volatile, uncertain, complex, and ambiguous environment, scholars have begun to follow management practice and turn to sustainability-oriented innovation. Researchers have focused on achieving a multi-level alignment of interests (Gruenhagen & Parker, 2020), where economic, social, and environmental demands are reflected and responded to at the innovation and enterprise levels (El Mouallem & Singh, 2021). Related concepts include 'sustainable development-oriented innovation' and 'sustainable development.

Concerning the third understanding, other scholars have provided their definitions. Some scholars combine the goals and processes of innovation and argue that sustainable innovation needs to meet both general economic goals and social and environmental development goals (Reficco et al., 2018). Iansiti and Levien (2004) prefer sustainable innovation to be market development, technological or process innovation oriented towards sustainable development. Some scholars have summarized Finland's sustainable innovation policy, arguing that sustainable innovation integrates ethical, social, economic, and environmental innovation activities and consists of five levels of principles: sustainable development, participatory innovation, continuous innovation, globalized innovation, and managed innovation (Engwall et al., 2021). The understanding of sustainable innovation and representative scholars are displayed in Table 2.2.

Table 2.2 Different understandings of the concept of sustainable innovation and representative scholars

Three understandings of sustainable innovation	Representative scholars
Some scholars see sustainable innovation as the durability of the competitive advantage that innovation brings	Knott (2003)
Some scholars have argued that sustainable innovation is ecologically green. An important measure of sustainable innovation performance is whether it is sufficiently beneficial to the ecological environment in which humans live or whether it minimizes the degree of harm to the environment.	Ramkumar et al. (2021)
Some scholars see sustainable innovation as sustainably oriented innovation	Gruenhagen and Parker (2020)

Source: According to Knott (2003), Ramkumar et al. (2021), Gruenhagen and Parker (2020), and related literature.

Considering the above, sustainable innovation in this study is defined as innovation that integrates the demands of various environmental actors and has a long-term value orientation. Such innovation requires coordination and cooperation between firms and developing a joint value proposition in continuous interaction and tolerance of uncertainty based on trust. Thus, theoretical observation and analysis of sustainable innovation require attention to both the interdependence and the interactions between firms.

2.1.3 Sustainable innovation and ambidextrous innovation

In the field of innovation, we can classify innovation as product innovation, process innovation, or service innovation according to the object of the innovation. In addition, researchers have also classified innovation according to its hierarchy into organizational innovation, sectoral innovation, and business system innovation (Grillitsch et al., 2019; Klarin & Suseno, 2021). Whether innovation is classified according to the object of innovation or the level of innovation, it is fundamentally a manifestation of different levels of innovation. Innovation is generally considered to be divided into two categories depending on the level of innovation: radical innovation and incremental innovation (Mardani et al., 2018).

Specifically, incremental innovation improves existing product market segments by responding to the needs of existing customers and markets. For example, the technological evolution of the engine of a fuel locomotive is consistent with a continuous improvement on the previous basis. It would fall under the category of incremental innovation.

Incremental innovation can be seen as reorganizing previously established technologies and market relationships (Stam & Van de Ven, 2021). For the various subjects in the ecosystem, incremental innovation is an improvement on an existing cooperation system, where they can make lesser adjustments to production lines based on existing cooperation methods. We argue that incremental innovation occurs in mature, procedural production chains (Engwall et al., 2021). As incremental innovation proceeds, members of a collaborative innovation network communicate frequently and closely, constantly developing and consolidating mutual trust. In the case of the fuel engine, most of its innovations have not had a significant impact on the existing ecosystem. This gradual, low-level improvement is welcome, or at least acceptable, to drivers (consumers), sales and maintenance, suppliers of raw materials, and governments.

Radical innovation typically disrupts existing market positions and constructs new market opportunities (Bocken & Geradts, 2020). Radical innovation is a complicated process for firms because it requires fundamental changes to existing practices (Dewar & Dutton, 1986), requiring a reconfiguration of existing knowledge, market relationships (Naseer et al., 2021). Radical innovations have more significant uncertainty than incremental innovations by their very nature. They are more likely to require longer development times, which can be intolerable for firms requiring short-term returns (Wiener et al., 2020). In addition, mature firms rarely engage in radical innovation because they find it difficult to accept the impact of radical innovation on, for example, existing organizational structures and market relationships (Scuotto et al., 2022).

Truong and Berrone (2022) define radical innovations as creating something new, destroying the existing ecosystem. They also argue that because such innovations are usually the result of many distributed R&D organizations and scientists, they are unlikely to have primary solid users or internal advocates to promote them. Michelin Tyre, for example, once developed the PAX, a high-performance tire tailored to the needs of drivers, whose safety was ensured by the PAX's no-blowout feature. However, the new product placed high demands on the supply of raw materials and maintenance, making it difficult to be accepted by upstream and downstream partners and ultimately leading to a failure (Adner, 2017). Therefore, radical innovation requires coordination between the various environment members, which requires frequent interaction over time to develop sufficient trust and understanding and a willingness to take risks for a common goal.

To achieve sustainable innovation, we need both incremental and radical innovation. Specifically, sustainable innovation requires partners to share a long-term goal and work together. Incremental innovation strengthens the relationships between ecosystem members and promotes the development of trust between them. But incremental innovation is more about immediate financial goals than long-term value propositions. Radical innovation is about longer-term, fundamental value goals. As such, it requires cooperation and trust between members.

In summary, the sustainable innovation that is the focus of this research needs to be achieved by both the company itself and other environmental actors. On the one hand, sustainable innovation is a long-term goal that requires the collaboration of many subjects to achieve, and it requires a core value proposition to guide it and a core output. Companies need to understand the interdependencies between actors in the ecosystem to achieve coherence. On the other hand, a company is not isolated from its environment; its innovative behavior affects other agents. Therefore, this chapter will review and sort out ecosystem theory and social network theory.

2.1.4 Summary of sustainable innovation theory

This thesis provides a three-pronged review of the theories of sustainable and ambidextrous innovation, namely, the evolution of innovation theory, the development of sustainable innovation theory, sustainable innovation, and ambidextrous innovation. By reviewing, sorting, and summarizing the classic and authoritative theoretical literature, this thesis clarifies the developmental lineage and relationship between sustainable innovation and ambidextrous innovation.

First, this thesis introduces the groundbreaking exploration of innovation theory by scholars such as Marx and Schumpeter and sorts out the development lineage and background of the national innovation systems and regional innovation systems. Based on the understanding of the objects of human innovation, Marx divided innovation into scientific innovation, technological innovation, and institutional innovation. Regarding the relationship between these three, Marx believed that from the perspective of promoting the level of human productivity, one of the three types of innovation is indispensable. Specifically, science is the foundation, technology is the core, and institutions are the guarantee.

After Marx, the most influential scholar of innovation was Schumpeter. According to Schumpeter (1934), innovation is the activity of regrouping factors of production as a way to gain profit. Based on Marx's classification of innovation, he divides business innovation into five categories, namely, product innovation, market innovation, raw material innovation, innovation in production processes or manufacturing methods, and innovation in organizational systems and their diffusion and spread within the firm. Based on Marx's classification of innovation, he divides business innovation into five categories, namely, product innovation, market innovation, raw material innovation, innovation in production processes or manufacturing methods, and innovation in organizational systems and their diffusion and spread within the firm. Schumpeter argues that the subject of business innovation is not all individuals, but a small number of entrepreneurs with heterogeneous traits. He regards innovation as the most important trait of entrepreneurs and even as a fundamental characteristic that determines entrepreneurial identity.

After the pioneering research on innovation by economists such as Marx and Schumpeter, subsequent scholars began to examine and explore the scope of application of innovation and developed the theory of national innovation systems and regional innovation theories. Freeman (1987) views national innovation systems as a structural network between the public and private sectors. The role of this network is primarily to provide a vehicle for activities that trigger, introduce, transform, and diffuse new technologies. The concept of regional innovation systems places more emphasis on location and geographical factors than the national innovation system, focusing on the synergy of different elements within a given region. Up to this point, extant study of innovation has gradually expanded from firms to the system in which they are located and among themselves.

Second, based on a review of innovation theories, this thesis compares the origins and development of sustainable innovation theory. Initially, Nonaka and Takeuchi (1991) conducted a pioneering study on sustainable innovation in companies from the perspective of knowledge

management. In 1999, POSTI defined the concept of sustainable innovation in two directions. On one hand, innovation in which the process itself is sustainable or the goal has sustainable characteristics. On the other hand, innovation in which its process or output has the goal of improving environmental quality. This means that sustainable innovation includes the concepts of green innovation and sustainable innovation from the very beginning, and is a higher-dimensional innovation requirement. Integrating the existing research on sustainable innovation and eco-innovation, this thesis defines sustainable innovation as innovation with a long-term value orientation that integrates the demands of all subjects in the environment (Engwall et al., 2021). Such innovation requires coordination and alignment between firms and a shared value proposition in ongoing interactions. Thus, theoretical observations and analyses of sustainable innovation need to focus on both the interdependence and interactions among firms.

Finally, by reviewing and sorting out innovation and sustainable innovation research, this thesis suggests that achieving sustainable innovation requires considering both incremental and radical innovation. Incremental innovation can be seen as a process of reorganizing previously established technologies, market relationships (Stam & Van de Ven, 2021). As incremental innovation proceeds, members of the innovation network communicate frequently and closely, continuously developing and consolidating mutual trust. Radical innovation typically disrupts existing market positions and builds new market opportunities (Bocken & Geradts, 2020). Radical innovation is a particularly difficult process for firms because it requires fundamental changes to existing practices (Dewar & Dutton, 1986), requiring a reconfiguration of existing knowledge, market relationships (Naseer et al., 2021). Radical innovation needs coherence among its members, and it requires them to interact frequently enough overtime to develop sufficient trust and understanding to be willing to take risks for a common goal. Thus, to achieve sustainable innovation, firms need both incremental and radical innovation.

2.2 Ecosystem

Companies need to collaborate with other companies to achieve sustainable innovation through incremental or radical innovation. Together, these collaborating firms form ecosystems. Firms exhibit different component complementarity in ecosystems, and these complementary structures influence the behavioral choices of firms, which in turn affect their sustainable innovation development.

2.2.1 Overview of the ecosystem

The term ecosystem originated in biology and was first coined by the British ecologist A.G. Tansley in 1935. Then many scholars have begun to use ecosystems to conduct research. They used the concept of ecology to explain the competitive and cooperative relationships between companies such as Intel, Microsoft and Telegraph, and Telephone (Ayakwah et al., 2018). They also paid attention to how car companies such as Chrysler and Ford evolve together in the ecosystem (Kochan et al., 2018). Moore defines an ecosystem as an economic community based on organizations and individuals, comprising suppliers, customers, producers, competitors, and other stakeholders, and divides ecosystem development into four stages (Chang et al., 2021; Moore, 2006).

First, the pioneering phase. This phase is the period of ecosystem formation when the core firms are looking for products and services with market potential. As the core of the system, the firm must provide favorable conditions to attract other firms to join and maintain interaction. Therefore, the exploration and discovery of core competencies and the coordination of relationships between firms in the system are crucial in the pioneering phase (P. Liu et al., 2019).

Second, the expansion phase. This phase requires the core enterprise to maintain the system's continued growth and must incorporate more enterprises into the system. The role of the core enterprise is vital in this phase, as it acts as the leader of the system and plays a crucial role in the other enterprises and between the enterprises and the design (Senyo et al., 2019).

Third, the leadership phase. In this phase, the main task of the core enterprises is to continue to act as leaders, maintain the system's development and innovation, keep the enterprises in their respective ecological niche, es, a component accordingly. During this phase, the position of each firm in the system is consolidated, and the core firms create significant value for the system (Dedehayir et al., 2018).

Fourth, the renewal phase. At this stage, the ecosystem has become more mature. The core companies in the leadership of the whole system must keep up with the changes in the environment and make appropriate adjustments in time to consolidate the system's self-renewal. If the entire system still adheres to the original thinking and does not improve in time, then the system will be heading towards the possibility of extinction (Dedehayir et al., 2018).

Throughout the four stages of ecosystem evolution, the ecosystem results from competition and cooperation in opposition to each other. There is competition and collaboration between the various actors within the system, and the two are intricately intertwined and transformed during the system’s evolution (Aaldering et al., 2019). Through this process, the subjects within the

system are interdependent and symbiotic, working together in the creative development of the system. A summary of cooperation and competition in the development of business ecosystems is shown in Table 2.3 below.

Table 2.3 Challenges of cooperation and competition in the evolution of business ecosystems

Development Stage	Cooperation challenges	Competitive challenges
Pioneering phase	Define new value propositions with customers and suppliers around initial innovations	Protect your ideas from others making similar offers. Connecting closely with vital customers, key suppliers, and essential channels
Expansion phase	Work with suppliers and partners to increase supply, offer new products to a vast market and achieve maximum market coverage	Eliminate the possibility of implementing similar ideas and ensure that your approach is the standard of the market in its class by dominating key market segments
Leadership phase	Present a compelling vision for the future and encourage customers and suppliers to work together to continue to improve the product range	Maintain strong bargaining power in an ecosystem that includes crucial customers and valued suppliers
Renewal phase	Working with innovators to bring new ideas to the existing ecosystem	Keep barriers tight to prevent innovators from building other ecosystems, keep customer switching costs high and gain time to inject new ideas into your products and services

Source: According to P. Liu et al. (2019), Senyo et al. (2019), Dedehayir et al. (2018), Aaldering et al. (2019), and related literature.

Introduced from biology to business, an ecosystem generally refers to a group of interdependent companies or organizations. Scholars have emphasized that different aspects of ecosystems depend on other units of analysis. In a literature review, Jacobides et al. (2018) divides ecosystems into Business ecosystems, Platform Ecosystems, and Innovation ecosystems.

2.2.2 Business ecosystems

Tran and Santarelli (2021) pioneered the concepts of organizational ecology and corporate populations. The ecological view of the enterprise emphasizes the combination of enterprise community and the external environment on which it depends to survive and develop. Some authors normally introduced the concept of business ecosystems based on the ecological perspective of business. They define a business ecosystem as an economic community based on organizational interactions in which firms become part of a business ecosystem (Oliveira &

Lóscio, 2018). Companies should seek to outperform their competitors and work together with them and the entire ecosystem. A business ecosystem includes consumers, producers, competitors, and risk-takers. The leading producers are the 'keystone species' of the business ecosystem and play an essential role in its co-evolution (Gao, 2021).

Moore identifies seven dimensions that are used to manage the business ecosystem. These are the customer, the market, the product or service, the experiential process, the organization, the stakeholders, social values, and government policy. Enterprise strategy needs to proceed from these seven dimensions and make decisions according to the main tasks and challenges in each stage of evolution to achieve leadership in the business ecosystem (Aaldering et al., 2019). In 1998, Moore expanded the definition of the business ecosystem to identify the structural characteristics and evolutionary mechanisms inherent in the ecosystem. He saw the business ecosystem as a dynamic structural system of customers, suppliers, producers, investors, trading partners, standard-setting agencies, trade unions, governments, social services, and other stakeholders. This system comes together in a form of spontaneity, high degree of self-organization, and some kind of chance (Polese et al., 2021).

Other scholars also gradually pay attention to the business ecosystem, and they define the business ecosystem from different perspectives. The first perspective focuses on the ecological aspect, Iansiti and Lakhani (2020) use the environmental niche in ecology to characterize business ecosystems. They argue that business ecosystems are made up of different firms but are interdependent. If one business's ecological niche changes, all other business ecological niches will be affected and change accordingly. Teece (2017) argues that business ecosystems focus on individual firms or new ventures and view ecosystems as organizations, institutions, and individuals that affect firms, customers, suppliers. J. Kim and Min (2019) and others point out that business ecosystems are economic systems consisting of many interdependent firms. Members of the system need to cooperate to capture the value that individual firms cannot create independently.

The second perspective focuses on the network dimension. Some scholars emphasize the importance of networks and see business ecosystems as networked systems that span the world. Some scholars define a business ecosystem as a structure of organizations with certain relationships. These organizations may be small businesses or large corporations, universities, research centers, public institutions (Holtzman et al., 2021). Other scholars study business ecosystems from the relationship between firms and business networks. They consider business ecosystems as networks of relationships between interdependent suppliers, firms, and customers (Vulpen et al., 2017). Zahra and Nambisan (2012) see business ecosystems as

networks that provide firms with resources, partnerships, and essential information. Such networks are formed based on long-term collaborative relationships between internal business members.

Although scholars have studied business ecosystems from different perspectives, most are defined as business systems of diverse organizational populations. At the same time, business ecosystems have some characteristics of both natural ecosystems and commercial, economic systems. Table 2.4 below summaries the connotations of business ecosystems, as described in the relevant literature.

Table 2.4 Collation of elements of business ecosystem characteristics

Author (year)	Content
Moore (1993)	Economic communities supported through interacting organizations and individuals
Aaldering et al. (2019)	The "4P3S" seven-dimensional framework: people, place, product, process, structure, shareowner, society
Iansiti and Lakhani (2020)	Three dimensions to measure the health of business ecosystems: birth rate, robustness, niche creativity
Teece (2017)	Business ecosystems focus on individual businesses or new ventures and see ecosystems as communities of organizations, institutions, and individuals that affect businesses and business customers, suppliers
J. Kim and Min (2019)	A business ecosystem is an economic community of interdependent businesses
Peltoniemi and Vuori (2004)	Business ecosystems have four essential characteristics of complex adaptive systems: self-organization, emergence, co-evolution, and adaptability
Peltoniemi et al. (2005)	The characteristics of business ecosystems include innovation and business success, conscious choice, dynamism, subject to change, many players, interdependence, i.e., competition with cooperation and shared destiny
Anggraeni et al. (2007)	The characteristics of the business ecosystem are studied from six aspects: firm characteristics, firm roles, network structure, network dynamics, network performance, and network governance
Zahra and Nambisan (2012)	A business ecosystem is seen as a network of resources, partnerships, and vital information that can be made available to businesses

Source: According to Moore (1993), Aaldering et al. (2019), Iansiti and Lakhani (2020), Teece (2017), J. Kim and Min (2019) and related literature.

Depending on the closeness and importance of the relationships between the system members, the business ecosystem can be divided into four subsystems: the core ecosystem, the competitive scenario, the support system, and the social and natural environment system.

Members of the core ecosystem are mainly direct suppliers, production companies, sales channels, and direct customers. The support system includes investors, government departments, research institutions, consumers, and supplier associations. The competition system includes direct competitors, potential competitors. The social and natural environment system includes macro elements such as political environment, economic environment, social environment, and scientific and technological environment that affect the survival and development of enterprises (Shi et al., 2021).

Depending on their position and characteristics in the business ecosystem, there are four different types of business: network cores, dominant, profit-seeking, and gaps. The network core makes connecting an extensive and decentralized business network easier to its customers. It can also contribute to the productivity and stability of the overall ecosystem by providing a 'platform' for other businesses to use, effectively stimulating systemic innovation. The dominant firm is vertically or horizontally integrated, occupying and controlling most of the nodes in the network. Sitting firms extract as much value as possible from the web but do not directly control it. Gap firms have specialist capabilities that differentiate them from other network members. This perspective helps firms judge their place in the business ecosystem and facilitates the synergistic evolution of firms in the system (Johnson et al., 2021; Pavlínek, 2022).

We summarize the key points of what we mean by a business ecosystem. A business ecosystem is a dynamic structural system of interconnected organizational members. These corporate members may be universities, research institutes, non-profit organizations, and possibly other organizations associated with the system. A business ecosystem is not a simple combination of businesses but a co-evolution in a mutually beneficial way.

2.2.3 Platform ecosystem

The platform concept was introduced to management from the computer field by Wheelwright and Clark (1992). In " What would Google do?," Jarvis (2009) also introduced the idea of "platform" and argued that the Internet is one big platform. Under the big Internet platform, companies such as Google are service platforms that create value for others. Gawer (2021) argues that the term platform has become ubiquitous. He points out that platforms are characterized by network effects and multilateral markets, purely for exchange and trade.

There are two leading roles in a platform ecosystem, Platform and Complementor (McIntyre et al., 2021). The platform ecosystem focuses more on the interdependencies between the platform and the complementors, and the many compliments can make the platform more valuable to the customer (Cusumano et al., 2019). Platforms are based on products and

services and provide complementary to the components. Complementary firms can share information and resources on the platform (Cenamor & Frishammar, 2021). Platforms are the core firms in an ecosystem or the economic catalyst for the system by integrating and coordinating system resources best to meet user needs (Zeng et al., 2021).

Compliments provide various aspects to the ecosystem. They are primarily based on niche markets and make the platform more responsive to the diverse needs of its users. Complement, therefore, plays more of a firm gap role in the platform ecosystem. A keystone in a platform ecosystem operates in several related or unrelated areas outside its core business, and the resources of the entire environment can enter the enterprise resource pool. The keystone is typically a platform company that maintains and facilitates the overall system, creating and sharing value with other companies (Subramanian et al., 2021). Gap firms mainly provide complementary products and services and develop synergies with the platform firm or other firms in the system (Verganti et al., 2020).

Generally speaking, platform companies do not need to take on all products and services but set the stage for complementary players to fulfill their roles. However, as the core of the ecosystem, platform companies need to contribute to creating more value in the overall ecosystem. Other ecosystem members have different components and need to improve their strategies in response to environmental changes (Muegge, 2013). In the face of market conditions, platform ecosystems can leverage diverse and complementary expertise and skills from outside the firm to address user needs. The potential of platform ecosystems comes from varied and specialized complementary, and the scale of the whole ecosystem cannot be replicated by individual firms (R. D. Wang & Miller, 2020).

The platform ecosystem generally consists of three main components: the commercial layer, the support layer, and the environment layer (Han, 2017). The commercial layer is the core part of the platform ecosystem, and most of the value creation and capture occurs in the commercial layer. The main components of the commercial layer include platform enterprises, supply-side enterprises, demand-side enterprises, and other complementary enterprises. Platform enterprises are the core of the commercial layer and the entire platform ecosystem. Supply-side enterprises are mainly product and service providers, usually have solid expertise but lack sales channels. Demand-side enterprises are the source of power for the platform ecosystem to component and create value. Platform companies form the platform ecosystem by identifying customer needs, and complementary companies mainly supplement the gap in the platform ecosystem (Yrjola, 2020).

The support layer mainly supports and maintains the commercial layer and is part of the

backend of the platform ecosystem. The support layer has a significant impact on the value creation and capture of the commercial layer. They can use their resource advantages to complete the support and transformation of the platform ecosystem (Alaimo et al., 2020). For example, they can support the platform ecosystem through their resources by injecting large amounts of liquidity and professional talents. The environment layer mainly includes the social, political, economic, and technological environments. In the development process, the platform ecosystem will be constantly influenced and constrained by the changes in the external environment. Hence, the platform needs to adjust to the changes in the background (Möller et al., 2020).

As a new business model, the platform ecosystem mainly revolves around the platform enterprise and combines the characteristics of a business ecosystem and a natural ecosystem (Kretschmer et al., 2020). As such, platform ecosystems are characterized by the following key features.

First, multilateralism. The critical characteristics of platform ecosystems derive from platform multilateralism, where each side refers to the different stakeholder groups that the platform brings together (Meijerink & Keegan, 2019). Platform firms play the role of market creators in multilateral markets, facilitating interactions between different groups. If other stakeholder groups use the platform to exchange directly, this platform market is multilateral. Parties usually face relatively high search and transaction costs (Petersen et al., 2019).

Second, platform centrality. Platform companies become the most important companies in the platform ecosystem by forming platforms, gathering various types of companies, and attracting investment. They play the role of regulating balance, integrating existing resources, and enhancing overall competitive advantage. The operation of the platform ecosystem needs to be driven by the strategic decisions of the platform enterprises, so in any platform ecosystem, the platform enterprises are the core enterprises (Q. Wang & Zhang, 2021).

Third, continuous dynamism. Platform ecosystem development is how platforms continually adapt to changes in the external environment. As customer and industry trends constantly change, the platform ecosystem must always meet new customer needs to maintain a competitive advantage. Competitor behavior leads to changes in the conduct of platform companies, complement, which in turn leads to changes in the platform ecosystem. Firms within the system adapt to changes in the external environment, and member firms enter and exit the platform ecosystem causing constant change (Hou & Shi, 2021).

Fourth, network effects. The network effect is the extent to which a single group of users affiliated with a platform brings value to other groups of users in the forum, which economists

refer to as a network externality (Springel, 2021). The emergence of a second user allows the platform to add value to the first user. This means that another user connecting to the platform ecosystem will significantly increase the potential value of the platform to other users. The value of the ecosystem grows exponentially rather than linearly, with each additional user adding considerably to the value of the entire ecosystem. The platform ecosystem will enter a self-enhancing cycle (Cennamo & Santalo, 2013).

2.2.4 Innovation ecosystem

Ecosystems are based on organizational interactions that form collaborative groups consisting of producers, suppliers, customers, and investors (Adner, 2017). Based on business ecosystem theory, innovation ecosystems are gradually coming to the attention of scholars. In 2003, the President's Council of Advisors on Science and Technology published a study where the term 'innovation ecosystem' was first formally introduced. In 2004, the American Council on Competitiveness published the report Innovation in America: A Study of Growth through Challenge and Change, which explicitly used the concept of "innovation ecosystems." Since then, innovation ecosystems have attracted much attention from academics (Granstrand & Holgersson, 2020). A synthesis of existing research and literature at home and abroad shows that research on innovation ecosystems has focused on the following areas.

2.2.4.1 Regarding the connotation of the innovation ecosystem

First, the ecological perspective. Innovation ecosystems emphasize that firms are no longer members of a single product but part of an ecosystem that spans multiple industries. Firms in the innovation ecosystem are constantly developing their capabilities, collaborating and competing with other firms to meet customer needs (Adner & Feiler, 2019). Owens et al. (2020) build on Moore's work and propose the concept of ecological niches to describe innovation ecosystems. They argue that an innovation ecosystem consists of firms that occupy different environmental niches but are related. Suppose the ecological position of one of the companies changes, the ecological position of the others will also change accordingly.

According to Mohamad et al. (2020), innovation ecosystems are based on innovation ecologies created to facilitate connections between innovation agents. The root of innovation lies in the fact that such links enable the flow of information between innovation agents, facilitating the diffusion of knowledge and technology.

Second, the collaborative perspective. Adner (2017) argues that innovation ecosystems focus on focused innovations and some components and complements supporting other

innovations and seeing ecosystems as collaborative arrangements. This collaboration emphasized the need for an ecosystem to understand interdependent actors who interact to create innovations that benefit the end customer. Ecosystem innovation can fail if coherence is not achieved within the ecosystem (Tsujimoto et al., 2018).

Adner and Feiler (2019) state that innovation is no longer a task that a single firm can accomplish but requires complementary synergies with different partners to create precious products and services for customers. A firm's innovation strategy must match the innovation ecosystem for the group of firms to create value far greater than the sum of the value created by individual firms. B. Sun et al. (2016) view innovation ecosystems as dynamic, interdependent, and mutually reinforcing systems that share innovative resources and complement each other's strengths.

Finally, from the network perspective. Nambisan et al. (2019b) see the innovation ecosystem as a network of loosely interconnected firms. Each firm synergizes around an innovation or innovation platform and is interdependent for overall effectiveness and survival. de Vasconcelos Gomes et al. (2018) view the innovation ecosystem as a loose network of suppliers, distributors, outsourcers, manufacturers, and firms. These subjects interact with each other in product creation and delivery.

In summary, the research on innovation ecosystems is sorted out as shown in Table 2.5 below.

Table 2.5 Combing innovation ecosystem studies

Researcher (time)	Contents	Research Perspectives
Adner and Feiler (2019)	Corporate ecosystems are joint groups based on organizational interactions	Ecological Perspectives
Adner (2017)	Innovation ecosystems focus on focused innovation and several components and complementary supporting other innovations and viewing ecosystems as collaborative arrangements.	Perspectives of the Co-Students
Garnsey and Leong (2008)	The Innovation Ecosystem is a self-organizing and dynamically evolving system of interactions, with the focal company at its core and suppliers, investors, research institutes, distributors, customers, competitors, and regulators at their disposal.	Organizational level
Jackson and Victor (2011)	There are subjects involved in product innovation that carry out innovative activities based on shared aspirations and goals and interact with the environment to form an open organic unity.	A systematics perspective
Nambisan et al. (2019b)	An innovation ecosystem is a network of loosely affiliated companies, each of which synergizes around an innovation or innovation platform and relies on each other for the overall good and survival.	Network Perspective
de Vasconcelos	The innovation ecosystem consists of a loose network	Web Perspective

Gomes et al. (2018)	of suppliers, distributors, outsourcers, manufacturers, and companies. They interact with each other in the creation and delivery of products.	
B. Sun et al. (2016)	A dynamic and balanced system of interdependence and interaction in a specific time and space dominated by manufacturing enterprises, composed of innovation-related subjects, with collaborative innovation as the purpose and cooperative symbiosis as the basis, realizing the sharing of innovation resources and complementary advantages through the flow of innovation materials, energy, information, and knowledge.	Perspectives of the Synergy

Source: According to Adner and Feiler (2019), Adner (2017), Garnsey and Leong (2008), Jackson and Victor (2011), and related literature.

2.2.4.2 Research on the structural elements of innovation ecosystems

At present, there is no consensus on the constituent elements or components of the innovation ecosystem. According to Granstrand and Holgersson (2020), innovation ecosystems are composed of two main components, namely participants and environmental conditions. The participants include both individual participants and organizational participants. Environmental conditions include rules, regulations, and the market environment. Zhao and Yi (2021) argues that innovation ecosystems are mainly concerned with core and impact levels. The core-level elements include technological innovation, development, and application.

The impact level mainly includes culture, talent, policy, funding, and management. Xie and H. Wang (2021) argues that innovation ecosystems contain at least three components: process, culture, and capability. Kahle et al. (2020) argues that resources, capabilities, and connectivity are essential components of an innovation ecosystem, while Russe and others argue that innovation ecosystems are composed of political, economic, environmental, cultural, technological, and cross-organizational subsystems. These subsystems interact to create a strong climate for innovation and thus sustained growth.

2.2.4.3 Research on the core characteristics of the innovation ecosystem

Hou and Shi (2021) argues that any firm should 'co-evolve with the ecosystem it operates, rather than compete or cooperate. Mei et al. (2014) identify the core characteristics of innovation ecosystems as "co-evolution." An innovation ecosystem is a system consisting of firms, consumers, and markets, as well as the natural, social and economic environment. Among them, an innovation ecosystem contains a loose network of suppliers, distributors, outsourcing firms, product and service manufacturers, technology providers, other organizations (Owens et al., 2020).

Opens a loose network creates symbiotic conditions for the innovation ecosystem members

and provides requirements for flexible relationship selection. Symbiotic evolution becomes an effective way to promote ecosystem alliances (Herczeg et al., 2018). Kolloch and Dellermann (2018) argue that changes in the relationships between system members are the essence of innovation ecosystem evolution. The combination of multiple factors leads to a multi-stage development of innovation ecosystems.

A healthy innovation ecosystem shifts business strategy from simple joint operations to collaborative systemic cooperation, product competition, system competition, and firm independence to symbiotic evolution (de Vasconcelos Gomes et al., 2018). As the dynamics of member organizations and the environment in innovation ecosystems increase, firms no longer see themselves as a single closed organization but as a whole with other related organizations. These firms link their destiny to the ecosystem and work together to achieve symbiotic evolution. As the system members evolve symbiotically, the innovation ecosystem becomes into a system with multiple core products and ultimately creates value that no single firm can create (Adner, 2017).

2.2.4.4 Research on innovation ecosystem management

Dondofema and Grobbelaar (2019) argue that the operational effectiveness of innovation ecosystems is affected by uncertainties such as product cycles, asset allocation efficiency, and risk assessment. Also, the system may be exposed to dependency risk, market risk, and risk of resource integration. Subsequently, Adner (2017) proposes an 'innovation ecosystem.' He argues that companies are no longer independent innovators but are part of a broader innovation ecosystem. Companies need to manage not only their innovation but also the innovation ecosystem. Costa and Matias (2020) found that while the government and economic environment had a positive impact on innovation ecosystems, the level of R&D, human capital, and early seed funding were key indicators of innovation.

Nambisan et al. (2019a) argue that innovation ecosystems depend not only on the extent to which entrepreneurs can integrate resources and solve problems but also on the support of the innovation ecosystem. Some scholars have analyzed innovation ecosystems in terms of three components: the state of cluster development, university-industry collaboration, and innovation culture (Schiuma & Carlucci, 2018). They argue that cluster formation accumulates knowledge and positively affects innovation activities and that collaborative R&D between universities and industry will increase innovation output.

In summary, this study selects theories related to innovation ecosystems to be applied at the firm level, not only to facilitate the firm's efficiency in the production process but also to

facilitate communication between the upstream and downstream of the product as a way to reduce costs and improve the firm's competitiveness. Adner (2017) state that an ecosystem consists of participants with varying degrees of multilateralism, non-general complementarity, and complete hierarchical control. He sees innovation ecosystems as a model for achieving complementary collaborations, with overall innovation capabilities being a key element influencing innovation performance. Commercializing a product or service requires many upstream components and the complementarity of downstream complementors (Jacobides et al., 2018). Complementarity is, therefore, essential in an innovation ecosystem.

2.2.5 Types and patterns of ecosystem complementarity

2.2.5.1 Dual characteristics of complementarity

As the study of ecosystems has become more intense, many scholars have also considered areas such as services and manufacturing. Based on this, the time is ripe for a new perspective on complementarity in ecosystems (Barry et al., 2019). Related studies point out that complementarity has dual characteristics, including unique complementary and supermodular complementary (Jacobides et al., 2018).

Pinheiro et al. (2020) state that unique complementary refers to the fact that two resources would be ineffective if not used together and need to be coordinated to maximize the benefits. Unique complementary can be unidirectional, i.e., one activity requires the other specific activity and vice versa. Combining activities will help achieve the overall goals of the system. At the same time, unique complementary can also be a two-way street, where one activity and another activity need each other and cannot be used without each other. This tends to lead to more proprietary resources, and Teece (2017) defines such specialized resources as those with bilateral dependencies. Argyres and Zenger (2012) argue that resource exclusivity can generate unique complementarities, making integrated resources more attractive.

Super-modular complementarity is the idea that the use of an asset can make another investment more valuable (Feizabadi et al., 2021). Amir (2019) state that if more is done by any subset of an activity that will increase the returns to any remaining subset of the activity, such activity is super-modular complementarity. Rahmandad (2019) argue that the return of two or more resources used in coordination is higher than that of uncoordinated use, or the cost of coordinated use is lower than that of awkward use. García-Marco et al. (2020) state that the marginal payoff of activity increases with other activities. Adding an activity while another is already being performed will result in a higher increase in innovation performance. Also, super-

module complementarity can be unidirectional or bidirectional.

Ecosystems arise from non-general patterns of complementarity between components, unique complementarity and super-modular complementarity. This pattern of complementarity is a concrete expression of interdependence and can be better reflected in the ecosystem complementarity matrix. The ecosystem complementarity matrix reflects the complementarities between the system components and can be easily adapted to produce and consume the complementarities before each component (Shipilov & Gawer, 2020). Production complementarity exists when the benefits of consuming two products together are more significant than those of consuming these products separately or when the cost of production is lower than producing them separately (Jacobides et al., 2018). The greater complementarity of these products is indicated when users consume them together to obtain higher returns than if they were finished independently.

The intensity of complementarity in production or consumption is beneficial for describing ecosystem complementarity because ecosystems contain different components, each of which may have different degrees of complementarity. A complementarity matrix can describe an ecosystem, as shown in Table 2.6 below.

Table 2.6 Ecosystem complementarity matrix

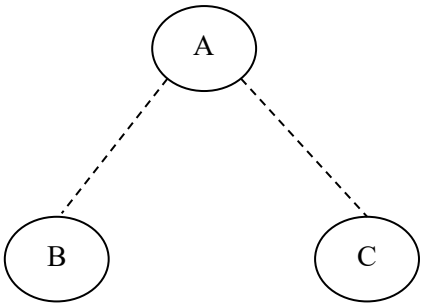
	A	B	C	D	E	F
Component A		3	1			
Component B	3					
Component C	1					
Component D					1	1
Component E				1		1
Component F				1	1	

The larger the value inside the matrix plot in the ecosystem complementarity matrix, the stronger the complementarity between the two components (Shipilov & Gawer, 2020). Once the strength of all complementarities in an ecosystem has been determined, comparisons can be made based on the average power of complementarities. For example, the average complementarity of the ecosystem consisting of components A, B, and C in the figure above is more substantial than the average complementarity of the ecosystem consisting of components D, E, and F. In general, ecosystems with a more vital average complementarity are likely to perform better than ecosystems with a weaker average complementarity because the former create higher value for the producer or consumer. As a result, these producers or consumers are more reluctant to leave the ecosystem, contributing to the ecosystem's overall health (Viswanadham, 2021).

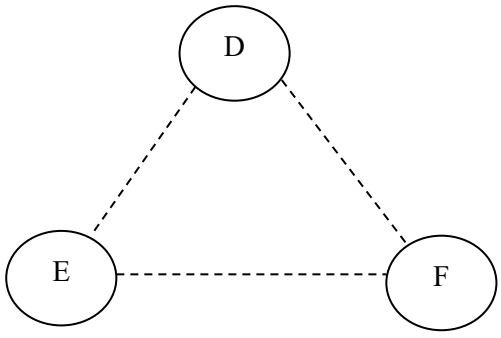
2.2.5.2 Component complementarity in ecosystems

In social networks, when a firm has different relationships with its two partners but no direct connection, it spans a structural hole between them (H. Wu et al., 2020). By contrast, a social structure in which all partners are interconnected does not have a structural fix. Scholars of social networks use two terms to describe these two different states, i.e., networks with more structural holes are called open networks, and net, where all partners are interconnectedness are called closed networks.

Based on the same logic, Shipilov and Gawer (2020) classify ecosystems according to the pattern of complementarity between the component components. When there is consumption or production complementarity between components A and B and between components A and C, but not between components B and C, there is hub-and-spoke complementarity between these three components. Conversely, if there are consumption or production complementarities between all three components, then the three components exhibit integrated complementarity (Tang et al., 2021). Figure 2.1 below reflects the structure of these complementarities.



a. Hub-and-spoke complementarity



b. Integrated complementarity

Figure 2.1 Hub-and-spoke and integrated complementarity

For example, in the case of Apple's iOS ecosystem, it exhibited a hub-and-spoke complementarity early on (Zhang et al., 2018). That is, office applications (such as Microsoft Office software) and data storage applications (such as Dropbox) were complementary to Apple's iOS system and iPhone, but without the opportunity to open files from Dropbox and

edit them in Microsoft Word, the three components did not have consuming complementarity. When iOS allows interaction in Word and Dropbox for transferring, reading, these three components form an integrated complementary structure.

Hub-and-spoke complementarity evolves towards integrated complementarity. The various actors who perform the components are looking for new ways to recombine more complementary components in production or consumption. In the case of Apple's iOS, for example, office software and storage applications will provide more value to consumers as they become interconnected. It is worth noting that a high degree of integrated complementarity is not necessarily good (Teece, 2017).

Lee and Alnahedh (2015) found an inverted U-shaped curve between the degree of technological interdependence and the performance of the industry or organization using these technologies (M. Kim et al., 2020). This is because, at low levels of technological interdependence, the components can be aligned to a higher degree, but the lack of complementarity makes it challenging to create higher value. When technological interdependence is too high, the components are constrained by each other, making radical innovation more difficult. This relationship also applies to relationships where ecosystem components are complementary.

2.2.6 Summary of ecosystem theory

This thesis provides a review of three aspects of ecosystem theory, namely, the concept of ecosystem theory, the development of different schools of ecosystem theory, and the introduction of component complementarity. Through a comprehensive review and summary of the literature, this thesis clarifies the theoretical perspective of the component complementarity of the ecosystem.

First, this thesis introduces the origin and concept of the ecosystem. The ecosystem is derived from biology and is used to describe the interdependent structure formed by subjects in the biological world. Moore first introduced the ecosystem to business and expanded the understanding of the ecosystem in terms of its internal structure and process evolution. An ecosystem is made up of subjects such as customers, suppliers, products and services, distribution channels, investors, trade associations, unions, and other institutions. Scholars classify the stages of ecosystem development as the birth stage, rapid expansion stage, core firm leadership stage, and system self-renewal or extinction stage (Chang et al., 2021).

In these four stages, member firms and core firms, as well as among member firms, form relationships that are both competitive and cooperative (Aaldering et al., 2019). In the

ecosystem, firms establish close interdependence in the process of competition and cooperation. While considering their own development, companies need to consider the overall development of the ecosystem (Kochan et al., 2018). In summary, this thesis describes an ecosystem as an economic community composed of many organizations and individuals based on the conclusion of extant research.

Second, this thesis reviews and compares the ecosystem concepts of different categories. Specifically, this thesis makes a review and comparison of the concepts and development history of the business ecosystem, platform ecosystem, and innovation ecosystem. Moore (1993) first introduced the business ecosystem and argued that firms interact with other participating actors in the ecosystem to constitute an economic community. A business ecosystem is considered a community whose members are self-organized and interdependent to gather together (Polese et al., 2021). On the other hand, the platform ecosystem consists of both platform enterprises and complementary players (McIntyre et al., 2021). The platform enterprise mainly provides the platform for the complementary players to perform their functions and contributes to the overall ecosystem value creation by attracting complementary players. Complementary players mainly provide complementary products and services to the platform ecosystem and collaborate with the platform companies and other companies to promote value creation (Verganti et al., 2020).

Innovation ecosystems are communities that bring together upstream and downstream firms in order to enable core innovation products (Adner & Feiler, 2019). From a synergistic perspective, an innovation ecosystem is a coordinating structure that brings together participating multilateral agents in order to achieve a core value proposition. Coherence within the system is required to create value from system resources that are greater than the sum of value created by individual firms (Tsujimoto et al., 2018). After sorting out the development of business ecosystems, platform ecosystems, and innovation ecosystems, this thesis argues that the innovation ecosystem theory is more suitable for corporate sustainable innovation research.

Finally, this thesis selects the innovation ecosystem as the theoretical basis and reviews the innovation ecosystem as well as the component complementarity, providing a powerful perspective for firms to achieve sustainable innovation. Adner (2017) states that an innovation ecosystem consists of a set of players that have varying degrees of multilateralism, non-general complementarity, and no full hierarchical control. The commercialization of a product or service requires not only a large number of upstream components but also the complementarity of downstream complementary players (Jacobides et al., 2018).

Therefore, complementarity is particularly important in the innovation ecosystem. Drawing

on the idea of network structure holes, Shipilov and Gawer (2020) classified two kinds of complementarity among components. When there is consumption or production complementarity between component A and component B and component A and component C, but not between component B and component C, these three components form a hub and spoke complementarity. Conversely, if consumption or production complementarities exist between all three components, then the three components exhibit an integrated complementarity (Tang et al., 2021). Lee and Alnahedh (2015) found an inverted U-shaped relationship between the degree of component interdependence and innovation (M. Kim et al., 2020). When component interdependence is low, components can be adapted to a higher degree, but higher innovation is difficult due to a lack of complementarity. When component interdependencies are too high, the components form limitations on each other and it is more difficult to perform radical innovation. In summary, this thesis will portray the ecosystem scenario using the integrated complementarities as well as the hub and spoke complementarities.

2.3 Social network

Social network scholars argue that network organizations result from expanding corporate boundaries in the current era, so network governance can also be considered an extension of corporate governance. Based on this, we argue that network governance is the design of a cooperative network between enterprises to a certain extent. The effective governance of the relationships between key players in the network achieves synergy, innovation, and goals among the network players. This study takes an ecosystem perspective to observe how firms can achieve sustainable innovation through network governance. Combined with ecosystem theory's emphasis on interdependent relationships, we argue that the structural characteristics of the overall network should be more emphasized in the review of network theory. In summary, we provide the following overview of social network theory.

2.3.1 Social network and network governance mechanism

Among the existing studies on network governance mechanisms, relational and contractual governance are the most central debate points. For example, Williamson (2000) have discussed these two perspectives on governance in their series of articles. The trade-off between contractual and relational mechanisms has been the subject of most research on network governance in social networks. Specifically, there has been a debate in network governance theory whether contractual governance to control opportunism or relational governance to build

trust is more critical (Gorod et al., 2018). Table 2.7 compares the literature that discusses the relationship between relational and contractual governance.

Table 2.7 Relationship between relational and contractual governance

Type	Key perspectives	Representative Authors
Formal control based on contractual governance mechanisms	1. Emphasis on the use of section hierarchies to control self-interested and opportunistic behavior 2. Coordination using the command system	Hennart (2006)
Social control based on relational governance	Alternative perspectives 1. Social control as an alternative governance mechanism to formal control 2. Emphasis on the role of trust mechanisms 3. Negative correlation between formal control and social control	Gulati et al. (2000)
	Complementary perspectives 1. Social control and relational contracts are similar 2. Social control is seen as a hybrid mechanism 3. Emphasis on social punishment 4. formal control helps social control to work and vice versa	Dyer et al. (2018)
	Adjusting the view 1. Social control has a lubricating effect 2. Internet is not a necessary but sufficient condition 3. Emphasis on trust and norms 4. Social control has regulatory effects depending on transaction costs and formal nature	Z. Cao and Lumineau (2015)

Source: According to Hennart (2006), Gulati et al. (2000), Dyer et al. (2018), Z. Cao and Lumineau (2015), and related literature.

There are several different views on the relationship between relational and contractual governance mechanisms.

The first is the substitution theory. Economic and sociological research generally sees a substitution relationship between relational governance and formal contracts, mainly as trust reduces transaction costs by "replacing contracts with handshakes."

Thus, Dyer and Singh (1998) argue that informal self-enforcing contracts crowd out the formal control of formal contracts with trust and reputation, and Gulati et al. (2000) makes it quite clear that contracts and trust are substitutes for each other, "trust avoids contracting costs and reduces the need for monitoring. Trust counteracts concerns about opportunistic behavior". Similarly, Uzzi (1997) argues that transactions are embedded in the social structure, saving a great deal of time that would otherwise be spent on contract negotiation.

Finally, Larson (1992) argues that formal contracts are uncrucial in examining transactions and that informal social control replaces legal contracts. The primary rationale is that if one party trusts the other, there is no need for the contract to specify actions. In conclusion, relational governance reduces transaction costs and increases flexibility and adaptability. There

are still some scholars who offer an alternative rationale that formal contracts undermine the process of transactional administration. Ghoshal and Moran (1996) argue that proper control is harmful to cooperation. Control means they are not trusted or are perceived as not behaving reasonably in the absence of control for those in power. The so-called 'supervisor's dilemma' arises for the controlling party, whereby super energy passion and mistrust in management further exacerbate the need for care and control.

Detailed contracts can be a barrier to good relationships. Some firms avoid using clear contracts because complex contracts reflect a lack of trust, diminish the need for camaraderie and turn cooperation into hostility. Bernheim and Whinston (1998) construct a model that shows that contracts encourage opportunistic behavior that does not allow for explicit activities in the contract. In summary, these scholars see relational governance and formal contracts as alternative mechanisms, with relational administration reducing the need for legal contracts and vice versa, or with legal contracts directly discouraging the establishment of relational governance.

Second is the complementarity theory. While the 'substitution theory' is compelling in studying the relationship between relationship governance and formal contracts, the 'complementarity theory' is equally valid. In high-risk situations, the combination of formal and informal protection mechanisms produces better performance than either mechanism alone (Dyer et al., 2018). Clear contractual terms, remedies, and dispute resolution processes combined with relationship norms that emphasize flexibility, solidarity, and durability can inspire confidence in inter-organizational cooperation. Clear contractual terms enhance expectations of each other's cooperative behavior and compensate for the informal limitations of relationship governance. Existing collective behavior further enhances expectations of future cooperation. Formal contracts guarantee success in the early stages of a transaction.

Some clauses in long-term contracts also stipulate the requirements for long-term cooperation. Uncertainty in the environment can undermine cooperative relationships. Suppose contracts move from simply specifying the outputs of collaboration to providing a framework for action to adjust the bilateral relationship (Isaac et al., 2019). In that case, this can help the relationship to be maintained and evolve. In addition, the process of contract development further enhances expectations of cooperation, providing a mechanism similar to relationship governance. For example, the activity of developing a complex contract requires joint decision-making, the joint resolution of contingencies, and collective punishment for breach of contract (Bird & Zellweger, 2018). Therefore, the process of creating contracts positively influences cooperative performance by developing social relationships, compensating for relational

governance.

The complementary relationship between relationship governance and formal contracts can also be reversed (Awan et al., 2018). Indeed, many dimensions of a transaction are difficult to specify in a contract, and it is difficult for managers to foresee and resolve potential contingencies. Consequently, it is difficult for contracts to maintain the relationship when unforeseen disruptions occur (D. Cao et al., 2018). While contracts can help extend the relationship by specifying processes that change accordingly, they do not ensure the continuation of the relationship or a mutually acceptable bilateral agreement. Relationship governance is a valuable complement to this limited adaptability of the contract, helping the parties to reach a settlement when disputes arise.

The relational value of solidarity is highlighted by the tendency to look to the future and the willingness of both parties to rely on each other for a long-term relationship. Managers will choose relationship governance and customized contracts to increase the likelihood of continuity. Second, relationship governance can further increase the complexity of formal agreements. When parties have established a strong partnership, some of the lessons learned from the collaboration are reflected in changes to the contra agreement. Cooperation experiences, information sharing patterns, improvements in performance measurement, and monitoring methods will be further clarified. As a result, relationship governance gives rise even more to more complex formal contracts.

The controversy between complementarity and substitution has been a significant issue in network governance (Hütten, 2019). Some scholars have tried to resolve this controversy by introducing some boundary conditions. For example, De Man and Roijakkers (2009) illustrate through a case study that the level of control and trust in coalition governance depends on the type and level of risk faced by the coalition. Control and trust are complementary when both task and relationship risks are high. When task and relationship risk is low, control and trust are substitutes. It has also been suggested that the existing literature discusses governance structures extensively but pays little attention to the relationship between governance arrangements and existing institutions at the transactional level.

Abdi and Aulakh (2017) validate the complementary relationship between the formal system and contractual governance and the substitute relationship between the informal system and relational governance using data from US firms. Zhou (2012) uses an empirical study of 168 foreign buyers. An empirical survey on transactions between 168 foreign buyers and local suppliers verifies the interaction between detailed contracts, centralized control, and relational governance, controlling for opportunistic behavior of local suppliers in emerging markets. The

findings show that arrangements are not effective in curbing the opportunistic behavior of partners when the legal system is not well developed. In such cases, relationship governance provides a mechanism for a legal agency. Relationship governance is a complement to contracts and an alternative to centralized control.

While many conceptual and empirical studies validate the effectiveness of relationship governance, few studies have examined the limitations of relationship governance in inter-organizational cooperation. Some literature has begun to address the trade-offs and limitations of relationship governance in recent years, but these studies are highly scattered and lack support from empirical data.

An important debate is whether relationship governance can still mitigate losses when opportunities for self-interested behavior exist. According to Granovetter and Mark (1985), mutually trusting parties to a transaction may still cheat when faced with options for self-interest, implying that trust may only be a disguise. The logic of transaction costs and moral hazard indicates that this is most likely to occur when performance is difficult to assess explicitly. Another critical controversy is whether embedded ties introduce relational rigidity, ignore dynamic adjustments (De Silva & Rossi, 2018; Oh & Yoo, 2021), and limit new partner search opportunities and capabilities. Anderson and Jap (2005) have argued that close relationships are most vulnerable to damage from the dark side of the relationship; for example, when trusting relationships are taken for granted, partnerships are more likely to be put at risk. The dual requirements of service networks for dynamism and stability also challenge the effectiveness of relationship governance. In summary, this study argues that network governance requires both relational and contractual management. In particular, we need a combination of governance mechanisms to achieve both radical and incremental innovation in achieving sustainable innovation.

2.3.2 Social network: the structural and relational perspectives

There are two main theoretical perspectives in social networks: the structural and relational perspectives (Dyer et al., 2018). These two perspectives have different assumptions, theoretical foundations, and analytical foci. From these two perspectives, scholars will propose different understandings of social networks. Table 2.8 summaries the main differences between network governance's structural and relational perspectives.

Table 2.8 Structural and relational perspectives of social networks

Features	Structural perspective	A relational perspective
Analytical Focus	Single transaction	Inter-company relations
Theoretical foundations	Transaction cost theory	Social Exchange Theory
Key assumptions	Partners tend to act opportunistically; network performance depends on the quality of the initial contract design	Partners tend to act in a trustworthy manner; network performance depends on the quality of the relationship process
Governance mechanisms	Complex deeds	Trust
Research limitations	A non-socialized view of human action	A transitional socialization view of human action

The structural perspective focuses on separate network bilateral transactions. The theory is based on transaction cost theory, and the underlying assumption is that alliance partners tend to act opportunistically. The higher the asset specialization, the higher the risk that one or both parties to the transaction will perform opportunistically (Papanastassiou et al., 2020), and hypothesis two is that the initial structural design of the bilateral trade is the most critical factor in explaining network performance (Hennart, 2006).

In contrast, the relational perspective focuses on bilateral partnerships between firms and variations in inter-firm relationships over time and across transactions and is based on social exchange theory. The underlying assumption is that partners tend to act trustworthy, especially when the parties to a transaction have a history of successful cooperation. From this perspective, researchers argue that inter-firm relationship management, such as facilitating communication and building trust, is a more critical factor in explaining network performance (Patnaik et al., 2020).

Due to different underlying assumptions, the structural and relational perspectives propose other mechanisms for network governance. The structural view sees complex contracts (or contracts with many precise terms) as an essential means of reducing opportunistic behavior (J. R. Brown et al., 2019; Verbeke et al., 2019). By specifying powers and obligations and penalties for breach, complex contracts reduce the ability and willingness of partners to behave opportunistically. Second, contracts are mechanisms for coordination. By clarifying the division of labor between partners and providing a process for integrating the division of labor, complex contracts simplify the decision-making process and avoid disputes over how to complete the project (Benito et al., 2019). In summary, the structural perspective suggests that complex contracts create a collaborative environment with stable expectations, reduce transaction risk and facilitate collective behavior.

The relational perspective considers relational governance, including trust mechanisms and

relational norms, as a means for partners to address interest maintenance and cooperation joint nation issues. Although there are many definitions of trust, the basic consensus is that trust refers to positive expectations of the other party in a risky situation (Lei et al., 2019). Some scholars (Sadegh et al., 2020) consider trust as a multidimensional concept that includes competence trust (for example, positive expectations that the partner will perform as contracted) and attitudinal trust (for example, the partner's willingness to complete).

According to the relational perspective, trust is a governance mechanism. The reason for this is twofold: first, the trust assures the partner that the partner will use the knowledge and information for better purposes. This reduces expectations about opportunism risk and the likelihood of using formal control mechanisms such as complex contracts. Trust can reduce costs and increase flexibility as complex contracts' governance mechanisms are costly and inflexible. Second, trust facilitates more extensive communication and information sharing among members of collaborating firms in an informal form. Cooperation between member firms no longer relies on contractual systems and processes but mutual adaptation and coordination.

Both the structural and relational perspectives have their limitations. View lacks contextual and historical perspective and ignores the social context in which bilateral transactions are embedded. On the other hand, the relational perspective is overly optimistic about human nature, overemphasizing the embeddedness of relationships and ignoring transactional conditions, such as opportunism and contractual risk (Dyer et al., 2018). Since this study adopts an integrated perspective of ecosystems and social networks, this implies that the subject of the study, for example, the firm itself, belongs to the ecosystem. Ecosystem theory already naturally encompasses interdependencies between issues, so we only adopt a structural perspective in our subsequent network analysis.

2.3.3 Structural embeddedness in social network

First, open structure. There have been two opposing views among scholars in network research on what kind of network structure can drive innovation. Some scholars argue that a closed network structure can provide an essential catalyst for forming the normative environment required for collaborative innovation (Coleman, 2019). In contrast, the other part of the scholarship points out that overly tight ties can hurt inter-organizational coordination and cooperation (R. S. Burt, 2019). Only open networks can provide a significant amount of social capital because loose connections are required to generate social capital.

In this study, we argue that open networks are characterized by (1) diversity of network

memberships, (2) willingness to accept new members, and (3) a component of the degree of connection to subjects outside the network (C. Wu & Reuer, 2021). Existing research suggests that networks characterized by diverse and fluid member relationships have the advantage of accessing a broader range of information and resources to facilitate product development and build market knowledge (Scaringella & Radziwon, 2018; Verdú & Tierno, 2019). In contrast, centralized communication with a few partners may prevent access to critical information and new opportunities (R. S. Burt & Soda, 2021), thus creating a disincentive to innovation (Coleman, 2019). For example, Rodan and Galunic (2004) findings suggest a positive relationship between network knowledge heterogeneity and the level of innovation exhibited by network members.

McEvily and Zaheer (1999) find that firms with diverse information have higher competitive power than firms with relatively homogeneous networks in terms of information flows. This suggests that network members grow better when they have heterogeneous and complementary resources, capabilities, and sources of information. For example, research on international business shows that firms in global networks with more heterogeneous members are more active and grow (Ferriani et al., 2020; Hannigan et al., 2021). “Due to the full integration of knowledge, technology and skills from various fields, innovation in technology, market and other aspects of the enterprise is stimulated” (Autio et al., 2018; Z. Cao & Shi, 2021; Spigel & Harrison, 2018).

Network-related research adult been conducted that networks that are reluctant to accept new members risk stagnating innovation and development. Markusen (1985), for example, argues that Pittsburgh in the late 19th century and Detroit in the early 20th century were similar to Silicon Valley in terms of dynamism and success. Still, their inward-looking tendencies made them uncompetitive as the steel and automobile industries matured. In contrast, many of the world’s most successful firms, Bresnahan et al. (2001), are based on their openness to various heterogeneous potential partners. Of course, excessive transparency can also be problematic. Markusen (1996) found that while open networks are usually more inclined to innovate when some are too open, they can destabilize their internal stability.

Second, enclosed structures. Coleman (1988), a representative figure in closed network research, elaborates on the positive effects of closed networks in his study of the role of closed networks and social capital. First, Coleman (1988)argues that in closed networks, network subjects naturally develop a shared knowledge background while forming long-term stable trust in the process of long-term communication and cooperation. This trust and knowledge background enables network subjects to reorganize resources among network members more

smoothly to achieve knowledge creation and collaborative innovation. Second, a closed network means that the issues in the network are no longer isolated from each other but are interconnected and influence each other. This close connection ensures that the network members know and trust each other, and other subjects in the network understand to learn all opportunistic behaviors.

As a result, issues in closed networks are more likely to follow the rules already in place and embrace collaborative innovation activities beneficial to the network (R. S. Burt et al., 2018; R. S. Burt & Soda, 2021). Existing research on industrial cluster networks, for example, suggests that closed networks are geographically concentrated and that the behavior of network actors is influenced by the economic, social, and cultural context of the region, with a tendency towards localization. The fact that subjects in closed networks can communicate and interact autonomously and irregularly facilitates the process of innovation generation and diffusion within the network, as it allows for more robust access to uncertain opportunities. In addition to this, the links between subjects in closed networks are multi-level and multi-category, which positively affects the whole and complex use of resources. These factors enable issues fasted networks to be more receptive to uncertainty and take risks, which are essential enablers for achieving innovation.

Due to differences in the flow of resources, control, and asymmetries between network members, each structural attribute will differentially affect what firms know about others, what actions firms are willing to take, and what actions firms can take. Thus, a firm's behavior in a network will be influenced by structural attributes. This research focuses on three critical structural features to describe the firm's position in the network.

Centrality refers to the position of an individual participant in a network, and it indicates the extent to which the actor at the center of the network occupies a central role in the network by participating in many vital connections (Kuskova & Wasserman, 2020). Since network connections are channels for exchanging resources between subjects, we argue that a high degree of centralization leads to pooling technology and knowledge to the centrally located topic (Galaskiewicz, 1979).

First, centrally located issues have access to more external assets, such as technology, capital, and management skills, from connected players. Second, because many information sources are integrated through their linkages, centrally located actors have faster access to new and vital information (Rogers, 1995). Third, high centrality implies higher status and power (Wasserman & Faust, 1994), as subjects with extensive connections tend to be perceived as having higher prestige (Brass & Burkhardt, 1992). As a result, centrally located issues usually

have access to better and more resources and opportunities (Gulati et al., 2000).

Structural autonomy is derived from R. S. Burt's (2001) study of structural holes. Structural autonomy is a crucial property of subjects in networks. Issues with structural autonomy have structural gaps between the other matters connected to, but not at their ends. To understand structural holes, we have a structural hole between B and C if subject A is connected to both B and C, but B and C are not directly bound to each other, for example, B and C can only reach each other through A. Structural holes can enhance information gains in several ways: diverse ties across unrelated groups mean less redundancy and higher information quality, early access to new information, and participation in more interactions (R. S. Burt, 2021). For firms with high structural autonomy, the advantage of structural holes allows them to access assets, information, and other resources from the network more efficiently, which further increases positive resource asymmetries. Structural autonomy implies a greater dependence of other agents on the core agent, thus giving the core agent a higher level of power and status.

Structural equivalence implies that subjects have similar relationships with other participants in the network, although they do not have to be directly connected (Kuskova & Wasserman, 2020). Therefore, structural equity valence is the degree of similarity between the network patterns of two subjects – the greater the similarity of the networks of two issues, the greater the structural equivalence of these subjects (Valente, 1995). Structurally equivalent participants tend to have similar characteristics and behaviors (P. Burt & Adelson, 1983). There are two different views on the idea. The socialized view is that such subjects interact similarly, leading to similar attitudes, resources, and behaviors. The picture with symbolic implications is that structurally equivalent subjects tend to imitate each other in their activities. Given the above characteristics of structural equivalence, two issues with structural equivalence can be regarded as having similar assets, information, and state flows, and therefore a certain symmetry in the allocation of resources.

2.3.4 Summary of social networks

This thesis reviews and comments on three aspects of social network theory, namely, social networks and governance mechanisms, structural and relational perspectives of social networks, and structural embeddedness characteristics of social networks. By reviewing, sorting, and summarizing existing studies, this study complements and refines the social network context for sustainable innovation choices of firms.

First, this thesis introduces the content of relational governance and contractual governance in the study of network governance mechanisms and the relationship between them. Social

network scholars argue that network organizations are the result of expanding corporate boundaries in the current era, so network governance can also be considered an extension of corporate governance. however, scholars have been controversial about the core issue of network governance (Gorod et al., 2018). Specifically, contractual governance emphasizes controlling opportunism and relational governance emphasizes building trust.

There are two main different perspectives on their relationship in existing research. The first view is that relational governance should replace contractual governance. Scholars argue that trust-based relational governance overcomes transaction frictions, such as opportunistic control, and enhances transaction agility (Gulati et al., 2000). The second view considers relational and contractual governance as two complementary mechanisms. Some scholars point out that firms using both social control and economic agreements ensure better performance than using only a single measure (Dyer et al., 2018). This is because strict control provisions allow the cooperating parties to develop stable cooperation expectations and overcome the shortcomings of the lack of obligatory relationship governance. In addition, contract formulation is a process of game playing and mutual understanding between the parties to a transaction, and because of the ex-ante restrictions on opportunism and ex-post penalty provisions, this can enhance the stability and expectations of cooperation between the parties to a transaction. This is corroborated by a large number of subsequent empirical studies. Therefore, this thesis argues that relational governance and contractual governance are complementary and indispensable for cooperation.

Second, this thesis sorts out and compares the structural and relational perspectives of social networks. As two important perspectives of social network research, the structural perspective and the relational perspective differ in terms of analytical focus, theoretical foundation, main assumptions, and governance mechanisms. Specifically, the structural perspective is based on transaction cost theory and presupposes that partner tend to take opportunistic actions. The focus of this perspective is on atomized network bilateral transactions.

The structural perspective assumes that complex contracts create a cooperative environment with stable expectations, reduce transaction risk, and promote cooperative behavior. Correspondingly, the relational perspective is based on social exchange theory and presupposes that partner tend to take trustworthy actions. The focus of this perspective is on the relationship of bilateral cooperation and the dynamic changes in the relationship. From the relational perspective, it has been argued that the quality of relationship management can have a significant impact on network performance, such as enhancing communication and fostering trust (Patnaik et al., 2020). The relational perspective argues that the benefits of cooperation, as

well as coordination between the two parties, can be maintained through means such as trust and relational norms. The corporate sustainable innovation choice scenario constructed in this study focuses on the position of the individual in the overall network and is more suitable for the selection of the structural perspective.

Finally, based on the choice of a social network structure perspective, this thesis further elaborates on the structural embeddedness characteristics of social networks. Due to differences in the flow of resources, control, and asymmetry among network members, the different structural characteristics will differentially affect what firms know about others, what actions firms are willing to take, and what actions firms are able to take. Thus, a firm's behavior in a network will be influenced by structural characteristics. This thesis focuses on three important structural characteristics to describe the position of the firm in the network. These three structural characteristics are centrality, structural autonomy, and structural equivalence.

Centrality refers to the position of a focal network actor in the network, which indicates the extent to which the network actor occupies a central position (Kuskova & Wasserman, 2020). Since network connections are channels for resource exchange between actors, high centrality leads to the pooling of technology, knowledge, etc. to the actor occupying the central position (Galaskiewicz, 1979). The concept of structural autonomy is derived from R. S. Burt's (2001) study of structural holes. Structural autonomy is a key characteristic of an actor in a network. The actor with structural autonomy has a greater advantage in accessing resources, information, etc., and are able to obtain higher resource asymmetry. Structural equivalence implies that subjects are similarly positioned to other participants in the network (Kuskova & Wasserman, 2020) and thus have higher similarity in resources, information, etc. This thesis will adopt the three dimensions of structural network characteristics to portray the network scenario of firms' sustainable innovation.

2.4 Theory contextualization

Since the establishment of Pudong New Area in Shanghai in the 1990s, the new Area has provided an important reference for promoting China’s economic development and innovating the economic development situation. After decades of development, the new area has gradually matured and become an important part of China’s economy. For example, Xiong’an New Area in China, Tianfu New Area in Sichuan, and Central Yunnan New Area in Yunnan are gradually playing key roles in local economic development and even future transformation. The new area provides a platform for enterprise cooperation and innovation, local resources development and

industrial development.

According to the current research, scholars generally classify firms' innovation approaches into incremental and radical innovations from the perspective of innovation intensity (Nasiri et al., 2017; Valle & Vázquez-Bustelo, 2009). Incremental innovation is a gradual, continuous innovation of existing technologies, focusing on improving the product's market segment (Sebastian et al., 2018). Radical innovation is a significant adaptation of technology or public good that will result in a new industry, product, or market and a substantial change in consumption patterns (Leifer et al., 2000). Both models are necessary for enterprises; in enterprise cooperation, the effective coordination between the two types of innovation business collaboration is vital for firms to achieve sustainable innovation (Keijl et al., 2016). Therefore, it is essential to explore the influencing factors of sustainable enterprise innovation.

It has been documented that innovation ecosystems and networks profoundly impact firms' innovation behavior (Gawer, 2014; Jacobides et al., 2018). Based on the theoretical review in the previous chapter, scholars have focused on the factors affecting radical versus incremental innovation in firms, and they have explained how factors such as policy support, firm resources, and level of competition affect both types of innovation from macro and micro perspectives, respectively. Nowadays, with the deepening trend of globalization and the rapid development of technology level, both product and business model innovation emphasize more on the ecosystem formed by cooperative firms together, and the influence of ecosystem on corporate innovation becomes more and more significant (Shipilov & Gawer, 2020).

However，there is little attention paid to how the complementarity structure of the ecosystem component affects radical innovation and incremental innovation, which is of great significance for our understanding of sustainable innovation of enterprises. Therefore, this thesis will focus on which ecosystem elements influence enterprise innovation behavior and control innovation tendency. Based on this issue, this thesis will use the policy capturing method and multi-case comparison method to research, as shown in Table 2.9.

Table 2.9 Sub-researches, goals, methods

Sub-Research	Research Goals	Research Method
Content 2.4.1	To explore the impact of component complementarity in ecosystems on sustainable innovation	Multi-case analysis
Content 2.4.2	To verify how component complementarity in ecosystems affect sustainable innovation	Policy capturing

2.4.1 Impacts of component complementarity on firm's sustainable innovation: multi – case analysis

With rapid economic and technological development, firms become increasingly complex and risky to innovate sustainably. They become increasingly dependent on the actors in their environment to grow together. Since the 1990s, management scholars have been using "ecology" as a metaphor for the business world, thus introducing the concept of the ecosystem (Sebastian et al., 2018). Ecosystems are formed around a joint value proposition and consist of customers, suppliers, other partners, and stakeholders that provide different complementary products or services.

However, existing research has focused on the role of asset complementarity among ecosystem members for their innovation. The impact of component complementarity in ecosystems on firms' sustainable innovation needs further investigation. In effect, ecosystems view innovation as a collaborative arrangement between organizations within an ecosystem that emphasizes how interdependent participants interact to create innovative products that benefit the end customer (Boyer, 2020). Member companies in the ecosystem jointly provide various components required for innovation. These components complement each other and play an essential role in the sustainable innovation of member companies in the ecosystem (Jacobides et al., 2018). The component complementarity of the ecosystem determines the cooperation environment between enterprises and partners and influences whether enterprises can fully utilize external resources, which is an essential focal point for achieving sustainable innovation (Shipilov & Gawer, 2020).

For new entrants, radical and incremental innovation coordination is crucial for achieving sustainable innovation in firms. In the research scenario of this thesis, these two types of innovation respond to unintended and expected innovation outcomes, respectively. The realization of these two types of innovation behavior also places different demands on the need for a component complementarity in the ecosystem. For innovation within expectations, where firms form ecosystems around a specific value proposition, the component complementarity in the ecosystem influences the pattern and complexity of business synergies and thus innovation (Adner & Kapoor, 2010; Shipilov & Gawer, 2020). Unintended innovations have a greater need for differentiated business collaboration patterns between firms, which require firms to carry content that is difficult to reason about with existing logic and engage in challenging experimentation.

This thesis classified component complementarity in an ecosystem into two types of

component complementarity structures: Hub and spoke ecosystem and Integrated ecosystem. To this end, we posed the research question: What is the relationship between the component complementarity structures of corporate ecosystems (Hub and spoke ecosystem and Integrated ecosystem component complementarity structures) and sustainable corporate innovation (radical versus incremental innovation)?

Based on the research questions in this section, a multi-case research approach is more helpful in exploring the results of this thesis. The thesis plans to select three typical cases and design the study accordingly: firstly, this section will conduct an internal analysis of the cases themselves. The design of this section is to select three typical firms with different component complementarity in the ecosystem and run an intra-case analysis，which is to understand the component complementarity structure and sustainable innovation performance of the case firms. In this thesis, three companies were selected as case samples: 36 Krypton Sichuan Branch with a high Hub and spoke component complementarity structure and a highly integrated component complementarity structure, Jiangxi with a high Hub and spoke component complementarity structure and average integrated component complementarity structure, and Yun Litchi with a highly integrated component complementarity structure and intermediate Hub and spoke component complementarity structure. Based on the above analysis, the research concludes that the component complementarity structure impacts the sustainable innovation status of the firm, as shown in Figure 2.2.

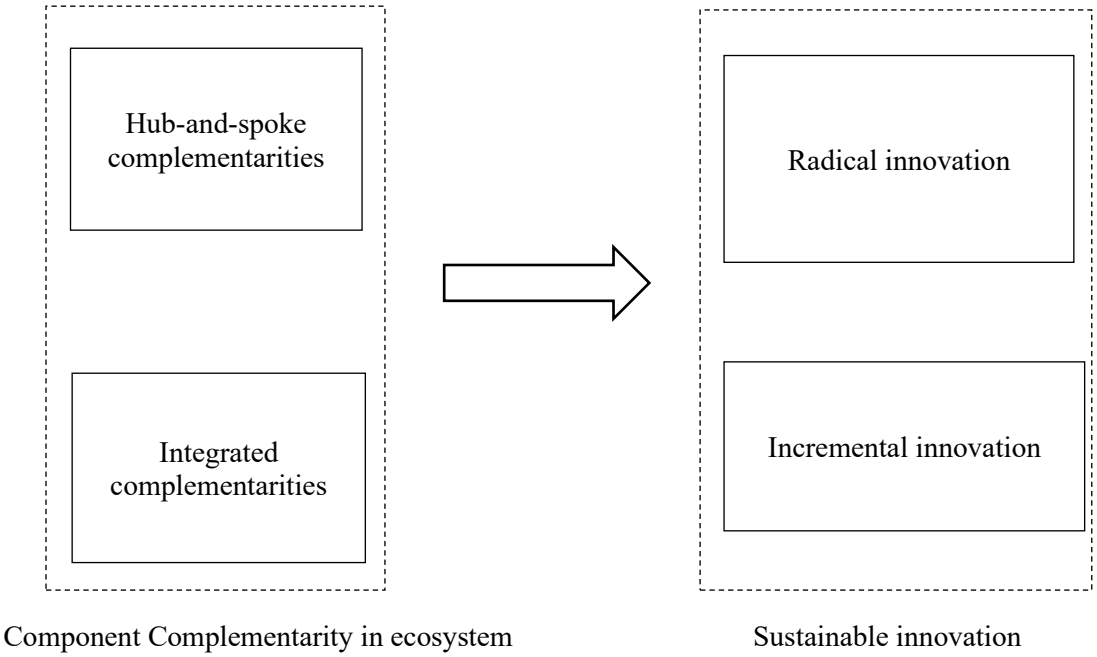


Figure 2.2 The impact of different component complementarity on sustainable innovation behavior

2.4.2 Impacts of component complementarity on firm's sustainable innovation: policy capturing investigation

Based on the above analysis, a multi-case study can help us explore the relationship between different component complementarity structures and sustainable innovation. However, many studies have shown that network factors influence firm innovation (Boudreau, 2010). The network can be an essential channel for new area firms to access the resources and information needed to innovate. The firm's position in the network will affect its ability to achieve sustainable innovation (Nasiri et al., 2017). To this end, this thesis develops a scenario questionnaire combining component complementarity structure and network structural characteristics to analyze further and validate the impact of component complementarity structure on sustainable innovation in new area firms.

Precisely, organizations together form a complex network. The position and status of firms in the network, for example, structural embeddedness, can have a differentiated impact on the sustainable innovation of firms. Centrality, structural autonomy, and structural equivalence are important structural embeddedness properties (Nasiri et al., 2017). Centrality reflects the position of the firm's organization in the network. It refers to how the focal firm occupies a strategic role in the network due to its involvement in many vital ties. Centrality also reflects the extent to which the focal an access resources and knowledge in the network, which affects its innovativeness. Structurally autonomous subjects have structural holes between issues connected to them but do not have structural holes of their own. Structural equivalence responds to the fact that participants have similar patterns of relationships with other participants in the network, which can influence the behavior of both parties (Sebastian et al., 2018).

To test the impact of the complementary component structure of the ecosystem on sustainable innovation of firms in a network structure scenario, this thesis adopts a quasi-experimental research approach, namely, policy capturing, which bridges the macro and microdomains and can capture the overall trends or patterns of organization-level decision making across many individuals. By combining the component complementarity structure with the structural embeddedness characteristics of the social network in which the firm is embedded, this research develops a decision scenario questionnaire that affects sustainable innovation in firms. Decision-makers make appropriate judgments based on the complete scenario, which enables them to test the differential impact of the component complementarity structure of the ecosystem on the sustainable innovation of the firm. As shown in Figure 2.3.

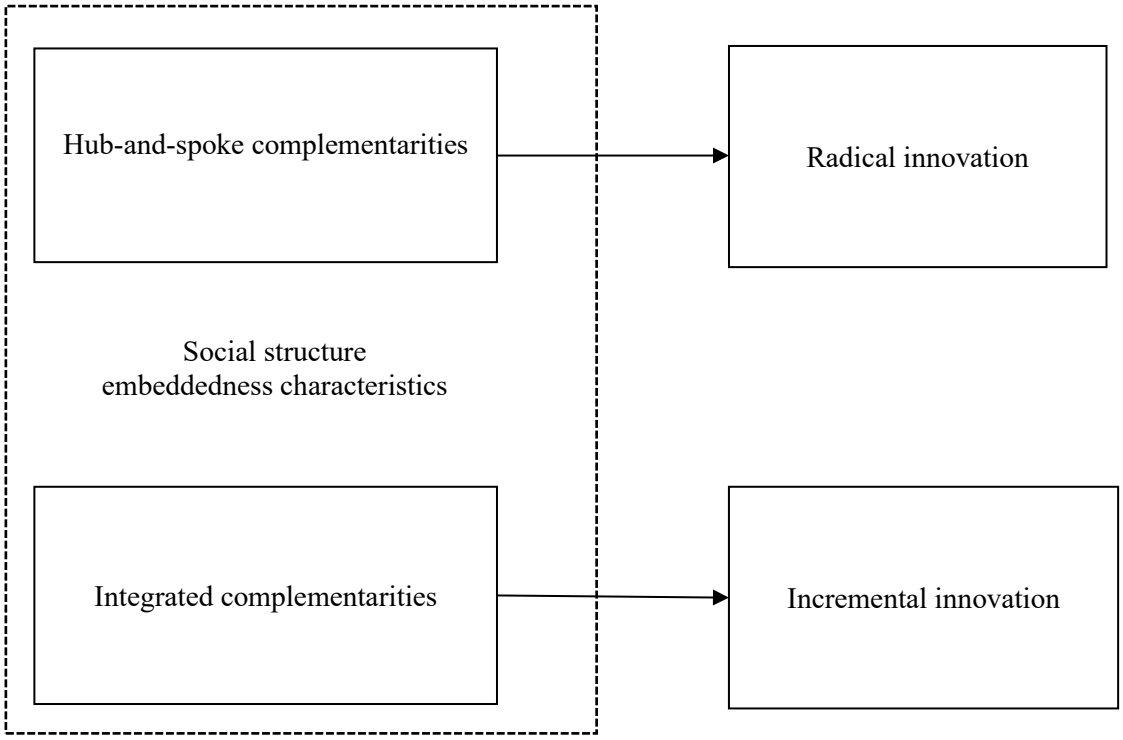


Figure 2.3 The impacts of component complementarity in ecosystems on firm's sustainable innovation

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Chapter 3: Research Design and Methods

China's new areas have been developing rapidly in recent years, playing a vital role in essential strategies and local economies. The establishment of the Xiong'an New Area in 2017 marked the development of the new area that has entered the new city model stage, putting forward higher requirements and challenges for developing the new area. As an essential part of the new areas, the new area residents enter a crucial carrier in transforming the new area's development model. In this new environment, new area resident enterprises need to respond to recent trends and seek sustainable innovation to meet the complex needs of the new area construction. Existing research suggests that sustainable innovation in new areas resident enterprises is not independent but needs to consider the patterns of component complementarity in the ecosystem. Therefore, this research focuses on the impact of the patterns of component complementarity on the sustainable innovation of enterprises in the new area, which is divided into the following two research areas: first, to explore the general rule of the patterns of component complementarity on the sustainable innovation of enterprises; second, to examine the differential impact of the patterns of component complementarity in the ecosystem on the sustainable innovation of enterprises.

For the sub-research one, this thesis adopts a multi-case study approach. The multi-case study approach follows the theoretical sampling principle and its underlying analytical logic is replication logic. In addition, our theoretical problem is to explore the different component complementarities in ecosystems and firms' sustainable innovation. Therefore, we need to select firms with different sustainable innovation behaviors and compare their component complementarity in order to generalize the pattern. In summary, we selected three companies as case studies, namely 36 Krypton Sichuan, Jiangxi City Construction, and Yun Litchi. These sample companies can be effectively replicated and compare.

36 Krypton Sichuan was established in April 2019 and is located in Wuhou Area, Chengdu. Based on Chengdu's business environment and excellent innovation and entrepreneurial dynamics, 36 Krypton Sichuan provides companies with media business, corporate venture capital services, and primary market data services.

Jiangxi City Construction was established in April 2019 and is located in Chengdu East New area. According to the Chengdu Municipal Government's eastward strategy requirements, Jiangxi City Construction is one of the nine integrated urban development operators in the "eastward" area. After entering the East New area, Jiangxi Urban Construction Company

adheres to the logic of "people, city, and industry.” It is responsible for the development and construction of Jiangxi North Area in Chengdu Tianfu International Airport New City, focusing on building an intelligent demonstration area in the future technology city of Chengdu East New area. Yun Litchi was established in April 2019, landing in Chengdu's Wuhou Area.

As a subsidiary of New Hope Group, Yun Litchi focuses on providing intelligent solutions for the cold chain logistics industry and building a big innovative cold chain platform in China. In the first quarter of 2021, Yun Litchi newly released a particular trunkline product, marking the first step of Yun Litchi's productized service. In summary, this research selects 36 Krypton Sichuan, Jiangxi City Construction, and Yun Litchi for a multi-case analysis to explore the general rule of components complementarities for sustainable innovation.

For the sub-research two, this thesis uses a policy capturing approach to construct a decision scenario on the patterns of component complementarity in the ecosystem. Ecosystems are formed by different players around a joint value proposition. Within an ecosystem, the patterns of component complementarity affect the process of business realization. To provide subjects with a complete scenario, we added three characteristics of the social network structural embeddedness, including centrality, structural autonomy, and structural equivalence to the patterns of component complementarity. The different attributes of structural embeddedness represent the different abilities of firms to access resources Hull information. The patterns of component complementarity and the structural embeddedness of social networks form a completer and more contextualized scenario. Managers we surveyed make judgments throughout the scene to test the differential impact of component complementarity on firms' sustainable innovation.

3.1 Research approach

The research objective of this study is to explore and test the mechanism of component complementarity on the sustainable innovation of the new area resident enterprises. Based on this, this chapter designs and plans the implementation plan for the subsequent study, which is described below.

Considering the increasing competition, firms increasingly need to focus on value creation. The value creation of a firm needs to be supported by sustainable innovation. As innovation becomes more and more open, it is increasingly difficult for a firm to innovate sustainably on its own. Innovation in firms requires not only internal improvements, but also the ability of other actors in the ecosystem to cooperate (Adner & Kapoor, 2010). In fact, in China's new

areas, innovation by the firm's resident in the new areas needs to be synergistic in terms of innovation output with the subjects of the ecosystem firms around the city's positioning of the new area. This has prompted researchers to wonder: what impact do ecosystems have on the sustainable innovation of new area residents?

Ecosystems, as an important form of interdependence between business management and the external environment, have received increasing attention from managers and scholars. However, not much research has been conducted on the distinction and measurement of ecosystems, and Shipilov and Gawer (2020) provides an operational theoretical framework for the distinction and measurement of ecosystems by drawing on well-established research on social networks. He draws on research on the structural characteristics of open and closed networks in social networks to categories the component complementarities that underpin the realization of value propositions, namely hub and spoke and integrated patterns of complementarity in ecosystem. This gives us an important insight into how sustainable innovation in firms has been much researched by social networks with different characteristics, what about ecosystems with different characteristics for sustainable innovation in firms? This raises the central question of our research: what is the impact of the different component complementarities on the sustainable innovation of firms located in the new area?

Of course, it is not possible to give reasonable hypotheses and test them based on existing theoretical studies on this important but novel issue. In order to ensure that the conclusions of this study have a fair degree of reliability and validity, the thesis is divided into two sub-researches. Sub-research one needs to answer： Q1 - How to explore the general pattern of the impact of the component complementarity in ecosystems on the sustainable innovation of the new area resident enterprises? Sub-research two needs to answer： Q2 - How to test the general pattern of the relationship between the component complementarity and radical and incremental innovation derived from the sub-research?

In response to the core objective of sub-research one, the thesis poses the following three questions.

Q1-1-What research methods are used to explore the general patterns of the impact of the component complementarity in ecosystems on the sustainable innovation of the companies located in the new area?

After referring to Eisenhardt (1989) and R. Yin (2004), this study argues that the case study approach can provide more insight into the details of how the component complementarity affects the sustainability of the businesses located in the new area. Compared to single-case

studies, multi-case studies are characterized by more accurate and reliable findings and more generalizability. At the same time, by comparing multiple cases, this study allows for the extension and iterative testing of findings (S. L. Brown & Eisenhardt, 1997).

Q1-2 - How to design a multi-case semi-structured interview outline?

Once the research method had been determined, a bespoke set of instruments for data collection was required based on the requirements of the research site and research method. A semi-structured interview questionnaire ensured the integrity of the case selection and data collection, in addition to the depth of the case study. In order to develop a semi-structured interview questionnaire suitable for this study, we conducted pre-research alongside the processing of literature and secondary data collection. The pre-research provided the necessary support for the researcher to gain a deeper understanding of the site and to make a preliminary judgement on the feasibility of the study and the pathway to conduct it. Based on this, and synthesizing the findings of Shipilov's (2020) and Boon's et al. (2013) other studies, this study identified semi-structured interview questionnaires around the ecosystem of projects and the perceptions of decision makers of companies moving into the new area, and conducted data collection in line with the requirements of a multi-case study approach. In addition, we drew on the coding commonly used in rooting theory to initially process the collected interview data to provide a basis for theoretical analysis.

Q1-3 - How to investigate the general pattern of component complementarity and radical and incremental innovation?

The innovation choices made by firms in deciding on the layout of projects in the new area need to take into account other actors in the ecosystem. By coding the interview data, we suggest that the radical and incremental innovation of the new area's resident firms can be conceptualized as 'lead layout' and 'synergistic layout'. In order to explore the general patterns of the impact of component complementarity on sustainable innovation in the new area, this study presents three new area layout projects with different performances and the component complementarity in ecosystems involved, and analyses the relationship between component complementarity and sustainable innovation in the new area from within and between cases (R. K. Yin, 2018). The intra-case analysis examines the relationship between component complementarity and sustainable corporate innovation. The intra-case analysis provides a systematic analysis of the components and innovations exhibited in each enterprise's project. The within-case analysis provides a systematic analysis of the components and innovations exhibited in each company's project. The conclusions of Study 1 are summarized through a systematic comparative analysis by judging the indicators of the variables of the case firms.

To ensure the integrity of this study, Sub-research two requires a test of the general patterns derived from the inductive comparison of multiple cases. This raises three questions for Sub-research two.

Q2-1 - What method is chosen for the test?

The behavioral choice between radical and incremental innovation for new area entrants is seen as a Contextual decision that requires a balance between macro and micro. The data collection research method should therefore provide a range of scenarios for the decision makers of the new area entrants to make appropriate decisions and judgements by assessing Contextual factors. Policy capturing not only restores details that are easily overlooked when making strategic decisions, but also allows the researcher to exercise some necessary control over the decision-making behavior of managers through the design of scenarios. In addition, it can avoid memory bias and other influences in questionnaires and interviews, and overcome the subjective influence of managers on decision making scenarios (Ireland et al., 1987; Karren et al., 2002). In addition, this study argues that policy capturing can also help decision makers to contextualize the more abstract concept of component complementarity.

Q2-2 - How to design a questionnaire for policy capturing?

Before designing a questionnaire for policy capturing, we first need to identify the complete theoretical scenario. Indeed, ecosystems have been receiving attention from industry and academia since their introduction into the field of strategic theory research by Moore (1993). Unlike the academic community, however, it is difficult for managers to distinguish ecosystems from concepts such as platforms, clusters and alliances. Therefore, we need to provide a complete theoretical scenario to help managers understand the concepts and the differences between them. Ecosystems and social networks are two of the most important manifestations of business management interdependence (Shipilov & Gawer, 2020). The elements of ecosystems and social networks enable the construction of more complete decision-making scenarios through the integrated description of multiple dimensions such as resources, information, and components. Synthesizing the interviews from multiple cases, we contextualized the theoretical concepts in relation to the research scenarios. Next, we iterated and adapted the questionnaire through pre-research and interviews with decision makers in several of the new area's resident companies, and provided uniform training to the research team members who administered the questionnaire. Finally, we conducted data collection and processing through the questionnaire.

Q2-3 - How to test the relationship between the component complementarity in ecosystems and the sustainable innovative behavior of the companies located in the new area?

The structure of the data obtained for this study based on the policy capturing questionnaire has the following characteristics: first, the values of each subject's decisions in each of the 16 scenarios are not independent; second, the combined effect of multiple factors on the subject's decisions cannot be excluded. Given the circumstances of the data, the statistical methods required for this study must be able to shed light on the relevance of the error terms in the statistical process. Among the existing statistical methods, SUR (Seeming Unrelated Regression) is able to meet these requirements well, and in comparison to traditional statistical methods, SUR also ensures that the results obtained without standard error clustering are essentially the same as those calculated by traditional statistical methods (Arceneaux & Nickerson, 2009). Therefore, the SUR method was used to examine the relationship between the different component complementarity and the sustainable innovation behavior of the enterprises in the new area. Table 3.1 summarizes the theoretical approach.

Table 3.1 Correspondence between research approach and specific objectives

Research questions	Specific objectives	Data Analysis Technique	Research Tools	Authors
1-1	a) Define the research method for the first sub-research	Pre-interview	Data Collection Instrument	Eisenhardt (1989); S. L. Brown and Eisenhardt (1997)
1-2	b) Develop and validate a semi-structural questionnaire for case data collection, based on the literatures about ecosystem and	Interview and secondary data collection	Data Collection Instrument	Adner and Kapoor (2010); Shipilov and Gawer (2020)
1-3	c) Investigate the relationship between component complementarities and sustainable innovation	Coding	Data Collection Instrument	Adner and Kapoor (2010); Shipilov and Gawer (2020)
2-1	d) Define the research method for the second sub-research	Trial Research	Data Collection Instrument	Gabriel, et.al, 2018
2-2	e) Develop and validate a PC questionnaire for data collection	Descriptive statistical analysis, Reliability Analysis	Data Collection Instrument	Adner and Kapoor (2010); Shipilov and Gawer (2020)
2-3	f) Test the relationship between component complementarities and sustainable innovation	Seemingly uncorrelated regression analysis	Data Collection Instrument	Arceneaux (2009); Boons et al. (2013)

3.2 Methods

3.2.1 Multi-case study

This thesis attempts to explore how component complementarity in ecosystems affects the sustainable innovation behavior of new area resident enterprises. Given that the research on the embeddedness of new area resident firms in the ecosystem is still in its infancy and there is a lack of relevant theoretical inquiry, sub-research one uses a case study approach to explore the influence mechanism. In addition, in order to sort out the relationship between different component complementarity in ecosystems on radical and incremental innovation, this thesis chooses a multiple case study approach to explore.

In fact, the case study approach is suitable for answering the "how" and "why" research questions (R. K. Yin, 2018). We aim to investigate the impact of the complementary ecosystem component structure on sustainable innovation in the new areas. The first step is to explore the mechanism of the complementary ecosystem component structure on sustainable innovation, which is a question of how. Second, case studies, as a standard qualitative research method, usually follow an inductive logic to explore complex and specific new phenomena emerging from management practices to effectively construct and validate new theories (R. K. Yin, 2018). This thesis attempts to identify general patterns of sustainable innovation behavior preferences of firms in new areas, which are rarely addressed in the existing literature. Therefore, a case study approach is appropriate (Bremner & Eisenhardt, 2021; McDonald & Eisenhardt, 2020).

Case studies can be classified based on the number of cases selected and divided into single-case and multiple-case studies (Bremner & Eisenhardt, 2021). Compared to single-case studies, multi-case analyses are more accurate, reliable, and general in their findings (Tidhar & Eisenhardt, 2020). At the same time, by comparing multiple cases, it can be verified that the results are not unique to a single point but can be repeated in various instances, thus extending and repeatedly validating the results (Katila et al., 2021).

There are several reasons for choosing multiple cases for this study: first, various firms can satisfy the saturation of the dependent variable and cover the different types of sustainable innovation behavior studied in this thesis; Second, numerous case studies add a degree of stability from conditions to outcomes, for example, the complementary structure of ecosystem components to the mechanisms of radical and incremental innovation behavior; Third, multiple cases can be compared with each other to ensure that the patterns found to hold in multiple situations, which helps to understand how the complementary structure of ecosystem

components acts on sustainable innovation in firms.

3.2.2 Theoretical deduction

The basic idea of the theoretical deduction is hypothesis testing logic. Through logical construction, deduces the speculative hypothesis to be tested and then uses the collected empirical data to verify the theory's truth. In trying a view, the idea does not directly use the empirical data collected to test the hypothesis to be an idea. Still, it needs to use deductive methods to deduce concrete, testable propositions from the abstract theory, rededicate the level of abstraction of the concept. This deductive logic, like inductive logic, draws on the research method of the natural sciences and applies to sociological research (Lakatos & Ji, 1980).

Theoretical testing in this thesis's research is to draw on deductive logic to obtain relatively concrete hypotheses from abstract theories. The test of the idea is achieved through the examination of the hypothesis. Therefore, this thesis takes the research question as its guide and explores the impact of the components complementary structure of the ecosystem on the sustainable innovation of the enterprises in the new area by searching, reading, and organizing the literature, as well as making principled selections from the theoretical perspectives in the literature. In summary, this thesis intends to use the ecosystem perspective as support and scientific guide for analyzing sustainable innovation in enterprises.

3.2.3 Policy capturing

Based on the particular scenario of this study, we have chosen an experimental scenario research method. This method allows us to observe the choices of business managers in different configurations of component complementarity in ecosystems and embedded social network structures. This approach has been widely used in sociology, organizational management, strategic management, and other areas of long-term applications (Eckerd et al., 2021; Gupta et al., 2019; Keding & Meissner, 2021).

This study uses a policy capturing approach. This is a collective term for a range of methods that are widely used in the field of strategic management research. The main form of the policy capturing approach is issuing a questionnaire. In the process of distributing the questionnaire, the researcher observes and examines how respondents understand and analyze contexts based on their judgments in different situations (Hitt et al., 2004; Zahra et al., 2000). A scenario is a researcher's "careful construction and description of a person, object or situation that represents a systematic combination of the various features of the study" (Atzmüller & Steiner, 2010). The

PC method has advantages over secondary data and traditional self-reporting. Closed decision contexts provide a highly controlled and reliable assessment of good performance, so that policy capturing methods can be observed separately for direct and interaction effects and carefully validated. In addition, indirect measures help to reduce subjects' social desirability issues and are less dependent on self-insight (Aiman-Smith et al., 2002; Karren et al., 2002).

The research method usually follows the following five steps: research design, research execution, analysis, interpretation of results, and reporting of results (Voigtsberger et al., 2019). In research design, we first need to identify the research question and gauge the method's suitability. Second, the decision problem must be real-life to ensure that it fits the real-life scenario; Also the selection of subjects needs to be representative, Hitt et al. (2004) selected 63 Chinese and 58 Russian business managers respectively in their study of firms' choice of alliance partners in the context of a transition system.

In addition, we need to avoid excessive correlation between scenario factors and too many contexts in terms of the selection, number, and interrelationship of scenario factors. The questionnaire was first adjusted through pre-research to ensure that the sun genuinely understood the menu's simple procedures during the mass distribution process when the study was executed. After the questionnaires have been collected, it is time to diagnose and evaluate the data, usually using methods such as Hierarchical Linear Models (HLM) and Seemingly Unrelated Regression Models (SUR). The regression results need to be understood and interpreted in the problem under study. Finally, the whole process of policy capturing is reported in full, describing the details of the process in as much detail as possible to make the study referable.

To explore the sustainable innovation choices of enterprises facing different patterns of component complementarity, this study needs to construct decision-making contexts through the combination of main influencing factors and tests the senior managers of enterprises with experience of entering new areas. This is a complex research process with conventional questionnaires and interview formats. Therefore, this study uses a Quasi-Experiment approach to test the decision making of senior managers of companies with experience in the new area and to analyze their influencing contexts and factors to verify the general patterns of the influence mechanisms of ecosystem components complementarities on sustainable innovation in companies obtained through a multi-case study approach.

3.3 Research objects

3.3.1 Qualitative research objects

Bremner and Eisenhardt (2021) suggests that replication law should be followed when selecting samples for multiple case studies, rather than the law of sampling followed in statistical analysis. At the same time, the selection of case companies needs to follow principles such as normality and typicality (Mao & Li, 2014). This approach requires a sample size that is not large and can be adjusted appropriately according to the research questions and theoretical areas involved. This thesis selected 36 Krypton Sichuan, Jiangxi City Construction, and Yun Litchi as the sample for the study, mainly considering the following factors.

First, to discover the general pattern of the component complementarity on sustainable innovation of enterprises, we deliberately selected three enterprises that showed apparent radical innovation behavior, incremental innovation behavior, or both in the development process. Second, the three firms belong to different industries, including technology and media, civil engineering and construction, and transportation. They have different firm sizes, ensuring the diversity of the sample and enhancing the generalizability of the study's findings. Third, given the research context of this thesis, all the selected case companies have experience in moving into a new area, which satisfies the scenario setting. Table 3.2 records the basic profiles of the three enterprises.

Table 3.2 Table of case companies in this study

Company name	Established	Nature of business	Business size	Industry
36 Krypton Sichuan Branch	2019	Private joint-stock companies	Medium-sized enterprises	Technology media industry
Chengdu Gao Xin Jiang Xi Urban Construction Company	2019	Other limited liability companies	Microenterprise	Property development industry
Chengdu Yun Litchi Technology Co.	2019	Private joint-stock companies	Small Business	Transportation

In summary, this thesis provides an in-depth analysis of these three case companies to explore the general patterns of complementary ecosystem components for sustainable innovation.

3.3.2 Quantitative research objects

The changing times and environment have put forward higher requirements for the development of enterprises. Whether traditional enterprises or emerging enterprises, mature enterprises or

start-ups, their long-term growth needs more innovative products to support. Among them, the enterprises settled in the new Area have strong particularity, mainly reflected in the following two points: First, the enterprises in the new area are introduced around the goal of the new area construction, which carries the purpose of the new area development; Second, the enterprises moving into the new area means entering a new environment, which needs continuous innovation to adapt to the new environment and new needs. This thesis selects the new area resident enterprises as the research object.

The quantitative study in this thesis uses a policy capturing approach to test the differential impact of the component complementarity on sustainable innovation in firms. This method differs from the usual questionnaire in that it must take into account the identity of the subjects, in addition to the restrictions imposed on the target company itself. For this study, top managers of companies with experience in the new area were selected to fill in the questionnaire. On the one hand, subjects need to have relevant innovation experience. We selected project personnel who have participated in or made decisions at least one or more times to start a new business through the survey. On the other hand, the subjects were the direct decision-makers of their projects or companies, including project managers, business leaders, company directors. In addition to this, companies from different industries, such as software and information technology services, real estate development, public safety, and healthcare, were selected to cover a wide range of sectors to ensure the study's validity.

3.4 Data collection

3.4.1 Case data collection

In this thesis, case data materials are obtained from multiple sources to meet the requirements of case study sources of information for the case study mainly consist of primary data and secondary data preliminary primary primarily obtained directly using interviews and inquiries, and the news media especially provide secondary data, commercial and government agencies, databases. Primary data is timely and credible, while secondary information is low-cost and quick to obtain. Combining the two sources makes the material obtained more adequate and accurate.

Specifically, the process of acquiring data for this thesis was divided into the following four stages: first, the research team entered the field in October 2019 to gain an extensive understanding of the research subject enterprises, among which three representative enterprises,

namely 36 Krypton Sichuan Branch, Chengdu Gaoxin Jiangxi City Construction Company, and Chengdu Yun Litchi Technology Co, Ltd, drew critical attention.

Second, secondary information was collected for the three typical case companies, mainly from the companies' official websites, press materials, WeChat tweets, and research reports. The data collected was collated and archived according to the research questions and ideas. Again, based on the knowledge accumulated in the early stage, the research team re-entered the research site in February 2020 to conduct focused interviews one after another. In conjunction with the research questions, interviews were conducted with senior or direct decision-makers of the company, such as the chairman and general manager.

Semi-structured interview questionnaires were created before each interview to ensure specific questions were brought into the field. We also have a special note-taker to take notes. After the interviews are completed, we will immediately document the recordings, go back over the questions, and make notes. Finally, depending on the needs of the study, we reach out to the company's partners and relevant department heads to conduct supplementary interviews to fill in the missing information. In addition to this, we maintain ongoing communication with companies to collaborate effectively and iterate on the research process and data collection process.

After the above four stages were completed, we summarized the data collected. Based on prior knowledge, this study focused on interviewing three case companies, namely 36 Krypton Sichuan, Jiangxi City Construction, and Yun Litchi. Table 3.3 records the time, subject, and length of each interview, as well as the word count of the recorded text.

Table 3.3 Interview material collection statistics

Serial number	Interviewed at	Companies interviewed	Interviewees	Length of interview /min	Word count for interview text /10,000 words
1	19 February 2020	36 Krypton Sichuan	Deng	22	0.22
2	22 February 2020		Chen	31	0.71
3	25 February 2020		Chang	60	1.32
4	23 August 2020		Cai	192	4.62
5	26 August 2020		Lan, Jiang, Dai	115	2.76
6	4 November 2020		Jia	45	1.08
7	26 August 2020	Heads of relevant departments in the new economy	Government Officer A	151	3.05
8	7 September 2020		Government Officer B	18	0.46
9	7 December 2020		Government Personnel C	14	0.36
10	23 September 2020	WISE Event Participating Companies	Business Personnel A	22	0.46
11	8 December 2020		Business Personnel B	5	0.11

12	9 February 2021	Jiangxi City Construction and its partners	Xu	65	1.35
13	9 February 2021		Zhao	56	1.22
14	28 August 2020		Zhang	45	1.1
15	22 October 2020		Shin	47	1.13
16	17 March 2021		Cao	53	1.2
17	17 March 2021		Dong	41	1
18	16 June 2021		Xiao	36	0.83
19	28 August 2020			24	0.25
20	22 October 2020		Teng	39	0.81
21	2 March 2021			60	1.34
22	6 November 2020		Ren	37	0.75
23	18 September 2021			114	2.63
24	15 February 2021		Cheng	86	1.51
25	13 April 2021			72	1.5
26	30 June 2021	Yun Litchi and its partners	Li, Teng	136	3.34
27	14 July 2021		Xu, Chen	191	4.72
28	21 July 2021		Huang, Li	144	3.5
29	23 July 2021		Fu, Yang	122	3.4
Total	29 interviews, 31 people interviewed, 2043 minutes of interview time, 444,100 words of interview text				

The secondary data for this thesis was collected mainly from companies and obtained online. They provided us with thesis-based information such as brochures, company profiles, and research reports in contacting companies.

In addition, we searched online and obtained information mainly from Baidu news, public websites, and the company's official website. Table 3.4 summarizes the sources, the number of articles, word count, and other information of secondary sources.

Table 3.4 Summary of secondary data statistics

		36 Krypton Sichuan	Jiangxi City Construction	Yun Litchi	Total
Baidu News	Time	2019 - Present	2019 - Present	2019 - Present	Established since
	Number of articles	34	19	6	59
	Word count (ten thousand)	4.5	1.8	0.58	6.88
WeChat Tweets	Number of articles	85	40	39	164
	Word count (ten thousand)	7.6	4.2	3.8	15.6
Businesses offer		Annual reports, corporate research reports, corporate-related promotional materials			

Note: The company names in the table are abbreviations

3.4.2 Questionnaire data collection

The main research question in the sub-research two is the influence of component complementarity in ecosystems on the sustainable innovation choices of the new area resident enterprises. Therefore, for selecting the sample, this study focused on selecting senior managers of resident enterprises in each new area in Chengdu, Sichuan Province, for the questionnaire distribution. There were several criteria for the respondents: first, the respondent's company had

to have practical landing experience in the new area. Second, the respondent must be a decision-maker or a core member of the decision-making team in the new area resident enterprise and have a good understanding of the whole process of moving into the new area.

After completing the questionnaire design, the research team conducted a pre-research questionnaire distribution in December 2020. Ten senior executives with experience in moving into the new area were selected for testing. This round of pre-survey was completed with a 100% return and validity rate, and from January to May 2021, the research team conducted a second round of large-scale questionnaire collection. Two researchers administered questionnaires to the top management teammate of the new area resident enterprises. This collection round was conducted entirely offline, with 39 questionnaires collected and 32 valid questionnaires, with an effective rate of 89.47%.

As the second round of collection samples mainly came from younger technology start-ups, several large established companies were selected for distribution in the third round of the pool in June 2021. This round was conducted in a combination of online and offline pairs, with a total of 22 questionnaires collected, of which 22 were valid, with an effective rate of 100%. Based on this, a total of 71 questionnaires were collected in this study, of which 64 were valid with an effective rate of 90.14%. Invalid questionnaires were due to subjects not filling them out carefully or having difficulty imagining the contexts' content. This study aggregated data from 64 businesspeople, each assessing methods and incremental innovation choices contexts, for a total sample size of 1024.

Table 3.5 shows the transcript of the questionnaire collection process. (The interviewees in the table have hidden their real names when forming the thesis because they are involved in the operation of the company).

Table 3.5 Record of the questionnaire collection process

Serial number	Stage	Time	Companies interviewed	Industry	Interviewees	Number of samples
1	The first collection of questionnaires (Pre-research)	10 December 2020	Spiegel Vision	Software and IT services	Cheng	16
2			Denying Bio	Technology Promotion and Application Services	Man	16
3			Walk the Talk IP Services Group	Technology Promotion and Application Services	LEUNG	16
4			Instead	Software and IT services	Zhang	16
5			AliCloud	Technology Promotion and Application Services	Cheng	16
6			Blueprint digital construction	Building decoration, renovation, and other construction industries	Cheng	16
7		15 December 2020	Chengdu Jiaotong Jianshou New Town Integrated Operation	Property development industry	Zhang	16
8			Comprehensive development of the Tianfu Olympic Sports City area	Property development industry	Wang	16
9			Chengdu Huantou Jianzhou New City Urban Operation	Property development industry	Liu	16
10			Chengdu Xingcheng Jianzhou Investment and Operation	Property development industry	Wang	16
11	The second collection of questionnaires	25 January 2021	Jiangxi Urban Development	Property development industry	Zhang, Wang	32
12			Habitat for Humanity	Building decoration and renovation industry	Sun	16
13			Joyous Skyhorse	Services	Wang	16
14		31 March 2021	Sun Sea Cloud Monitor	Software and IT services	Cui, Sun	32
15			Hershey Hi-Tech	Professional and technical services	Jiang	16

16		Julang Technology Co.	Software and IT services	Hu	16
17		Viva Technology	Software and IT services	Yang	16
18		Central Technology	Technology Promotion and Application Services	Xue	16
19	2 April 2021	Holy Point Century Technology	Technology Promotion and Application Services	Pope, Wang	32
20		New West Soft Technology	Software and IT services	Jiang	16
21		China Merchants International Tender	Professional and technical services	KWOK	16
22		Bing Sen Hongye	Public safety industry	Chen	16
23	15 April 2021	Huayu Dental	Medical industry	Gao	16
24		Wingfeather Vision Technology	Software and IT services	Hu	16
25		Chuansheng Fire	Public safety industry	Gao	16
26	16 April 2021	Precision Position Technology	Research and experimental development	Zhou	16
27	20 April 2021	Goldwise Home Technologies	Software and IT services	Li	16
28		Ort Cloud	Software and IT services	Hong	16
29		Bajan Interactive	Research and experimental development	Chen	16
30		Bailiwick Technology	Wholesale trade	Yang	16
31		AoFast Technology	Software and IT services	Xu	16
32	23 April 2021	Pickup Technology	Software and IT services	Wang	16
33		Elfball Environmental	Professional and technical services	Zhang	16
34		Foley Tongda	Wholesale trade	Luan	16
35		Yugtronics	Research and experimental development	James	16
36	29 April 2021	The Turing Era	Technology Promotion and Application Services	Zhang	16
37		Jusco Human Resources Consulting	Consulting	Pope	16
38	19 May 2021	Hazel Capital	Financial Services	Song	16

39			Kanos sculpture	Wholesale trade	Xu	16
40			Aimeng Technology	Software and IT services	Woo	16
41			Bovis twins	Internet and related services	Valley	16
42		20 May 2021	To Cloud Technology	Research and experimental development	Yang	16
43		2 June 2021	The Great Way Robot	Technology Promotion and Application Services	Wang	16
44			Chengdu Rong'e Supply Chain Group	Business Services	Rowe	16
45		3 June 2021	Chengdu Taste of Things Design Co.	Professional and technical services	Wang	16
46			Tianfu Yuan Brand Marketing Planning	Business Services	Li	16
47			Xingcheng Culture	Other financial services	Fan	16
48		4 June 2021	China Railway ICT (High-Speed Rail Advertising)	Technology Promotion and Application Services	Li	16
49	The third collection of questionnaires		Huangguoshu Central Kitchen	Catering	Yuan	16
50		5 June 2021	Tianfu Fund	Capital Markets Services	Hu	16
51			Jiu San Science and Technology	Research and experimental development	Li	16
52			Jones Lang LaSalle	Real estate	Xu	16
53		9 June 2021	Gulin Langjiu	Wine and beverage manufacturing	Wang	16
54			China Resources Financing	Financial Services	Yang	16
55			Prosperity City Development Limited	Professional and technical services	HO	16
56		26 June 2021	Qianhai United Network Technology	Internet and related services	Wang	16
57			Sichuan Benchmark Electric	Electrical machinery and equipment manufacturing	Hu	16

58		Chengdu XUNHE Technology	Software and IT services	Zhou	16
59		Bingo Valley	Broadcast and film production industry	Bin	16
60		Yuanda Property Group	Real estate	Cai	16
61		Habitat for Humanity	Real estate	Zhang	16
62	7 July 2021	Shenzhen Capital Operation Group	Business Services	Lou	16
63		Chengdu Construction Group	Construction and installation industry	Yang	16
64	23 July 2021	Habitat for Humanity	Real estate	Hu	16
Total	64 valid questionnaires, full sample data size 1024				

The questionnaire collection process in this work strictly followed the steps of policy capturing to ensure its reliability and validity. The specific process was as follows in the attachment. The process of questionnaire collection is provided in Annex A, and the questionnaire is provided in Annex B.

3.5 Variable description

3.5.1 Description of case study variables

(1) Radical versus incremental innovation

Existing research classifies innovation as radical or incremental, depending on the degree of innovation (Ettlie et al., 1984). Mirata and Emtairah (2005) define radical innovation as creating something new that disrupts the existing ecosystem. Specifically, enterprises jump out of the current cooperation model and do a few previous projects to explore further cooperation modes and market potential. Novelty, uniqueness, and must be adopted are commonly used as three criteria for identifying radical innovations (Dahlin & Behrens, 2005). Aldrich and Fiol (1994) define incremental innovation as to how firms reorganize previously established technologies and market relationships. This is done by responding to existing cooperation projects, and market needs to improve the efficiency of project cooperation models or market product areas.

(2) Hub-spoke versus integrated complementarity

Adner (2017) states that ecosystems are synergistic arrangements between actors with multilateral collaborative partnerships and non-generic complementarities to achieve core value propositions. In recent years, scholars have begun to focus on the critical role of components in ecosystems. Ander notes that non-generic complementarities between components are essential to ecosystems and make their existence possible. The interdependencies between components in an ecosystem can be effectively expressed in the patterns of component complementarity.

This thesis classifies the patterns of component complementarity as Hub and Spoke Complementary and Integrated complementarity, based on Shipilov and Gawer’s (2020) literature. Both patterns of component complementarity are more concerned with the interdependence between external components in the project that are interdependent with the firm's components. Hub and Spoke complementarity is formed when there is consumption or production complementarity between components A and B, and A and C, but not between components B and C. If there is no such complementarity between the three components, then

there is a Hub and Spoke complementarity between the three components. Conversely, if there is consumption or production complementarity between all three components, then the three components exhibit integrated complementarity with each other. In other words, if no interdependencies are established between the external components, this pattern of component complementarity is a hub-spoke complementarity. If the external components are interdependent, component complementarity is integrated.

3.5.2 Measurements of questionnaire variables

The questionnaire design process for this study, based on a policy capturing approach, is as follows. Based on existing research, this work recognizes that new area. Resident enterprises need to balance radical and incremental innovation to achieve sustainable innovation. Second, to closely describe the state of interdependence between the internal and external environment in a realistic scenario, this study selected five factors that constitute the scenario of decision making, such as Hub and spoke and integrated complementarity in the component complementarity in ecosystems, centrality, structural autonomy, and structural equivalence embedded in the social network, based on ecosystem theory and social network theory. Each scenario factor was assigned a value of 0 or 1, indicating insignificant and significant characteristics, respectively, and constituting 2^5(32) different contexts of sustainable innovation.

The key to the policy capturing research method is the design of the scenario questionnaire, and the interpretation of the variables in the scenario questionnaire will directly affect the subjects' understanding of the questionnaire and the scenario. This work combines theory and practice to explain the variables (Table 3.6).

Table 3.6 Description of questionnaire scenario variables

Questionnaire	Variable name	Explanation of variables
Behavioral choices	Collaborative layout	Companies respond to the innovation needs of others, seeking supply and demand gaps and synergies
	Lead layout	Companies initiate innovation targets, explore potential models and lead the way
Contextual variables	Hub and Spoke complementarity	Interdependent structures in the external components required to implement the business
	Integrated complementarity	Interlinked structures in the external components required to implement the business
	Centrality	Centrality refers to the position of an individual participant in the network. It indicates the extent to which the actor at the center of the network occupies a central role by participating in many vital connections.
	Structural autonomy	Structural autonomy is derived from the study of structural holes, where subjects possessing structural autonomy have structural holes between other subjects connected to them but not at their ends.

	Structural equivalence	Structural equivalence is the degree of similarity between the network patterns of two subjects; the more significant the similarity, the greater the structural equivalence of these subjects.
	Business size	The size of the business is determined by the number of employees, one if the number is under 50, 2 if the number is between 50 and 99, 3 if the number is between 100 and 299, 4 if the number is between 300 and 999, and 5 if the number is over 1000.
	Operating time	One is in business for less than three years, two if between 3 and 5 years, three if between 5 and 10 years, four if between 10 and 20 years, and five if more than 20 years.
Control variable	Level of competition in the industry	There are five levels according to the level of competition: very low, low, average, high, and very high, representing 1-5 respectively.
	Corporate Impact	There are five levels of influence: very small, small, average, large, and huge, representing 1-5, respectively.
	State-owned enterprises	One if the nature of the enterprise is state-owned, 0 otherwise.
	Foreign-owned enterprises	One if the nature of the enterprise is foreign owned, 0 otherwise.
	High-tech companies	One type of business to which the company belongs is high-tech, 0 otherwise.

First, the dependent variables in this study are incremental and radical innovation. Incremental innovation improves an existing product market segment by responding to existing customers and markets (Aldrich & Fiol, 1994). Radical innovation typically disrupts current market positions and builds new market opportunities (Boons et al., 2013). Based on the understanding of this scenario in the new area, this study considers that the incremental innovation of the companies in the new area is more in response to the current innovation needs of others, taking on the role of collaborators. It, therefore, uses the term "collaborative layout" to indicate incremental innovation. Similarly, radical innovation in the new area is represented by the firms' initiative to initiate innovation goals in the new area, taking a leading role, hence the use of 'lead layout' to represent radical innovation in the questionnaire.

Second, the Contextual factors studied in the questionnaire are the components complementarity patterns and the structural embedded characteristics. Specifically, the patterns of component complementarity include Hub and Spoke Complementarity and integrated complementarities. Shipilov and Gawer (2020) argue that when there is consumption or production complementarity between component A and component B and between component A and component C, but not between component B and component C, then there is a Hub and Spoke complementarity between these three components. If there is consumption or production complementarity between all three components, then the three components exhibit integrated complementarity. In short, Hub and Spoke and integrated complementarity can be described as

mutually independent or interlinked structures within the external components required to realize a business.

Characteristics of structural embeddedness in social networks include centrality, structural autonomy, and structural equivalence. Centrality refers to the position of an individual participant in a network. It indicates the extent to which an actor at the center of the network occupies a central role by participating in many vital connections (Kuskova & Wasserman, 2020). Structural autonomy is derived from the study of structural holes, where subjects with structural autonomy have structural holes between other subjects connected to them but not at their ends (R. S. Burt, 2001). Structural equivalence is the degree of similarity between the network patterns of two subjects; the more significant the similarity, the greater the structural equivalence of these subjects (Baishya & Samalia, 2020; Ouellet et al., 2019). The interpretation of these three variables is equally viable in the new area, so we continue to follow that statement in the questionnaire.

Finally, the study selected the control variables: enterprise size, operation time, industry competition degree, enterprise influence, enterprise nature, enterprise type, and industry. According to the existing literature, these factors may contribute to differences in firms' ability to access resources and information, influencing preferences in the choice of sustainable innovation behavior.

Chapter 4: Component Complementarity in Ecosystems and Firm's Sustainable Innovation: Multi-case Study

This chapter focuses on exploring sub-research one, i.e., exploring the mechanisms that influence the component complementarity in ecosystem on the sustainable innovation of the resident enterprises in the new area. Specifically, this chapter adopts a multi-case study approach to conduct a comparative analysis of the component complementarity of the three firms and their sustainable innovation. The structure of the study indicates that the hub and spoke complementarity is conducive to the development of radical innovation of the enterprises, and the integrated complementarity is conducive to the development of incremental innovation of the enterprises.

4.1 Intra-case analysis: case description

Companies have two options when laying out new projects in a new area. One is for the new area resident enterprises to lead in laying out new projects in the new area, with the other participating entities working in tandem with them. The other is that other subjects show new projects, and the new area resident enterprises are more collaborative with other subjects to layout projects. The choice of whether a new area occupant enterprise takes the lead or collaborates in the location of new projects is more influenced by the component complementarity in the ecosystem in the new area (Shipilov & Gawer, 2020). Different components mean they play different roles in firms' placement of new projects. Components often draw on the capabilities of other organizations, have other economies, and therefore influence various innovations (Buenechea‐Elberdin et al., 2018).

The within-case analysis focuses on 36 Kr Sichuan, Jiangxi City Construction, and Yun Litchi, using each project in the development process as the basic unit of analysis and analyzing which components in the ecosystem each project needs to support its layout on the ground. Also, this section provides a summary description of the sustainable innovations demonstrated in each project.

4.1.1 36 Kr Sichuan case

In April 2019, 36 Kr officially settled in Wuhou Area, Chengdu. 36 Kr Sichuan is based on Chengdu's business environment and excellent innovation and entrepreneurial dynamics, based on the media business, corporate venture capital services, primary market data services, industrial innovation center, to serve the growth of enterprises and promote local economic development.

In the course of 36 Kr Sichuan's action, it has undertaken the 2019 WISE Chengdu New Economy and New Products Promotion Project, Sichuan Telecom's 5G Double Gigabit + Industrial Internet Project, the 2020 China Digital Economy Investment and Financing Matchmaking Project, and the "Navigating the Future, Digital Intelligence, and High-Tech" New Economy Enterprise Development Promotion Project.

The Chengdu New Economic Committee (CNEC) has long been weak in nurturing lo, cal new economy companies and challenging to attract foreign investment. 36 Kr Sichuan worked with CNEC after landing on the site. It took the lead in organizing the Chengdu New Economy and New Products Presentation at WISE 2019, using its resource matching component to its advantage. Before the event, 36 Kr Sichuan released the link to purchase tickets, information on the list selection, and guests' personal information. The public needs to select the outstanding companies from hundreds or even thousands of companies, special list selection component, and conduct unique visits to the companies on the list.

36 Kr Sichuan will invite Chengdu city leaders, executives of new economy companies, startup executives, investment institutions, investors, and other subjects as guests to deliver thematic speech content output at the conference site, playing a project thematic speech component. This project also has a product display component, which can provide an opportunity for Chengdu's new economy enterprises to display their products and dock to the national market, and also offer a platform for Chengdu's area and county governments to publicize their policies on attracting investment and talent and play the advantage of policy promotion component. This promotion, the first time 36 Kr Sichuan and a local government have cooperated, goes beyond the existing business cooperation model of the companies and is a gradual process of both sides exploring new cooperation models.

On May 15, 2020, 36 Kr Sichuan and Sichuan Telecom cooperated on the 5G double gigabit and industrial Internet project. 36 Kr Sichuan, Sichuan Telecom, and other subjects took advantage of undertaking the event component, inviting academia, industry and technology companies, and other industry subjects to actively dialogue on 5G, new infrastructure, industrial

Internet, and other related topics for in-depth discussion.

Lu zhou Laojiao, Foxconn, Siemens, Tong wei Solar, Tian yi, Kang he, and other companies and Sichuan Telecom cooperated in providing trial contexts for the industrial internet and playing the component of project contexts provision. HD video + AI, 5G, and other technologies to promote the industrial Internet, medical, education, cultural tourism, and other fields of the production environment, production lines, and other data and information processing through the technology-enabled component. 5G network enables Lu zhou Laojiao robots to make and load wine, supporting production and manufacturing. Foxconn's Shenzhen campus has tried out various contexts for new 5G applications to improve the operational efficiency of 5G in the industrial internet sector.

Meanwhile, China Telecom launched the "5G+Cloud+AI" New Crown Pneumonia Intelligent Assist Analysis System, used in frontline contexts like Huoshen Mountain, Leishen Mountain, Wuhan Tongji, and Xiehe to provide testing efficiency. With the digital transformation of industry in all sectors, the demand for 5G+industrial internet wireless usage contexts is also growing, and the technology R&D component will play a more critical role. Sichuan Telecom leads the landing of this project, and 36 Kr Sichuan uses its advantages as a collaborator to promote the project.

36 Kr Sichuan also cooperates with Sichuan's Internet Information Office on the 2020 China Digital Economy Investment and Financing Matchmaking Project. This project is a platform for the government, digital economy enterprises and investment institutions, experts in the economic field, and other subjects to build a communication platform for investment and financing services and promote in-depth matchmaking between well-known investment institutions and outstanding enterprises in Sichuan Province. This project can enhance the efficiency of investment and financing docking and encourage the integration of scientific and technological innovation and quality capital through the project roadshow component.

The provincial Internet Information Office and other central bodies played the project screening component. They screened out 6 Sichuan Internet enterprises in advance, such as Chengdu Digital Union Technology Co Ltd and Chengdu Lian’an Technology Co Ltd, to conduct project roadshows on-site according to their advantages and characteristics, with representatives of well-known investment and financing institutions and experts attending the meeting on site. Representatives from several top investment institutions across the country such as China Internet Investment Fund, Matrix Partners China, Innovation Works, and other well-known domestic investment and financing institutions played investment service component, and new economy experts conducted project review component on the projects

participating in the roadshows through online and offline linkage.

In addition to the "Cloud Roadshow" event, 36 Kr Sichuan, together with China's digital economy investment and financing institutions, continue to lead the promotion of related activities and hold summits, signing ceremonies, and other offline activities, to take advantage of the component of undertaking activities, but also the timely organization of investment and financing institutions for field visits and other activities.

With the rapid changes in the external environment, the emergence of new technologies, the rapid iterations of business models, and the increasingly competitive marketplace, on 7 August 2020, 36 Kr Sichuan and the Chengdu High-tech Area New Economy Development Bureau hosted the Chengdu High-tech Institute of Big Data and Intelligent Industry to host the "Navigating the Future of Digital Intelligence in High-tech" new economy and enterprise development program. Chengdu High-tech Area is home to many new economy enterprises. However, the cultivation, training, and digital transformation of new-economy enterprises in the area are still important challenges in the development process of these enterprises. Based on this demand, 36 Kr Sichuan and other subjects actively component to undertake the event and undertake this New Economy and Enterprise Development Conference.

The conference invited Professor Yongjian Pu and well-known investor Wei Zhu to share a professional content component on the macro trends of the market and the strategic development of new economic enterprises in the post-epidemic era from the academic perspective and professional capital perspective. At the same time, 36 Kr Sichuan also invited professional training institutions to perform a training component for new-economy enterprises in the high-tech area. By providing components through contexts, these new economy enterprises are allowed to enter real contexts inside to experience the impact of the digital economy, big data technology on their business models, thereby helping them successfully transform and upgrade and seize the advantages of the digital economy wave.

In summary, after 36 Kr Sichuan landed in Chengdu's Wuhou Area, it mainly carried out the 2019 WISE Chengdu New Economy and New Products Promotion Project, Sichuan Telecom's 5G Double Gigabit + Industrial Internet Project, the 2020 China Digital Economy Investment and Financing Matchmaking Project, and the "Navigating the Future, Digital Intelligence and High-Tech" New Economy and Enterprise Development during the development process. A summary of the ecosystem components and sustainable innovation in these projects is shown in Table 4.1.

Table 4.1 Summary of the ecosystem components and sustainable innovations in projects

Company Name	Projects	Components	Sustainable innovation
36 Kr Sichuan	WISE 2019 Chengdu New Economy and New Products Promotion Project	The implementation of this project requires an ecosystem of resource links, list selection, presentations, policy advocacy, and product showcases.	This project is the first time 36 Kr Sichuan has worked with a local government on a project and the first time that the government has participated in a presentation where the two sides gradually explored new modes of cooperation collaboratively.
	Sichuan Telecom 5G Dual Gigabit + Industrial Internet Project	The implementation of this project requires an ecosystem of event-taking, scenario-providing, technology enabling, and technology research and development components to support the project together.	This project is a Sichuan Telecom-led project, and 36 Kr Sichuan is more of a collaborative effort with Sichuan Telecom to promote the project.
	2020 China Digital Economy Investment and Financing Matchmaking Programme	The implementation of this project is supported by an ecosystem of event-taking, project screening, project roadshows, reviews, and investment services.	This project is a joint project between 36 Kr Sichuan and the Sichuan Provincial Internet Information Office, and 36 Kr Sichuan has been active as a partner in the development of the project during the cooperation process.
	"Navigating the Future, Digital Intelligence and High-Tech" New Economy and Enterprise Development Seminar Programme	The implementation of this project requires an ecosystem of event-taking, content-sharing, scenario-providing, and training components to support the project together.	This project is a joint project between 36 Kr Sichuan and the New Economic Development Bureau of Chengdu High-tech Area, and 36 Kr is a collaborator in this project.
Jiangxi Urban Construction	China-Israel (Chengdu) Country Park Projects	The layout and implementation of this project require an ecosystem of integrated city operation components, research support components, investment operation components, talent import components, technology service components, and IPO coaching component support.	This project is the process of Jiangxi Urban Construction taking the lead in trying out new business models without complete clarity on the industrial planning of the new eastern area.
	AliCloud iM2 Global First Store Project	The layout and implementation of this project require an ecosystem of integrated urban operation components, resulting in transformation components,	This is a new cooperation project led by Jiangxi Urban Construction and Ali Cloud. The project model was not previously planned clearly, and it

		science, and technology service components, and resource import components to support.	is a process of exploration led by both sides together.
	Shibandeng Town, Lujia Town Community Projects	The layout of this project requires an ecosystem of project implementation components, survey components, design components, and construction contracting components to come together to support it.	As the main body for implementing the project, Jiangxi Urban Construction takes the overall lead in the performance of this project on the ground, and each body works together to explore new modes of business cooperation.
	Dry Product Project of Yun Litchi	The implementation of this project requires an ecosystem of platform support components, one-click ordering components, shipping components, and monitoring components to support the project together.	This project is a collaborative layout of multiple subjects such as Yun Litchi and carriers, monitoring agencies. It is a project that is promoted by all subjects in concert.
Yun Litchi	Distribution Product Project of Yun Litchi	The implementation of this project requires an ecosystem of distribution, storage, packaging, sorting, and transit components to support the project.	This project is a collaborative layout project between Yun Litchi and several participating entities and is a joint effort between multiple parties to drive the project's growth.
	Warehouse Product Project of Yun Litchi	The implementation of this project requires an ecosystem of storage, monitoring, technical support, and distribution components to support it together.	In this project, Yun Litchi is essentially responsible for services and actively cooperates with other subjects to promote the project's implementation.

4.1.2 Jiangxi Urban Construction case

Established in April 2019, Jiangxi Urban Construction is a joint venture between Chengdu High-Tech Investment Group Limited and Chengdu Xingcheng Habitat for Humanity Real Estate Investment Group Limited. Following Chengdu's eastward strategy requirements, Jiangxi Urban Construction has landed in Chengdu's East New area and become one of the nine integrated urban development operators in the "eastward" area.

Jiangxi Urban Construction is mainly responsible for developing and constructing the Jiangxi North Area of Chengdu Tianfu International Airport ew City and creating the Future Science and Technology City Smart Manufacturing Demonstration Area in Chengdu East New Area. Jiangxi Urban Construction mainly engaged in the China-Israel (Chengdu) Country Park project, Ali Cloud iM2 Global First Store project, and community projects in Shibandeng Town and Lujia Town in the East New area.

As one of the nine integrated urban development operators in the "Eastward" area, Jiangxi Urban Construction has established the China-Israel (Chengdu) Country Park in cooperation with Israeli companies, taking into account its own corporate history and the characteristics of the area. The country park has a global perspective and links to high-end international and domestic innovation resources, providing innovation resources for many enterprises.

Jiangxi City Construction plays its own urban integrated operation component and leads the country park to thrive in the direction of aerospace, intelligent manufacturing, new materials, and other industries. Companies such as Chengdu Xingcheng Investment Group and Chengdu High-Tech Investment Group are responsible for project investment and operation component; Scientific research institutions such as the University of Electronic Science and Technology and Jiusan Society provide academic and scientific research support components; Institutions such as the Sichuan Thousand Talents Plan Experts Association and the Israeli Consulate General in Chengdu provide talent and industrial resources import component; Subjects such as Ali Cloud provide science and technology services component; Fosun Group provides listing counseling component.

These entities are actively building the main ecological engine of "innovation-R&D-transformation" in the country park, gradually realizing the platform hub component of the country park, effectively linking the education and talent chains with the industrial chain, supply chain, and innovation chain, cultivating the "New Born New Emergence. "This has led to the continuous maturation of new industries.

In the country park, Jiangxi Urban Construction has joined hands with AliCloud to build

the AliCloud iM2 Global First Store project, the world's first high-quality science and innovation space and new industrial complex with "scene incubation + new retail + future community-integrated innovation." iM2 Global First Store project aims to build a unique retail experience scene with the main groups being Post-95 and post-00 generation consumer groups.

In leading the landing of this project, Jiangxi City Construction has signed agreements with the University of Electronic Science and Technology and the Israel Research Centre of the University of Electronic Science and Technology to provide scientific research support and scientific research results transformation components for the project; the Management Committee of the High-tech Area provides policy support component for the project; enterprises such as Jiusan Technology Community and Infinity Capital provide scientific and technological service component; Sichuan Thousand Talents Program Experts Association, Consulate General of Israel in Chengdu, Ali Cloud and other institutions to provide talent, industry, technology, Israeli quality enterprises, and other quality resources import component; The iM2 project led by Jiangxi Urban Construction follows the trend of consumer upgrading and provides an immersive user consumption experience of "new retail + black technology."

Jiangxi City Construction also actively undertakes community engineering projects such as the community engineering project of Shibanzhi Town (Phase I) and the community engineering project of Lujia Town (Phase I). As the main body for implementing the two community engineering projects, Jiangxi City Construction takes the lead and is specifically responsible for the development and construction of the projects and sales and other matters and undertakes the project implementation component. To Chengdu High Investment Construction and Development Co., Ltd. as the project bidders, openly bids for component units such as survey, design, and construction contracts that meet the project conditions to promote the project development.

Among them, the survey component mainly involves the measurement and mapping of external power lines such as ring network cabinets; the design component mainly involves scheme design, planning plan design, and construction plan design; Construction contracting component mainly involve residential and kindergarten, elementary school, community complex, commercial, underground garage, municipal roads, and other public construction support projects.

In summary, Jiangxi Urban Construction was established in the East New area due to Chengdu's "Eastward" strategic planning. Its development has taken the lead in laying out the China-Israel (Chengdu) Country Park project, the Ali Cloud iM2 Global First Store project, and community projects in Shibanzhi and Lujia towns. The ecosystem components and sustainable

innovation in these projects are summarized in Table 4.1.

4.1.3 Yun Litchi case

Founded in April 2019, Yun Litchi is a technology-based company in the smart logistics industry. The company's team consists of experts from the Ali family. Algorithmic matching can quickly match people, vehicles, roads, goods, and warehouses to provide intelligent solutions for the cold chain logistics industry. The company offers a full range of cold chain storage and transportation services, with 52 offline operations and a nationwide network. During Yun Litchi, it has mainly laid out dry, distribution, and warehouse products projects.

At the beginning of 2021, Yun Litchi released a new dedicated trunk truck product, followed by the launch of a trunk LTL product, which together form the Dry Product, marking the first step towards product serviceability. The dry product project integrates more than 70,000 vehicles across the country on top of the platform, achieving nationwide coverage of cold chain trunk lines, building the country's largest cold chain trunk transport network, and providing platform support and transport components for product transportation nationwide. By integrating vehicle resources and complex chain product resources, users can place orders online according to their needs, and carriers can take orders online.

The products required by users can be quickly delivered to industrial and production enterprises in 34 provinces and 645 cities and counties across China, effectively solving the problems of slow product transportation and difficult delivery across the country in the process. Through the use of SaaS system clusters such as OMS, TMS, WMS, BMS, and CRM, the platform can monitor orders online during the entire process of product storage, order placement, and transportation.

The Yun Litchi uses an intelligent solution for shop demand forecasting and minimum storage management in projects using digital means when distributing the products. The distribution product has established more than 200,000 reach sites across the country, enabling "same-day" delivery to more than 30 core cities and "next-day" delivery to more than 600 cities and counties, solving the problems of low city coverage and difficult time control. Across the country, the project has built over 240,000 square meters of warehouses, undertaking storage components such as dry storage, refrigerated storage, constant temperature storage, frozen storage, and essential kitchens.

The products in the warehouses can be quickly delivered to customers such as food and beverage retailers and new food e-commerce companies through specialized packaging, sorting, and transit components, effectively solving problems such as low distribution efficiency and

fluctuating volumes.

The warehouse product mainly undertakes warehousing components and has advantages such as multi-story in the same city, multi-temperature area coverage, multi-component value-added services, fixed storage management, and standard pricing. Subsequently, with the arrival of the 5G era, the importance of information technology for the cold chain logistics industry will be more prominent, effectively solving the pain points of the warehouse product project such as the significant influence of area, high-temperature area requirements, and complex flexible billing.

Through the WMS intelligent warehouse management system for warehouse supervision cloud warehouse interconnection, Yun Litchi owns more than 50,000 vehicles and a three-temperature warehouse of 300,000 square meters. At the same time, through the distribution component, the products are sent to be reached to target customers such as catering, retail, e-commerce, community group buying type enterprises.

In summary, Yun Litchi is building a modern intelligent logistics service network that integrates warehousing, distribution, and processing. Yun Litchi has mainly laid out projects for the dry product, distribution product, and warehouse product in the development process. A summary of the components and sustainable innovation in these projects is shown in Table 4.1.

4.2 Intra-case analysis: case mining

This work provides a comprehensive overview of the ecosystem components and sustainable innovation in each of the projects implemented in the company through an in-case analysis. The result then analyses whether each project exhibits a hub and spoke and integrated complementarity and whether the project exhibits radical or incremental innovation to obtain the type of component complementarity pattern and the type of sustainable innovation for the enterprise as a whole.

4.2.1 36 Kr Sichuan case

36 Kr Sichuan and the Chengdu New Economy Committee jointly promote the 2019 WISE Chengdu New Economy New Products Promotion Conference, where 36 Kr Sichuan plays the advantage of linking resources to attract new economy companies, investors and investment institutions, and other subjects to attend the conference and make a list selection of the companies on the list.

Outstanding entrepreneurs, start-ups, and local governments were invited to give

presentations and product demonstrations, and the government took the opportunity to promote information on investment attraction and more. From the point of view of the pattern of component complementarities, there is an interdependence between the resource linking component, the list selection component, the particular lecture component, the policy promotion component, and the product display component. However, there is no close interdependence between these components except the special lecture and policy promotion components. As a result, the project has a hub and spoke complementarities, as shown in Figure 4.1.

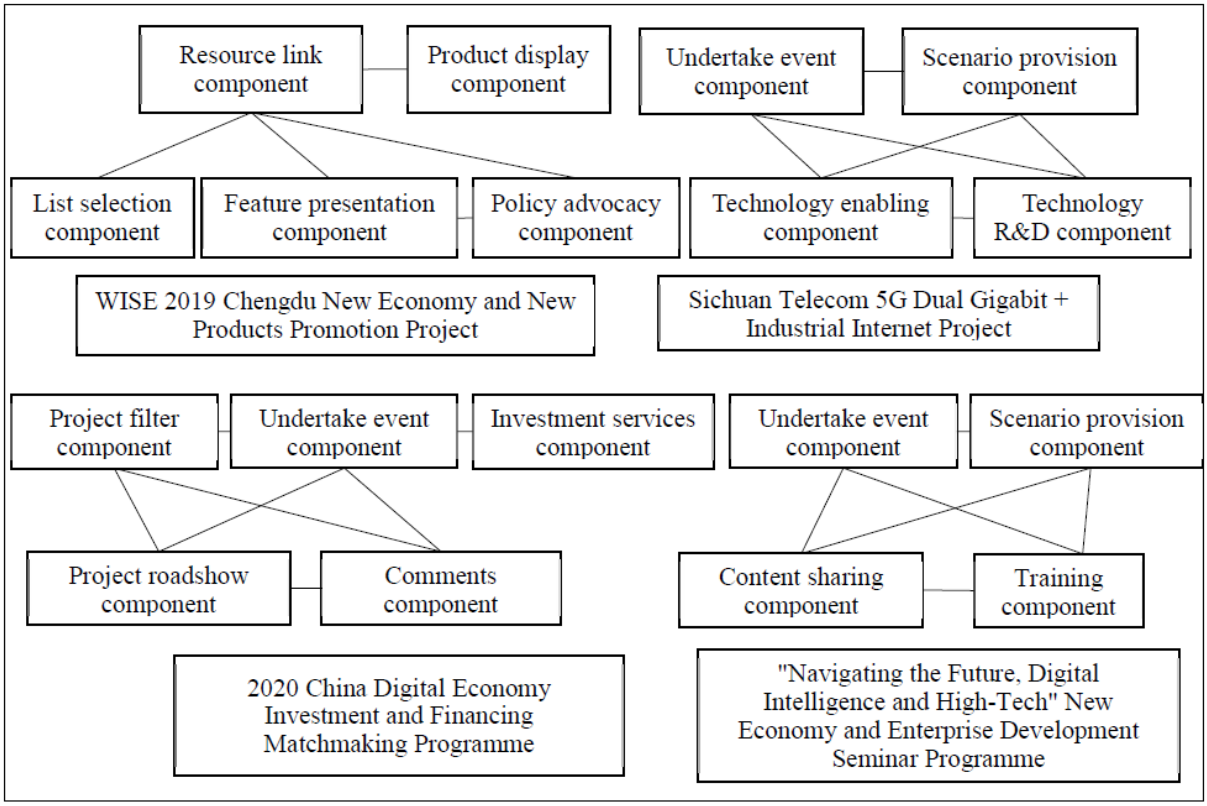

Figure 4.1 Component complementarity in the 36 Kr Sichuan project

At the same time, this project was the first collaboration between 36 Kr Sichuan and a local government and the first time a local government had participated in a WISE conference. 36 Kr Sichuan and the government had no experience working together. It was a process led by both parties to explore new collaboration models and build trust with significant radical innovation.

In the 5G Dual Gigabit and Industrial Internet project, 36 Kr Sichuan took on the ecosystem undertaking activities component as a collaborator to help Sichuan Telecom carry out this project. By undertaking activities in the Industrial Internet, education, cultural tourism, healthcare, cloud gaming, and other tracks through entities such as 36 Kr Sichuan, Sichuan Telecom was able to promote its core technology effectively and put it into practice in contexts such as Luzhou Laojiao, Foxconn, Chengdu Kuanzhai Alley, Chengdu Huaxi Hospital,

Huoshen Mountain and Leishen Mountain. From the perspective of the pattern of component complementarities, there is interdependence between undertaking activities, scenario provision, technical support, and technological research and development components. Therefore, this project shows significantly integrated complementarities, as shown in Figure 4.1.

At the same time, this project was led by Sichuan Telecom, 36 Kr Sichuan was more likely to use its strengths to cooperate with Sichuan Telecom to carry out the project, and the two sides worked together to improve the existing business without exploring new business, which is mainly manifested as significant incremental innovation.

In the 2020 China Digital Economic Investment and Financing Matchmaking Project, 36 Kr Sichuan mainly undertakes the launching component. In the project, the Sichuan Internet Information Office conducted a fine screening of the roadshow projects, selecting six well-known Internet enterprises in Sichuan Province to complete the project roadshow, and investors from notable domestic investment and financing institutions will provide professional comments on the roadshow projects as well as investment services.

From the point of view of component complementarities, the project has a close interdependence between undertaking activities, project screening, project roadshow, and commenting components. The investment service component is not interdependent with the project screening component, the project roadshow component, or the review component, except for the event hosting component. As a result, both hub and spoke and integrated patterns of complementarity are evident in this project, as shown in Figure 4.1.

At the same time, 36 Kr Sichuan co-leads the project with the Net Office to undertake the project and helps the Net Office as a collaborator to carry out subsequent offline activities such as signings and summits, showing both incremental and radical innovation overall.

36 Kr Sichuan cooperated with the government to undertake the "Navigating the Future, Digital and Intelligent High-Tech" new economy and enterprise development presentation project, effectively helping the government to solve the problems plaguing the New Economy Committee and local governments in the development, training, and transformation of new-economy enterprises in Chengdu. In this project, 36 Kr Sichuan is the primary host of the event's component and resource links, attracting several experts to share their content. The project also invites professional institutions to take on the training component, training Chengdu enterprises on professional transformation and strategic planning.

From the perspective of component complementarities, there is an interdependence between the event undertaking component, the scenario providing component, the content sharing component, and the training component. Therefore, the project as a whole exhibit

integrated complementarities, as shown in Figure 4.1. The project is led by the New Economic Development Bureau of the Chengdu High-Tech Area, and 36 Kr Sichuan plays a supporting role in this project, working with the New Economic Development Bureau to improve the project, rather than exploring new business models. As such, the project is primarily an incremental innovation.

To sum up, 36 Kr Sichuan mainly undertakes the 2019 WISE Chengdu New Economy New Product Promotion Project, Sichuan Telecom 5G Dual Gigabit + Internet Project, 2020 China Digital Economy Investment, and Financing Matchmaking Project, and New Economy and Enterprise Development Promotion Project. In the process of landing these projects, 36 Kr Sichuan took the lead in laying out the 2019 WISE Chengdu New Economy New Product Promotion Project and the 2020 China Digital Economy Investment and Financing Matchmaking Project, as well as collaborating on the Sichuan Telecom 5G Dual Gigabit + Internet Project and the New Economy and Enterprise Development Presentation Project.

Overall, 36 Kr Sichuan ecosystem showed significant performance in both hub and spoke and integrated patterns of complementarity and in both radical and incremental innovation. 36 Kr Sichuan component complementarities pattern and sustainable innovation characteristics are summarized in Table 4.2.

Table 4.2 Component complementarity and sustainable innovation characteristics of three companies

Conception	Component complementarity		Sustainable innovation	
Measured variables	Hub and spoke complementarities	Integrated complementarities	Radical innovation	Incremental innovation
36 Kr Sichuan	Significant	Significant	Significant	Significant
Characteristics mining	The resource linking component and the undertaking activity component in the 2019 WISE Chengdu New Economy and New Products Promotion Project and the 2020 China Digital Economy Investment and Financing Matchmaking Project play a connector role in the projects, connecting the transmission of information between components, and these projects as a whole show a significant hub and spoke complementarities.	All Sichuan Telecom 5G Dual Gigabit + Internet Project and the New Economic and Enterprise Development Evangelism Project have established close interdependencies and significantly integrated complementarities. The 2020 China Digital Economic Investment and Financing Matchmaking Project components have established close interdependencies, significantly integrated complementarities.	The 2019 WISE Chengdu New Economic and New Products Promotion Project is a 36 Kr Sichuan-led layout landing project focusing on radical innovation. The 2020 China Digital Economy Investment and Financing Matchmaking Project is a project co-led by 36 Kr Sichuan and the provincial Netcom Office to layout the landing, mainly in the form of radical innovation.	The Sichuan Telecom 5G Double Gigabit + Internet Project, the New Economy and Enterprise Development Promotion Project, and the 2020 China Digital Economy Investment and Financing Matchmaking Project are projects laid out under the leadership of Sichuan Telecom, the Provincial Netizen Office, and the Chengdu High-Tech Area New Economy Development Bureau. 36 Kr Sichuan plays a significant role as a collaborator in these projects, with multiple entities working together to promote the implementation of the projects, with significant performance in incremental innovation.
Jiangxi Urban Construction	Significant	Not significant	Significant	Not significant
Characteristics mining	In the three projects, no other components are closely interdependent except for the integrated urban operation component and the project implementation component, which are interdependent with each project's other components. The hub and	All three projects have to be interdependent through the integrated urban operations and project implementation components, and the integrated complementarities are not significant in these projects.	Three projects, all of which were jointly led and laid out by Jiangxi Urban Construction in conjunction with Israeli companies, Ali Cloud and other participating entities, were in a mode not previously experienced, more a process of trying out	In all three projects, the business cooperation model has gone entirely beyond the scope of the original cooperation experience and is more a process of exploring new models; incremental innovation is not significant in any of these projects.

	spoke complementarities are significant in these projects.		new business models and radical innovation was significant in all of these projects.	
Yun Litchi	Not significant	Significant	Not significant	Significant
Characteristics mining	All components in the dry, distribution and warehouse product projects establish close interdependencies, and the hub and spoke complementarities are not significant in any of these projects.	All components in the dry product, distribution product, and warehouse product programs have established close interdependencies, and integrated complementarities are significant in all of these projects.	Dry product, distribution product, and warehouse product projects are all within the initial planning process to improve the project; Yun Litchi did not lead the original layout and did not have a new business, radical innovation in these projects is not significant performance.	The dry, distribution and warehouse product projects are part of Yun Litchi collaborating with Fresh Life to improve the original one-stop service in the cold chain industry and not explore new business models. Incremental innovation is significant in all of these projects.

4.2.2 Jiangxi Urban Construction case

As one of the nine integrated urban development operators, Jiangxi Urban Construction and Israeli companies lead the China-Israel (Chengdu) Country Park, mainly responsible for the integrated urban operation components. The country park is positioned with a global perspective, linking various high-end international and domestic innovation resources and creating an innovation ecosystem to help Chengdu and Chongqing become the most influential science and technology innovation center in the country.

From the perspective of the pattern of component complementarities, the project's integrated urban operation component and the listing and coaching component, technology service component, talent import component, investment and operation component, and research support component all establish interdependence, but these components do not develop a close interdependence with each other. Therefore, the overall hub and spoke complementarities are more significant.

At the same time, Jiangxi Urban Construction has established a Sino-Israeli (Chengdu) Country Park in the new eastern part of the city, in conjunction with Israeli companies. The two sides jointly nurture the "New Born New Emergence" and explore a new cooperation model between the new eastern area, the future science and technology city, and Israeli specialty industries. As a result, the radical innovation of the project is significant.

Within the country park, Jiangxi Urban Construction has joined hands with Ali Cloud to create the iM2 Global First Store project, where both parties jointly explore a new model of cooperation. In the project, Jiangxi Urban Construction, University of Electronic Science and Technology of China, High-Tech Area Management Committee, and other multiple parties participate in the project's landing to create a new scene that meets the new generation of post-95 post-00 consumer groups.

From the perspective of a pattern of component complementarities, the integrated urban operation component and the results transformation component, policy support component, science and technology service component, and resource import component in the ecosystem establish interdependence. Still, these components have not been found interdependence with each other before. As a result, the project as a whole exhibited a hub and spoke complementarities, as shown in Figure 4.2.

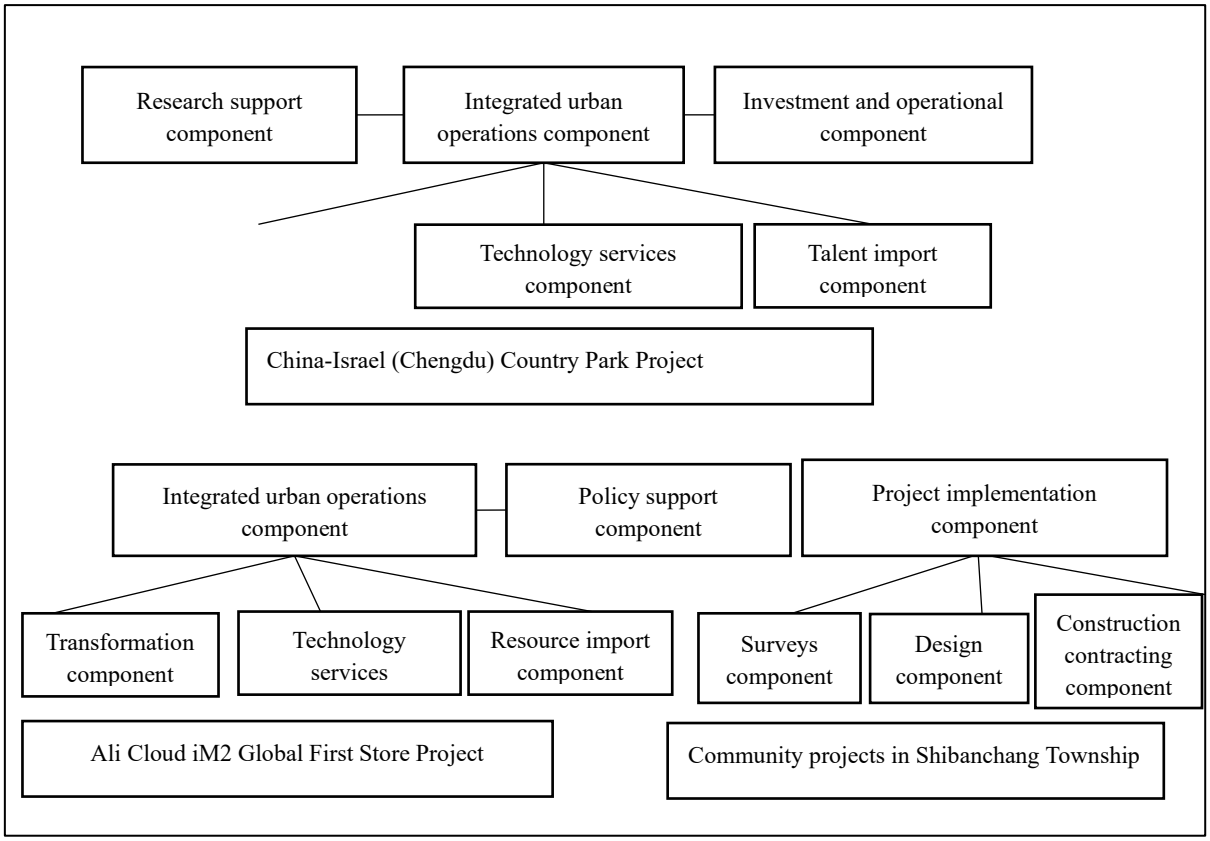

Figure 4.2 Component complementarity in the Jiangxi Urban Construction projects

At the same time, Jiangxi Urban Construction has joined hands with AliCloud to create the world's first high-quality science and innovation space and new industrial complex of "scene incubation + new retail + integrated innovation for future communities" within the Eastern New Area. The AliCloud iM2 global first shop project mainly explores new retail experience contexts and creates a new benchmark for consumer upgrading. It is part of leading the experimentation of new business models. As such, the project's radical innovation performance is significant.

Jiangxi Urban Construction also takes the lead in implementing community engineering projects in Shibandeng Township and Lujia Township. There are simple components, survey, design, and construction contracting components in community engineering projects in Shibanchang Township and Lujia Township. These components are not closely interdependent, except for interdependence between the project implementation component and other components. In contrast, the hub and spoke complementarities are significant, as shown in Figure 4.2.

At the same time, community projects such as Shibandeng Township and Lujia Township are exploring a new model of digital smart communities led by Jiangxi Urban Construction. As one of the nine area operating companies, Jiangxi Urban Construction is responsible for taking

the lead in laying out the landing of this project. As a result, the radical innovation in the project has been significant.

To sum up, Jiangxi Urban Construction and Israel jointly built the country park, cooperated with Ali Cloud to construct the Ali Cloud iM2 global shop project, and implemented community engineering projects such as Shibandeng Town and Lu Jia Town, gradually exploring new cooperation models. As one of the nine area operators in the Eastern New Area, almost all of these projects are projects that Jiangxi Urban Construction is responsible for leading the layout.

Overall, Jiangxi Urban Construction's hub and spoke complementarities have performed significantly. In contrast, its integrated complementarities have not performed considerably, and its radical innovation has performed dramatically, while its incremental innovation has not performed significantly. A summary of the pattern of component complementarities and sustainable innovation characteristics of Jiangxi Urban Construction in the local ecosystem is shown in Table 4.2.

4.2.3 Yun Litchi case

Yun Litchi Dry Product focuses on national cold chain dry services. To guarantee the implementation of this project, the dry product platform ensures that carriers and users can quickly place orders online by integrating more than 70,000 vehicles across the country. The project also requires OWTB's SaaS system cluster + extensive data management to achieve 7x24-hour monitoring of the entire lifecycle of orders.

From the point of the pattern of component complementarities, the platform support, the one-click order, the transport, and the monitoring components establish a close interdependence in the project. Therefore, the integrated complementarities of the project are significant, as shown in Figure 4.3. At the same time, the dry product is a cold chain trunking service laid out by Yun Litchi in collaboration with Fresh Life, which is a process of improving the business model on the original foundation. Therefore, the dry product project incremental innovation performance is more significant.

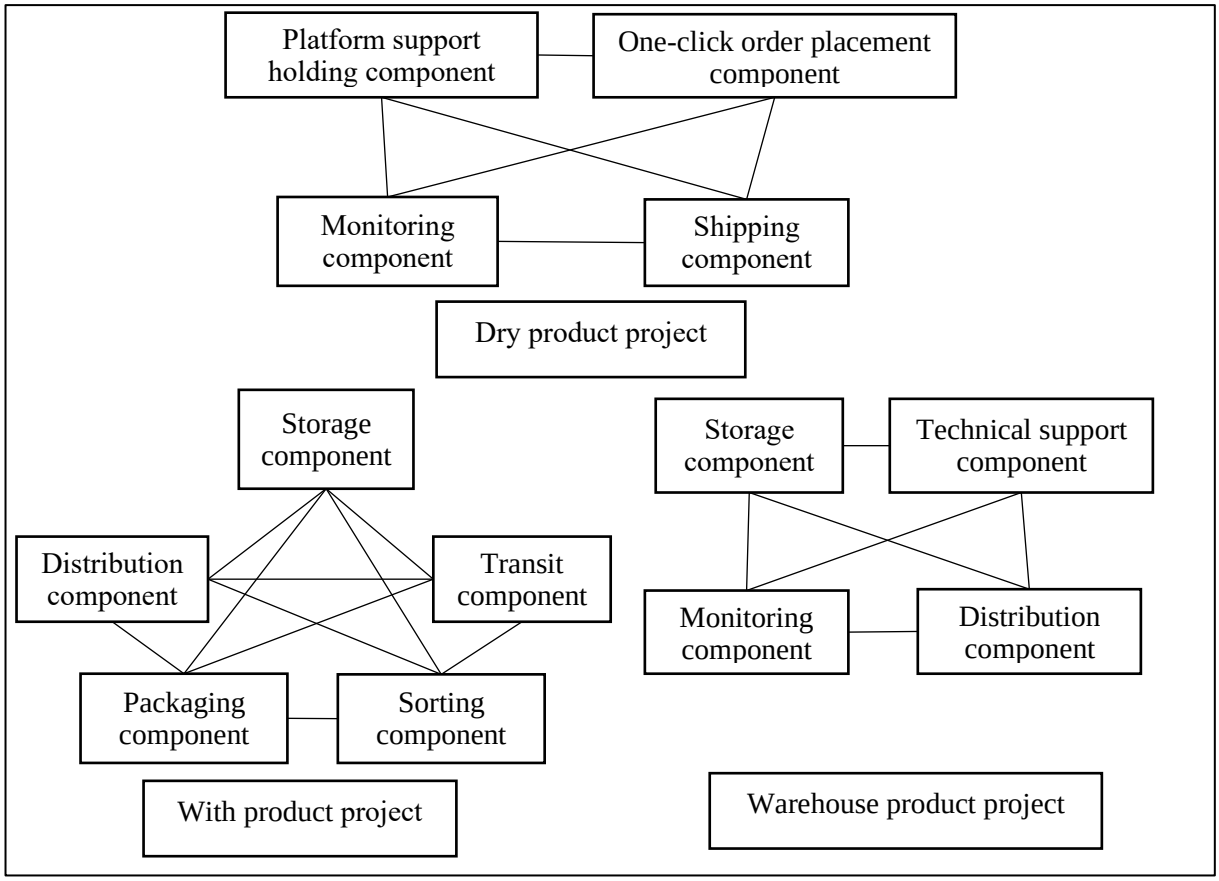

Figure 4.3 Component complementarity in the Yun Litchi project

Yun Litchi distributes products through more than 200,000 touchdown sites across the country to achieve a full range of distribution in core cities and core areas and counties. The project establishes over 240,000 square meters of warehouses across the country to undertake product storage, packaging, sorting, transit, and other components. From the perspective of the pattern of component complementarities, the project's distribution, storage, packaging, sorting, and transit components are all closely interdependent. Therefore, the integrated complementarities of the project are significant, as shown in Figure 4.3.

At the same time, the distribution product project is designed to solve the problems of the small urban coverage, low product distribution efficiency, and fluctuating cargo volume of Fresh Life. It is a process of improving the project based on the original business model. Therefore, the incremental innovation performance of the distribution product project is more significant.

The Yun Litchi Warehouse product project establishes a large number of warehouses to warehouse products in various areas and counties across the country, and by using emerging technologies such as 5G to support the cold chain inventory of products, the effects are monitored throughout the entire process, at all times and in all directions. From the perspective of the pattern of component complementarities, the project's warehousing, monitoring,

technical support, and distribution components all establish a close interdependence. As a result, the integrated complementarities of the project are more significant.

At the same time, the warehouse product project is designed to solve the problem that products cannot be effectively warehoused due to the influence of location and is more of a scope to improve the original planning business. Therefore, the warehouse product project is more significant in incremental innovation.

To sum up, Yun Litchi dry product, warehouse product, distribution product, and other projects together to provide customers with a full range of cold chain products one-stop service. The three product projects aim to improve the cold chain service chain based on the original business. They are based on solving the projects' problems according to demand without exploring new business models. On the whole, Yun Litchi has significantly integrated complementarities, a non-significant hub and spoke complementarities, important incremental innovation, and a non-significant radical innovation.

A summary of the pattern of component complementarities in the ecosystem and the sustainable innovation characteristics of Yun Litchi in the local ecosystem is shown in Table 4.2.

4.3 Cross-case analysis and results

The within-case analysis provides a systematic understanding of the development history of each case company. The following section presents a comparative analysis of the case companies. The relationship between hub and spoke and integrated complementarity and radical and incremental innovation patterns can be summarized, and research results showed.

4.3.1 Hub-and-spoke complementarities and sustainable innovation

From the perspective of a hub and spoke complementarities and sustainable innovation, both 36 Kr Sichuan and Yun Litchi show very similar evolutionary paths in their development. 36 Kr Sichuan has undertaken projects such as the 2019 WISE Chengdu New Economy and New Products Promotion Conference and the 2020 China Digital Economy Investment and Financing Matchmaking Conference after landing in Chengdu, mainly showing a hub and spoke complementarities and radical innovation.

As a project subsidiary of New Hope's Fresh Life layout one-stop cold-chain warehousing, Yun Litchi cooperates with other entities. Its hub and spoke complementarities are not significant, nor is its radical innovation performance. Overall, 36 Kr Sichuan and Yun Litchi

provide excellent material for analyzing the relationship between the hub and spoke complementarities and sustainable innovation.

36 Kr Sichuan actively plays its resource linkage advantage. It cooperates with the Chengdu New Economic Committee to promote the landing of the 2019 Chengdu New Economic and New Products Promotion Conference. During the project implementation process, the resource linking, list selection, and presentation components actively cooperated in carrying the project. These components did not establish a close interdependence with each other. As a result, 36 Kr Sichuan has taken on the project through a hub and spoke complementarities.

At the same time, the WISE conference has not been carried out in Chengdu before and is a relatively new form of activity. 36 Kr Sichuan has taken the lead in hosting the 2019 WISE conference, attracting new economy companies and investment institutions from Chengdu to the event. Cai X, who is from 36 Kr Sichuan, said: "Chengdu City New Economy Committee for the cultivation of local, new economic enterprises is still relatively weak, it is difficult to attract investment to enterprises to Chengdu, so we were running the meeting to help Chengdu City, the city government is involved." Overall, 36 Kr Sichuan hub and spoke complementarities performs significantly, as does radical innovation.

Compared to 36 Kr Sichuan in the hub and spoke, complementarities are not significant in the Yun Litchi in radical innovation. Yun Litchi is a warehouse and distribution service provider in the cold chain logistics industry laid out by Fresh Life, which can quickly integrate people, vehicles, goods, and warehouses through algorithms. The dry product project, the distribution product project, and the warehouse product project are all part of a comprehensive urban modern intelligent logistics service platform that integrates warehousing, distribution, and processing with other subjects in the logistics industry chain. The creation of each product project, mainly through the integrated complementarities to undertake, hub and spoke complementarities performance are not significant.

At the same time, the development of these projects is also cooperation between Yun Litchi and other participating entities to layout the business, in the process of collaboration to gradually establish a relationship of trust, further promoting the improvement of the entire project. Overall, the radical innovation of Yun Litchi is not significant.

From the comparison between 36 Kr Sichuan and Yun Litchi, it can be concluded that the hub and spoke complementarities have a significant impact on radical innovation in the business. 36 Kr Sichuan landed and led the layout of the new economy and new products promotion in Chengdu. This is the process of exploring new models and trying out new businesses carried by a hub and spoke complementarities, where radical innovation is developed.

As Yun Litchi's hub and spoke complementarities do not perform significantly, it needs to cooperate with external entities to explore models when laying out new projects. Its ability to lead the business layout is limited, and radical innovation does not perform significantly. The comparative analysis shows that 36 Kr Sichuan is better developed than Yun Litchi in the hub and spoke complementarities. Therefore, 36 Kr Sichuan is also more developed in radical innovation. 36 Kr Sichuan and Yun Litchi are shown in Table 4.3 regarding the pattern of component complementarities and sustainable innovation characteristics.

Table 4.3 Comparison of component complementarity and sustainable innovation characteristics among three enterprises

Conception	Component Complementarity	Sustainable innovation
Measured variables	Hub and spoke complementarities	Radical innovation
36 Kr Sichuan	Significant	Significant
Yun Litchi	Not significant	Not significant
Measured variables	Integrated complementarities	Incremental innovation
36 Kr Sichuan	Significant	Significant
Jiangxi Urban Construction	Not significant	Not significant

The analysis of the two companies, 36 Kr Sichuan and Yun Litchi, shows that 36 Kr Sichuan has developed a higher hub and spoke complementarities compared to Yun Litchi. Its radical innovation has also developed higher. Therefore, this work results that the hub and spoke complementarities are conducive to the development of radical innovation in the company.

4.3.2 Integrated complementarities and sustainable innovation

36 Kr Sichuan and Jiangxi Urban Construction show similar evolutionary paths from component complementarities and sustainable innovation. 36 Kr Sichuan, after landing in Tianfu New Area, was not very familiar with the local business environment and was more cooperative with the local government, the New Economy Committee, and other units, and the two sides gradually built up a trusting relationship during the cooperation process, which mainly turned out to be integrated complementarities and significant incremental innovation.

After landing in the new eastern area, Jiangxi Urban Construction cooperated with Ali Cloud and other subjects to lead the new area project landing layout as one of the nine area company operators. The integrated complementarities were, and the incremental innovation was not significant. Overall, 36 Kr Sichuan and Jiangxi Urban Construction provide analytical material for our analysis of the relationship between the integrated complementarities and sustainable corporate innovation.

36 Kr Sichuan is located in the Tianfu New Area. It has taken the initiative to work with Sichuan Telecom, the Sichuan Internet Information Office, the Chengdu High-Tech Area New

Economy Development Bureau, and the High-Tech Big Data Smart Industry Research Institute, using its strengths to work with these entities to implement projects. In these projects, the main components undertaken by 36 Kr Sichuan and other components have established a close interdependence, launching the project through integrated complementarities. Cai X of 36 Kr Sichuan said: "When 36 Kr Sichuan first landed, our strength was probably in organizing events, and few companies and investors came to the events in the beginning, so we took the initiative to contact Sichuan Telecom and other subjects to go and work with them." In working with local entities, 36 Kr Sichuan slowly developed a relationship of cooperation and trust, and more collaboration was subsequently developed. Overall, 36 Kr Sichuan's integrated complementarities have performed remarkably well, as well as incremental innovation.

Jiangxi Urban Construction, which has performed less well with 36 Kr Sichuan in terms of the integrated complementarities, has also completed less well in incremental innovation. Jiangxi Urban Construction is an incoming company that has landed in the new eastern area as a result of Chengdu's eastward strategy, working with multiple entities such as Ali Cloud and Israeli companies to lead the layout of projects such as Ali Cloud's iM2 global premiere shop, the China-Israel (Chengdu) Country Park and community projects such as Shibandeng Town and Lujia Town. In these projects, Jiangxi Urban Construction plays more of an integrated urban operation component, attracting other components to co-host the projects mainly through a hub and spoke complementarities.

At the same time, these projects led by Jiangxi Urban Construction are all brand new projects in the new eastern area. They are exploring and experimenting with various entities' new business models and development patterns. Hu XX of Jiangxi Urban Construction said, "When these projects were first laid out, they were completely new businesses, and there was no model to learn from at home or abroad, so we could only explore them gradually through us." Overall, Jiangxi Urban Construction's integrated complementarities do not perform significantly, nor does its incremental innovation.

In the case of 36 Kr Sichuan and Jiangxi Urban Construction, the integrated complementarities have significantly impacted incremental innovation. 36 Kr Sichuan has worked actively with each of the entities it landed. Sichuan Telecom and other entities have carried out projects through component strengths such as undertaking activities. In the course of the projects, the subjects gradually build up a cooperative relationship to carry out more long-term projects, facilitating the development of incremental innovation in the company.

As Jiangxi Urban Construction's integrated complementarities do not perform significantly, it is less capable of cooperating with others when laying out projects with other subjects and

does not perform well enough in collaborative project layouts, making its incremental innovation performance less significant. The comparative analysis shows that 36 Kr Sichuan has a higher degree of integrated complementarities than Jiangxi Urban Construction, and therefore 36 Kr Sichuan also has a higher development in terms of incremental innovation. 36 Kr Sichuan and Jiangxi Urban Construction component complementarities and sustainable innovation characteristics are shown in Table 4.3.

A comparative analysis of the two companies, 36 Kr Sichuan and Jiangxi Urban Construction, shows that 36 Kr Sichuan gets a higher development of the integrated complementarities than Jiangxi Urban Construction. Its incremental innovation also brings a higher result. Therefore, this work results that the integrated complementarities are conducive to incremental innovation in the company.

In summary, this work analyses the components in the projects laid out and landed by 36 Kr Sichuan, Jiangxi Urban Construction, and Yun Litchi, as well as the interdependencies and pattern of component complementarities between these components, and also analyses the performance of sustainable innovation in the projects of the three enterprises. The relationship between the pattern of component complementarities and radical innovation before is analyzed by comparing 36 Kr Sichuan and Yun Litchi, leading to the first result of this work that the hub and spoke complementarities are conducive to the development of radical innovation in enterprises.

By comparing 36 Kr Sichuan and Jiangxi Urban Construction, the relationship between the integrated complementarities and radical innovation is analyzed, leading to result 2 of this work, that is, the integrated complementarities are conducive to the development of radical innovation in enterprises. Therefore, the companies resident in the new area needs to target the innovative attributes of their projects in the development process and achieve sustainable innovation with the help of a pattern of component complementarities.

4.4 Summary of the multi-case research

In the sub-research one, three typical cases are selected and analyzed to explore the relationship between component complementarities and sustainable innovation. To achieve sustainable innovation, the enterprises resident in the new area need to consider their components and other components in the ecosystem and interdependencies (Adner & Feiler, 2019). From an ecosystem perspective, different components and their component complementarity have different impacts on sustainable innovation (Shipilov & Gawer, 2020). For example, an

ecosystem's upstream and downstream components have differentiated impacts. Therefore, this work explored the relationship between the hub and spoke and integrated patterns of complementarity in the ecosystem and sustainable innovation (Hoffmann et al., 2018; Thomas & Autio, 2019). This research finds that the hub and spoke complementarities favor the development of radical innovation and the integrated complementarities favor the development of incremental innovation. This provides an appropriate complement to the relationship between component complementarity in ecosystems and sustainable innovation.

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Chapter 5: Component Complementarity in Ecosystems and Firm’s Sustainable Innovation: Hypotheses and Validation

This chapter focuses on Sub-research two, which verifies how component complementarity affects sustainable innovation of the new area resident firms. Through a multi-case analysis, Sub-research one summarizes the mechanisms by which component complementarity influences sustainable innovation in the new area resident enterprises. Based on this, Sub-research two adopted a policy capturing approach to test the decisions of decision makers in the new area resident enterprises under the influence of component complementarity in the ecosystem. Considering that network embeddedness is an important element influencing firms' access to resources and information, Sub-research two introduced a structural embedding element in the questionnaire design of policy capture.

The results of the research show that (1) Hub and Spoke complementarity is positively correlated with radical innovation and not significantly associated with incremental innovation for the new area resident enterprises. (2) Integrated complementarity is positively correlated with the incremental innovation and not significantly associated with radical innovation for the new area resident enterprises. (3) When centrality is significant, integrated complementarity is positively associated with radical innovation for the new area resident enterprises.

5.1 Theoretical background

As an essential part of China's economy, new areas have always been tasked with reforming institutional mechanisms and regional economic development. With the establishment of the Xiong'an New Area, the construction of new areas in China, represented by national-level new areas, has moved towards exploring new city models that carry innovation and sustainable development. As a vehicle for the transformation of the construction model of the new area, the enterprises resident in the new area are an essential part of the new area. In the current scenario, the new area resident enterprises are increasingly linked to the overall objectives of the new area compared to the public enterprises. It is under pressure to meet growth in size and revenue and constantly seeks innovative paths to support the evolving and complex needs of the new area.

In this context, some scholars have highlighted how firms can develop sustainable innovation through radical and incremental innovation changes (Burritt et al., 2019; Kobarg et al., 2019). The former involves regular and continuous change, retaining current production systems, and continuously improving capabilities. In contrast, the latter refers to discontinuous changes that replace existing components and require new capabilities. As sustainable innovation often requires significant changes to processes and products, some researchers argue that incremental innovation is not sufficient to achieve the goal of sustainability (Arocena & Sutz, 2021; Kastrinos & Weber, 2020). Sustainable innovation often requires going beyond incremental adjustments to create new markets and value. Therefore, radical innovation will be necessary (Nasiri et al., 2017). Balancing radical and incremental innovation is essential for new area resident enterprises to respond to the emerging needs of new area development.

However, innovation in a firm is not independent; it depends not only on the resources and capabilities that the firm possesses but also on the interdependencies with external collaborators that need to be considered. Existing research identifies ecosystems, as manifestations of the interdependence between firms and external environmental agents, as an important scenario that constitutes a firm's strategic decisions. Existing research points to a strong relationship between the component complementarity in ecosystems and the sustainable innovation performance of firms (Shipilov & Gawer, 2020).

Different components are located in various positions in component complementarity in ecosystems, which may mean that these components play different roles in the firm’s innovation performance. Components often draw on the capabilities of other organizations, have other economies, and therefore exhibit various innovation performances (Nambisan et al., 2019b). Upstream ecosystem components can constrain firm innovation performance by limiting the productive capacity of the core firm. In contrast, downstream ecosystem components can constrain firm innovation performance by restricting the ability of customers to make a profit when purchasing a product (Kapoor, 2018; Rietveld & Schilling, 2021). Thus, the impact of different component complementarity in ecosystems on a firm's sustainable innovation performance is different.

Studies have classified component complementarity in ecosystems as integrated and Hub and spoke complementarities (Furr, 2021). In contrast to Hub and spoke complementarity, integrated complementarity requires the management of multiple interdependent and mutually constraining complementarities, and the potential for innovation by individual components can be limited. Therefore, integrated components complementarity structures are less likely to undergo radical innovation with radically more significant changes and more conducive to

incremental innovation performance. Similarly, Hub and spoke complementarities may cause firms to miss opportunities to innovate using interdependent components, which is more conducive to radical innovation performance (Burford et al., 2022). Therefore, resident firms need to effectively coordinate integrated and Hub and spoke complementarities according to the actual situation to develop sustainable innovation in the ecosystem.

As subjects embedded in a specific business network, sustainable innovation in the new area resident enterprises requires access to resources, information, From the social network in which they are embedded. Therefore, in considering the choice of sustainable innovation behavior by the ecosystem in which the new area's resident enterprises are embedded, it is also necessary to consider their location status in terms of access to resources, information. Centrality is an essential indicator of the position of an individual participant in a network, indicating the extent to which an actor at the center of the network occupies a central role in the network by participating in many vital connections (Kuskova & Wasserman, 2020).

When centrality is significant, the new area resident enterprise has higher status, power, and prestige (DellaPosta, 2020; Weeden & Cornwell, 2020), leading to a more substantial influence on other actors and more significant benefit capture. Based on this, it is argued that new area resident enterprises with important centrality are more likely to use their resources and information to maximize the effects in other component complementarities in ecosystems, thus promoting radical innovation.

5.2 Research hypotheses

This study focuses on the preferences of component complementarity in ecosystems on the sustainable innovation choices of enterprises in the new area. Hub and Spoke complementarity and integrated complementarity are selected as contextual elements to measure the component complementarity structure and investigate the research mechanism of their preferences for radical and incremental innovation.

Based on the findings of the previous multi-case study, this study concludes that Hub and Spoke complementarity is significantly and positively correlated with the radical innovation of new area resident enterprises; integrated complementarity is significantly and positively correlated with incremental innovation of new area resident enterprises, and integrated complementarity is significantly and positively correlated with the radical innovation of new area resident enterprises when centrality is significant. The relationship between the specific contextual variables and the dependent variable is shown in Figure 5.1.

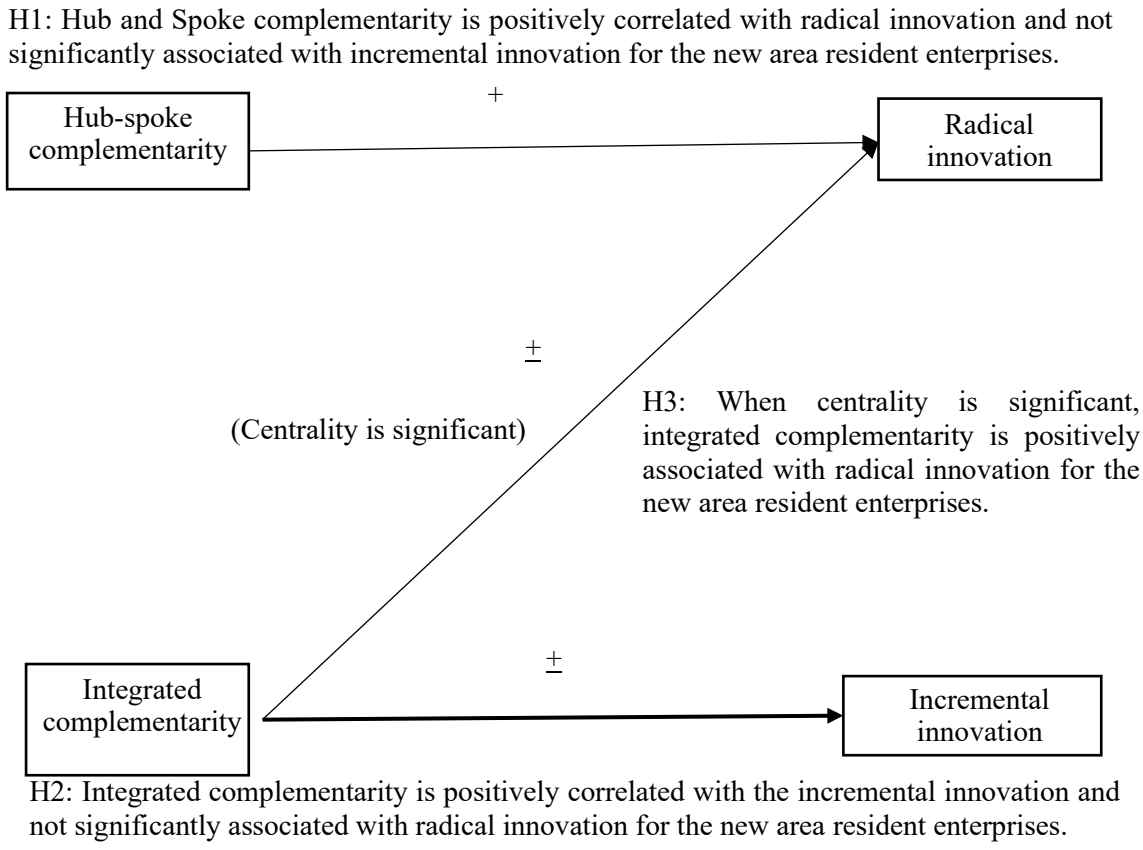

Figure 5.1 Diagram of the relationship between contextual and dependent variables

It has been noted that different types of innovation differ significantly in terms of their goals and requirements and the innovative, cognitive, and organizational processes associated with them (Kobarg et al., 2019; Tiberius et al., 2021). Specifically, radical and incremental innovations differ in terms of the complexity and novelty of the knowledge they embody (Bogers et al., 2018; Lupova-Henry & Dotti, 2019; Soto-Acosta et al., 2018), the knowledge and skills required, and the firm's existing capability base (Centobelli et al., 2019; Luger et al., 2018), the ease of learning (Abubakar et al., 2019; Helfat & Raubitschek, 2018; Meyer et al., 2020), the different types of resources and the different scales and degrees of complementarity of these resources (Centobelli et al., 2019; del Carmen Triana et al., 2019; Eggers & Park, 2018; Si & Chen, 2020). Thus, the main characteristic of radical innovation is the novelty of the knowledge component (Calabrò et al., 2019; Papa et al., 2018), which affects the ecosystem's components, understanding, and processes (Bhattarai et al., 2019; Kobarg et al., 2019; Tiberius et al., 2021). It is systemic and complex, relying on the cooperation of various ecosystem actors. Therefore, for new area entrants, a Hub and Spoke complementary ecosystem is more straightforward, with less complementarity carried by external agents and less difficulty in coordinating new area entrants to promote radical innovation.

At the same time, this systematic nature of radical innovation requires firms to monitor and

assimilate various technological developments in their environment (Jaspers & Ende, 2010) and to rely on the firm's new methods and materials, which are derived from recombination of internal and new (external) knowledge (Cozzolino et al., 2018; Tiberius et al., 2021). The advanced knowledge required for radical innovation is widely dispersed outside the boundaries of the firm dependence of innovation on the external environment increases as the complexity of knowledge and processes increases (Kobarg et al., 2019).

Furthermore, existing research points out that radical innovation requires a certain degree of breadth of collaboration (Sebastian et al., 2018). Therefore, radical innovation by new area entrants requires an existing ecosystem that can be scaled up relatively quickly. In an ecosystem with the new area resident firms as the core, complementary relationships between external components that exhibit weaker complementarities, radical innovation by the new area resident firms can better external coordinate components and innovation outputs in a self-centered manner, taking less account of the interdependencies between external components, thus facilitating the smooth realization of radical innovation. Therefore, this study concludes a significant positive correlation between Hub and Spoke complementarity and the radical innovation preferences of firms in the new area.

H1: Hub and Spoke complementarity is positively correlated with radical innovation and not significantly associated with incremental innovation for the new area resident enterprises.

Incremental innovation is relatively less dependent on the external environment than radical innovation. Specifically, "incremental innovation involves relatively small technological changes and provides relatively low incremental customer benefits per dollar" (Rajapathirana & Hui, 2018; Tiberius et al., 2021). Much, though not all, of this knowledge embodied in incremental innovation and the innovation skills used in the process, are expected to reside within the firm (Nambisan et al., 2019b; Schiuma & Carlucci, 2018) or to be closely related to the firm's knowledge base (Alvesson & Spicer, 2019; Kobarg et al., 2019), reducing the amount of knowledge that can be drawn from the heterogeneous need to remove from the recombination of external expertise. Furthermore, incremental innovation is less systematic (Keijl et al., 2016). It can be seen as a process of assembling within a previously established technology domain, stimulated by high levels of familiarity and 'cognitive legitimacy' (Stam & Van de Ven, 2021; Urbano et al., 2019), and supported by an absorptive capacity that consists of an of expertise in a narrow range of closely related knowledge domains (Barley et al., 2018; Shujahat et al., 2019).

As incremental innovation is driven by a focused focus on improvements within isolated components and knowledge, Sebastian et al. (2018) argue that the complexity of the required knowledge for a specific, isolated product or knowledge domain will be substantial.

Furthermore, repeated, in-depth interactions within a particular knowledge domain can reuse similar knowledge elements, facilitating routine creation (Choudhury et al., 2021; Luger et al., 2018). Thus, although incremental innovation does not involve significant technological innovation, it requires a strong familiarity with markets and technologies and the accumulation of significant performance outputs through continuous improvement (Hollander, 1965), which requires new area firms to have a deep understanding of the interactions between the various components of the ecosystem when undertaking incremental innovation. In addition, incremental innovation changes existing markets relatively little and uses the existing base to reinforce the dominance of existing firms (Christensen et al., 2018; Dyer et al., 2018; Luger et al., 2018).

When hub and spoke complementarity in the ecosystem is significant, the components carried by the external subjects complement each other, and the ecosystem components are highly interdependent. At the same time, component complementarity has developed gradually over time. Integrated complementarity is a more mature and stable ecosystem complementary structure than hub and spoke complementarity (McIntyre et al., 2021). Therefore, this study argues that integrated complementarity supports improved and reinforced innovation synergy models. Based on this, hypothesis 2 is proposed in this study.

H2: Integrated complementarity is positively correlated with the incremental innovation and not significantly associated with radical innovation for the new area resident enterprises.

Firms need to consider the ecosystem in which they operate and the scenario in which social networks are embedded (Hannigan et al., 2021). Through social network embedding, enterprises obtain resources and information to support sustainable innovation, establish stable interactions with innovation agents in the ecosystem, and build trust mechanisms and reduce transaction costs. Enterprises resident in new areas are often the product of parent company entrepreneurship and embedded in social network, which need to be considered in studies examining the impact of component complementarity in ecosystems on sustainable innovation. In addition, ecosystems, as an expression of the component interdependence of firms managing themselves and their external environment (Shipilov & Gawer, 2020), require social networks to access resources, information to support their components.

Based on this, this study selects structural embeddedness and adopts centrality as an essential characteristic to measure structural embeddedness. Centrality refers to the position of an individual participant in a network. It indicates the extent to which an actor at the center of the network occupies a central role by participating in many vital connections (Kuskova & Wasserman, 2020). Since network connections are channels for exchanging resources between

subjects, we argue that a high degree of centrality leads to pooling technology and knowledge to the subject occupying the central position (Huybrechts & Haugh, 2018).

First, centrally located subjects have access to a broader range of external assets such as technology, capital, and management skills from associated players. Second, because many information sources are integrated through their linkages, centrally located actors have faster access to new and vital information (Rogers, 1995). Third, high centrality implies higher status and power (Spanellis et al., 2021) as subjects with extensive connections tend to be perceived as having higher prestige (Brass & Burkhardt, 1992). As a result, centrally located subjects usually have access to better and more resources and opportunities (Centobelli et al., 2019; Hoffmann et al., 2018).

A new area resident enterprise that is not significantly central is at a disadvantage in accessing critical resources and information. An integrated complementary ecosystem will face multiple dimensions such as resources and components, making it challenging to achieve radical innovation. Compared to firms in integrated complementary ecosystems, firms in the hub and spoke complementary ecosystems could remain independent in terms of component complementarity and thus seek radical innovation paths despite being disadvantaged in terms of resources and information. Firms' resident in new areas with significant centrality has a clear advantage in accessing essential resources and information.

Thus, in the integrated complementarity state, the new area's resident companies face component complementarities that the benefits of centrality can overcome. In the hub and spoke complementarity state, the firms in the new area are more independent and autonomous in terms of interdependence in different dimensions, and therefore also tend to be radical innovators. Based on this, this study proposes hypothesis 3.

H3: When centrality is significant, integrated complementarity is positively associated with radical innovation for the new area resident enterprises.

5.3 Variables and measurement

(1) Dependent variable

In this study, based on theoretical research and pre-interviews, the subjects' behavioral choices for sustainable innovation in the new area, for example, radical and incremental innovation, were each replaced by lead layout and synergistic. The two indicators measured the extent of each of the two tendencies: the attractiveness of lead layout to the subjects, the likelihood of achieving lead layout, and the beauty of synergistic layout to the subjects, and the

likelihood of achieving synergistic layout.

Also, this study used a 7-point Likert scale to assign a value to the subjects' degree of preference, with 1 to 7 representing a low to the high degree of discretion. The questionnaire was used to test the correlation between the attractiveness and feasibility of sustainable innovation. The correlation coefficient between the attractiveness of the lead layout and the likelihood of lead layout was 0.875 ($p< 0.001$), and the correlation coefficient between the attractiveness of the lead layout and the likelihood of lead layout was 0.793 ($p< 0.001$). This indicates a strong correlation between the different layouts on the subjects' attractiveness and the likelihood of behavioral implementation. This study defines that the value of subjects' preference for radical innovation = value of subjects' preference for lead layout = value of attractiveness of lead layout to subjects + value of likelihood of subjects choosing lead layout; the value of subjects' preference for incremental innovation = value of subjects' preference for synergistic layout = value of attractiveness of synergistic layout to subjects + value of likelihood of subjects choosing the synergistic layout.

(2) Contextual variables

The success and failure of firms as open systems depend on how the interdependence with the external environment is managed (Astley & Fombrun, 1983; Pfeffer & Salancik, 2003). There are two primary manifestations of managing interdependence between firms and the external environment in existing research: ecosystems and social networks. An ecosystem consists of "a set of actors with varying degrees of multilateral, non-generic complementarity that are not entirely controlled by a hierarchy" (Jacobides et al., 2018). Social networks are formal and enduring inter-organizational relationships that are strategic to their members (Gulati et al., 2000). Social networks can provide a theoretical reference for this study as another manifestation of the interdependence between business management and the external environment. At the same time, the relevant elements of social networks can also provide a more realistic decision-making scenario for policy capturing studies. Therefore, elements of the ecosystem and social networks were selected as scenario variables to measure the sustainable innovation decision-making contexts of the new area resident enterprises.

At the ecosystem level, this study adopts Shipilov and Gawer's (2020) view to classify ecosystem component complementary structures as Hub and Spoke Complementary and Integrated Complementary. At the social network level, three characteristics of the structural embeddedness dimension, namely centrality (Kuskova & Wasserman, 2020), structural autonomy (R. S. Burt, 2001), and structural equivalence (P. Burt & Adelson, 1983), were selected to measure the position of the firm in the network.

To measure the above five elements, 0 and 1 represent insignificant and significant features, respectively. For example, when the value of hub and spoke complementarity is little, features of Hub and spoke complementarity in the enterprise. The specific values are given randomly in the simulated decision contexts.

(3) Control variables

The control variables in this study are mainly background control variables of the subject's enterprise, including the size, age, competition intensity, influence of the enterprise, whether the enterprise has foreign capital, whether the enterprise is state-owned, and whether the enterprise belongs to the high-tech industry. In this study, data were obtained through a demographic questionnaire accompanying the scenario questionnaire, and each control variable was measured using 1 to 5 or 0 to 1, depending on the actual situation.

5.4 Policy capturing analysis and results

5.4.1 Reliability and validity assurance

In sub-research two, a variety of methods were used to ensure the reliability and validity of data. The study referenced in this research used a policy capture approach to collect questionnaire data, which distinguishes from other questionnaires that are used to understand the real situation of the respondents. Instead, it designs a virtual scenario questionnaire by theoretically distilling Contextual factors (Zhu et al., 2021). Therefore, we combined the research questions and the questionnaire methodological objects to describe the research variables thickly to ensure that the variables in the questionnaire accurately reflect the theoretical definitions and that the variables have the reliability to directly reflect the theoretical elements.

At the same time, as mentioned above, there was no significant correlation among the explanatory variables in the questionnaire, possessing internal reliability. Regarding validity, we ensured the validity of the study in three ways. First, as is stated above, we conducted a rigorous screening of respondents to ensure that the questionnaire captured the target information. Second, we conducted in-depth interviews with a number of senior managers of the companies in the new area prior to the mass distribution of the questionnaire. After they completed the questionnaire, the researcher collected their comments on the question items, variable expressions, and then revised them. This ensured that subsequent respondents were able to understand the questionnaire content. Third, in view of the particularity of the

questionnaire composition captured by the policy, SUR regression analysis was specially adopted to ensure the validity of the regression analysis.

5.4.2 Description and correlation

The data from the valid questionnaires eventually obtained through the policy capturing method in this study were statistically analyzed to get the following correlation coefficients as shown in Table 5.1 and Table 5.2. Specifically, Table 5.1 shows the correlation analysis between the dependent and simulated decision-making scenario variables. Table 5.2 shows the correlation analysis between the dependent and actual variables.

Table 5.1 Correlation coefficients between dependent variables and simulated decision scenario variables

	1	2	3	4	5	6	7
1.Hub-and-spoke complementarity	1.000						
2.Integrated complementarity	0.000 (1.000)	1.000					
3. Centrality	0.000 (1.000)	0.000 (1.000)	1.000				
4.Structural autonomy	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	1.000			
5.Structural equivalence	0.000 (1.000)	0.000 (1.000)	0.00 (1.000)	0.000 (1.000)	1.000		
6. Collaborative layout	0.024 (0.435)	0.216 (0.000)	-0.025 (0.423)	0.128 (0.000)	0.121 (0.000)	1.000	
7. Lead layout	0.213 (0.000)	0.040 (0.203)	0.562 (0.000)	0.152 (0.000)	-0.004 (0.898)	0.007 (0.817)	1.000
Mean	0.50	0.50	0.50	0.50	0.50	8.68	8.86
SD	0.50	0.50	0.50	0.50	0.50	3.16	3.66

Note: N=1024, P values in brackets

Table 5.2 Correlation coefficients between dependent and actual variables

	1	2	3	4	5	6	7	8	9
1. Firm size	1.000								
2. Firm age	0.628 (0.000)	1.00							
3. Competition intensity	0.085 (0.007)	0.274 (0.000)	1.000						
4. Firm's influence	0.492 (0.000)	0.455 (0.000)	0.124 (0.000)	1.000					
5. State-owned capital	0.278 (0.000)	0.045 (0.147)	-0.080 (0.010)	0.388 (0.000)	1.000				
6. Foreign investment	0.285 (0.000)	0.241 (0.000)	0.023 (0.472)	0.107 (0.000)	-0.073 (0.020)	1.000			
7. High-tech industry	-0.162 (0.000)	-0.055 (0.079)	0.046 (0.145)	-0.050 (0.111)	-0.250 (0.000)	-0.088 (0.005)	1.000		
8. Incremental innovation	-0.002 (0.950)	0.056 (0.073)	-0.010 (0.758)	0.039 (0.215)	-0.067 (0.031)	0.003 (0.926)	-0.052 (0.099)	1.000	
9. Radical innovation	0.061 (0.053)	0.067 (0.033)	-0.033 (0.289)	0.019 (0.553)	-0.034 (0.272)	0.009 (0.772)	-0.025 (0.427)	0.007 (0.817)	1.000
Mean	2.06	2.72	3.86	3.40	0.25	0.02	0.33	8.68	8.86
SD	1.30	1.19	0.79	0.72	0.43	0.12	0.47	3.16	3.66

Note: N=1024, P values in brackets

5.4.3 Results of seemingly uncorrelated regression

The structure of the data obtained for this study based on the policy capturing questionnaire has the following characteristics: first, the values of each subject's decisions in each of the 16 contexts are not independent; second, the combined effect of multiple factors on the subject's decisions cannot be excluded. Given the particular circumstances of the data, the statistical methods required for this study must shed light on the relevance of the error terms in the statistical process. SUR (Seeming Unrelated Regression) can meet these requirements among the existing statistical methods. In contrast to traditional statistical methods, it ensures that the results obtained without standard error clustering are essentially the same as those calculated by conventional statistical methods (Arceneaux, 2009). Therefore, the SUR method was used in this study to process the study data, and the results are shown in Table 5.3.

Table 5.3 SUR regression analysis

Variables	Model I Radical innovation	Model II Incremental innovation
Cons.	5.435 (0.625, 0.000)	6.657 (0.660, 0.000)
Contextual variables		
Hub and Spoke complementarity	1.553 (0.178, 0.000)	0.140 (0.187, 0.455)
Integrated complementary	0.315 (0.179, 0.078)	1.404 (0.189, 0.000)
Centrality	4.136 (0.179, 0.000)	-0.114 (0.189, 0.547)
Structural autonomy	1.104 (0.178, 0.000)	0.798 (0.187, 0.000)
Structural equivalence	-0.029 (0.177, 0.871)	0.766 (0.187, 0.000)
Control variables		
Firm size	-0.024 (0.098, 0.803)	-0.194 (0.104, 0.061)
Firm age	0.238 (0.105, 0.023)	0.212 (0.111, 0.055)
Competition intensity	-0.236 (0.118, 0.046)	-0.150 (0.125, 0.229)
Firm’s influence	0.128 (0.156, 0.411)	0.388 (0.165, 0.018)
State-owned enterprises	-0.696 (0.242, 0.004)	-0.841 (0.255, 0.001)
Foreign-owned enterprises	-1.151 (0.762, 0.131)	-0.627 (0.804, 0.435)
High-tech companies	-0.117 (0.198, 0.556)	-0.513 (0.209, 0.014)
Chi2	675.42 (0.000)	113.63 (0.000)

Note: N=1024, with standard error and P-value in brackets, respectively

From the SUR regression data in Table 5.3, it can be seen that among the component

complementarity in ecosystems, hub and spoke complementarity is significantly and positively associated with radical innovation preferences of the new area resident firms ($p<0.001$), and integrated complementarity is significantly and positively related to incremental innovation preferences of the new area resident firms ($p< 0.001$).

Hypotheses 1 and 2 were tested. This suggests that the choice for radical innovation among the new area resident firms increases when the ecosystem's hub and spoke complementarity feature is significant. The preference for incremental innovation among the new area's resident firms increases when the integrated complementarity feature of the ecosystem is essential.

On this basis, this study also conducted a SUR regression analysis on the correlation between the component complementarity in ecosystems in a given social network context and firms' preferences for radical versus incremental innovation, as shown in Table 5.4.

Table 5.4 SUR regression analysis (centrality equals 0 or 1)

Variables	Model I Radical innovation	Model II Incremental innovation	Model I Radical innovation	Model II Incremental innovation
	centrality equals 0		centrality equals 1	
Cons.	5.713 (0.901, 0.000)	7.224 (0.877, 0.000)	9.257 (0.810, 0.000)	5.755 (0.956, 0.000)
Contextual variables				
Hub and spoke complementarity	1.930 (0.264, 0.000)	0.228 (0.256, 0.372)	1.184 (0.228, 0.000)	0.041 (0.268, 0.879)
Integrated complementary	-0.026 (0.271, 0.925)	1.933 (0.262, 0.000)	0.574 (0.228, 0.012)	0.935 (0.268, 0.001)
Structural autonomy	1.324 (0.264, 0.000)	0.727 (0.256, 0.005)	0.826 (0.229, 0.000)	0.892 (0.271, 0.001)
Structural equivalence	0.441 (0.264, 0.095)	0.633 (0.256, 0.013)	-0.530 (0.228, 0.020)	0.914 (0.269, 0.001)
Control variables				
Business size	0.117 (0.156, 0.452)	-0.363 (0.151, 0.016)	-0.135 (0.121, 0.262)	-0.111 (0.142, 0.437)
Operating time	0.075 (0.159, 0.638)	0.343 (0.154, 0.026)	0.407 (0.132, 0.002)	0.087 (0.156, 0.578)
The degree of competition in the business	-0.496 (0.178, 0.005)	-0.092 (0.173, 0.594)	0.039 (0.151, 0.795)	-0.213 (0.178, 0.233)
Corporate influence in the industry	0.363 (0.221, 0.101)	0.038 (0.214, 0.859)	-0.123 (0.212, 0.562)	0.838 (0.251, 0.001)
State-owned enterprises	-1.204 (0.366, 0.001)	-0.397 (0.355, 0.263)	0.072 (0.310, 0.817)	-1.322 (0.366, 0.000)
Foreign-owned enterprises	0.054 (1.413, 0.969)	-1.353 (1.370, 0.323)	-1.557 (0.843, 0.065)	-0.496 (0.994, 0.618)
High-tech companies	-0.573 (0.285, 0.044)	-0.334 (0.276, 0.226)	0.439 (0.266, 0.099)	-0.672 (0.314, 0.032)
Chi2	103.69 (0.000)	76.21 (0.000)	72.61 (0.000)	58.39 (0.000)

Note: N=512, with standard error and p-value in brackets, respectively

From the SUR regressions in Tables 5.4, it can be seen that hub and spoke complementarity is significantly and positively correlated with the radical innovation preferences of the new area residents when centrality is not significant ($p<0.001$), while integrated complementarity is not significantly associated with the radical innovation preferences of the new area residents. When centrality was important, hub and spoke complementarity was significantly and positively correlated with radical innovation preferences of new area residents ($p<0.001$), and integrated complementarity was also significantly and positively associated with radical innovation preferences of new area residents ($p<0.05$), and hypothesis 3 was tested.

5.4.4 Results and findings

First, this study found that hub and spoke complementarity is positively correlated with radical innovation by the new area's resident firms. Integrated complementarity is positively correlated with incremental innovation by the new area's resident firms. This implies that component complementarity in ecosystems strongly influences the new area residents' choice of sustainable innovation behavior. When making their sustainable innovation choices, new area resident enterprises need to consider the coordinated structure of the innovation output of different innovation agents in the ecosystem.

When the component complementarity in ecosystems is significantly hub and spoke complementarity, the innovation output of the various actors in the ecosystem, with the new area resident enterprises as the core, is less dependent on each other or on the components they carry. New area resident enterprises are more independent and autonomous in their components to achieve radical innovation. Incremental innovation requires new entrants to be familiar with the market and the relevant technology to build on what it already has. When the component complementarity in ecosystems is significantly integrated, the interdependence of each component is more substantial, and the level of understanding and synergy between them is more significant. Therefore, integrated complementarity can promote the choice of incremental innovation.

Second, this study finds that social network scenarios influence the impact of ecosystems on sustainable innovation. Specifically, when centrality is not significant, integrated complementarity is not significantly correlated with radical innovation among new area entrants; when centrality is important, integrated complementarity is associated substantially with radical innovation among new area entrants. This implies that the social network embeddedness of the new area's resident firms not only impacts their preferences for sustainable innovation as an independent influence but also acts as an important contextual factor that influences component

complementarity in ecosystems.

5.5 Summary of the policy capturing research

First and the most important, this sub-research has verified the effect of different component complementarities on radical and incremental innovation. In addition, we provide an integrated perspective of ecosystems and networks to study innovation. Numerous studies have shown that sustainable innovation in firms is influenced by component complementarities and network factors (Aka, 2019; Hernandez-Vivanco et al., 2018). Networks can provide firms in new areas with access to the resources and information needed to innovate and are a necessary condition and ground for firms to exploit component complementarity to achieve sustainable innovation (Castañer & Oliveira, 2020; Gnyawali & Ryan Charleton, 2018).

To this end, this sub-research further analyses and validates the relationship between component complementarities and sustainable innovation by developing a scenario questionnaire based on the integration of component complementarity in ecosystems and the structure embeddedness of social networks. It finds that when centrality is significant in a firm's embeddedness structure of the social network, there is a positive correlation between the hub and spoke and integrated patterns of complementarity in the ecosystem for both radical and incremental innovation. This provides a reference for the relationship between the structure embeddedness of social networks, component complementarity in ecosystems, and sustainable innovation.

Chapter 6: Conclusions and Future Study

Based on the research question "How does the component complementarity in ecosystems affect the sustainable innovation of enterprises in the new Area", this study sorted out the sustainable innovation theory and the component complementarity in ecosystems. On the basis of theory, this thesis introduces the theoretical scenarios and method of the research respectively in Chapter two and Chapter three. Then, through the case studies of the enterprises in 36 Kr Sichuan, Jiangxi City Construction and Yun Litchi in Chapter 4, this thesis summarizes the general rules of the relationship between the radiative and integrated component complementarity in ecosystems and the variables of radical innovation and incremental innovation of enterprises. In Chapter 5, this thesis designs a scenario-based questionnaire on component complementarity in ecosystems and structure embeddedness of social networks, combined with field research and interviews, to test the general patterns of relationships between component complementarity in ecosystems and sustainable innovation derived from the multi-case study. Finally, chapter 6 presents the conclusions, theoretical implications, management implications, research gaps, and future research perspectives.

6.1 Key conclusions

Based on the core research question -- the impact of component complementarity in ecosystems on the sustainable innovation of enterprises in the new area, this work explores the following two sub-studies. Sub-research one examined the relationship between the hub-and-spoke complementarities of the new area resident enterprises and the sustainable innovation of enterprises. The relationship between the integrated complementarities of the ecosystem of the new area resident enterprises and the sustainable innovation of enterprises. Secondly, the Sub-research two verifies the impact of the component complementarity in ecosystems of the new area resident enterprises on the sustainable innovation of enterprises.

In the sub-research one, using the multi-case study approach, three typical cases are selected and analyzed in this work. First, the intra-case analysis focuses on the projects of the three enterprises resident in the new area, the component complementarities of these projects, and studies the performance of sustainable innovation in the projects of the three companies. On this basis, we conduct a comparative analysis between the cases. The relationship between

hub and spoke complementarities and radical innovation is analyzed by comparing 36 Kr Sichuan and Yun Litchi. The relationship between integrated complementarities and radical innovation is analyzed by comparing 36 Kr Sichuan and Jiangxi City Construction. This work explored the following conclusions: the hub and spoke complementarities are conducive to the development of radical innovation in the new area resident enterprises; the integrated complementarities are conducive to the development of incremental innovation in the new area resident enterprises.

Based on sub-research one, the structure embeddedness of the social network of the new area resident enterprises is necessary for the enterprises to perform their component complementarity in ecosystems to achieve sustainable innovation. Based on this, we design a questionnaire for the study scenario through a quasi-experimental approach of policy capturing, in which component complementarity in ecosystems and the structure embeddedness of the social network together comprise the study scenario to restore the details of the managers in making decisions. In the end, through three rounds of data collection, a total of 71 questionnaires were collected for this study, of which 64 were valid, with a validity rate of 90.14%. This study aggregates the data from 64 businesspeople, with 16 radical versus incremental innovation selection scenarios assessed by each business person, for a total sample size of 1024 scenarios.

The results of this study show that the hub and spoke complementarity in ecosystems has a positive correlation with the radical innovation of enterprises in the new area, but has no significant correlation with the incremental innovation; the integrated complementarity is positively correlated with incremental innovation and not significantly correlated with radical innovation among the new area resident enterprises; the integrated complementarity is positively correlated with radical innovation in the new area resident firms when their centrality is significant.

6.2 Theoretical implications

This study focuses on sustainable innovation in the new area from the perspective of component complementarity in ecosystems, bringing theoretical insights into sustainable innovation and component complementarity in ecosystems.

(1) To realize sustainable innovation, the enterprises settled in the new area need to consider both radical innovation and incremental innovation.

As the external environment changes rapidly, firms increasingly need sustainable innovation to adapt to the changing environment, focusing on radical and incremental innovation. Sustainable innovation cannot be achieved by one or the other but by combining the two (Lupova-Henry & Dotti, 2019). On the one hand, companies need radical innovation to create new ventures in their development process that did not exist in the previous ecosystem, reconstruct existing perceptions and market relationships. On the other hand, companies also need incremental innovation to make minor adjustments and improvements to their existing products, services, and businesses to improve operational efficiency. Radical innovation and incremental innovation are two essential approaches to sustainable innovation for companies in the new area, and effective coordination between them is key to achieving sustainable innovation.

(2) The component complementarity in ecosystems affects sustainable innovation of new area resident enterprises.

To achieve sustainable innovation, the enterprises resident in the new area need to consider their components and other components in the ecosystem and interdependencies (Adner & Feiler, 2019). From an ecosystem perspective, different components and their component complementarity have different impacts on sustainable innovation (Shipilov & Gawer, 2020). For example, an ecosystem's upstream and downstream components have differentiated impacts. Therefore, this work examined the effect of the hub and spoke and integrated patterns of complementarity in the ecosystem on sustainable innovation (Hoffmann et al., 2018; Thomas & Autio, 2019). The work finds that the hub and spoke complementarities favor the development of radical innovation and the integrated complementarities favor the development of incremental innovation. This provides an appropriate complement to the relationship between component complementarity in ecosystems and sustainable innovation.

(3) The relationships between component complementarity in ecosystems and sustainable innovation are influenced by social networks.

Numerous studies have shown that sustainable innovation in firms is influenced by component complementarities and network factors (Aka, 2019; Hernandez-Vivanco et al., 2018). Networks can provide enterprises in new areas with access to the resources and information needed to innovate and are a necessary condition and ground for firms to exploit component complementarity to achieve sustainable innovation (Castañer & Oliveira, 2020; Gnyawali & Ryan Charleton, 2018).

To this end, this works further analyses and validates the relationship between component complementarities and sustainable innovation by developing a scenario questionnaire based on

the integration of component complementarity in ecosystems and the structure embeddedness of social networks. It is found that when centrality is significant in a firm's embeddedness structure of the social network, there is a positive correlation between the hub and spoke and integrated patterns of complementarity in the ecosystem for both radical and incremental innovation. This provides a reference for the relationship between the structure embeddedness of social networks, component complementarity in ecosystems, and sustainable innovation.

6.3 Practical implications

In recent years, new areas and new cities have become the key to drive the rapid economic development of the area. As an essential component of the new area, the enterprises in the new area need to follow the development trend of the new area and seek sustainable innovation to meet the needs of the new area. On this basis, this thesis selects three enterprises settled in the new area to explore the relationship between the component complementarity in ecosystems and sustainable innovation. The relationships between component complementarity and sustainable innovation are then tested through a quasi-experimental approach. The results of this work have practical implications for achieving sustainable innovation in the new area.

(1) understanding sustainable innovation of a firm and impact factors.

As an important driving force in the development and reform of China's economic system, the new areas have assumed an essential historical task in the latest round of deepening reform and sustainable economic and social development in China. As a critical player in the sustainable innovation process in the new areas, the enterprises in the new areas are essential vehicles for developing the new areas and transforming their models. For the enterprises in the new area, they need to be aware of the factors that influence the process of sustainable innovation. This research finds that different enterprises are located in diverse ecosystems and social networks, which require different components, resources, and capabilities for sustainable innovation and exhibit various sustainable innovations. Therefore, enterprises in new area need to choose an excellent radical or incremental innovation about their position in the ecosystem, components, and ability to access resource information, bargaining power, and other factors.

(2) understanding and managing the interdependence between firm and external environment.

With the rapid development of the economy and society, the interdependence between the actors involved in the business community has become more intense. At the same time, the interaction between enterprises and their external environment is becoming more frequent.

When enterprises innovate, they no longer rely on their strengths, but also needs to comprehensively consider other participants and the interdependent relationship between them. Therefore, factors such as which components are present in the firm's ecosystem and the complementary structure of the interdependencies of the components will influence sustainable innovation. At the same time, the state of the firm's structure embeddedness of social networks can also influence sustainable innovation. For firms to innovate sustainably, they need to be fully aware of the ecosystems and social networks in which they operate and manage these different interdependencies effectively.

6.4 Limitation and future research

The research is explored through a multi-case study approach and a quasi-experimental approach. From the perspective of case analysis, the research discusses the relationship between component complementarity and sustainable innovation in the projects of the case firms. Based on this, social network structure embeddedness scenario is added to form the component complementarity in ecosystems and social network structure embeddedness characteristics scenario questionnaire for a deeper exploration. Due to the objective factors of knowledge structure, research ability, and research conditions, this study has some deficiencies that need to be further addressed in future research. The shortcomings of the study and the outlook for future research are as follows.

First, the case companies selected for this study are all settled enterprises in the new area of Chengdu, Sichuan. As innovation resources, policies and technologies vary from region to region, sustainable innovation and the required components and component complementarity in ecosystems are different from area to region. Therefore, the findings of this research can be further extended to enterprises in other provinces, cities, and counties with higher or lower levels of innovation, and further research needs to be explored.

Second, the research examines the relationship between component complementarity and sustainable innovation in firms by using the structure embeddedness of social networks as a research scenario in a quasi-experimental approach. In fact, both the component complementarity and the structure embeddedness of social networks are two different forms of interdependence. This research only examines the relationship between component complementarity and sustainable innovation, and future research could further investigate the relationship between social network structure embeddedness and sustainable innovation.

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Annex A: Details of Questionnaire Collection Process

First, by reading a large amount of literature, we sorted out the factors influencing firms' sustainable innovation behavior. At the same time, combined with the actual situation of the observed companies, we summarized the preference items for the acquisition of sustainable innovation behavior of companies that fit the actual scenario. After several iterations of discussion with the research team, any unreasonable and imperfect points were corrected.

Second, we selected representative companies such as 36 Krypton Sichuan, Jiangxi City Construction, and Yun Litchi for in-depth exchanges. For the final behavioral preferences, we explored the different sustainable innovation behaviors of the target companies as a practical basis for the questionnaire design. We conducted a dialogue through an exchange between scholars and practitioners for Contextual factor refinement. This exploration ensures that the questionnaire design can be mapped to the theory while avoiding the research being divorced from the actual situation.

Third, a scenario questionnaire was developed based on the research framework, with each factor having two states of significance and insignificance. Value means that the element is more evident in the scenario and needs to be focused on, while smallness implies it is general. The contexts are formed by randomly combining the different shapes of each factor. We use a 7-point scale to characterize managers' preferences for two innovative behavioral decisions, ranging from 1 to 7, with higher scores indicating a higher probability of choosing the behavior or its occurrence.

Fourth, the challenging part of the policy capturing study was describing and understanding the contexts. To enable policymakers to understand the contexts constructed by the questionnaire effectively, the research team led by the author and the entrepreneurs repeatedly discussed the format and presentation of the questionnaire and conducted rigorous training for the field deliverers. Based on existing research, 16 contexts were developed, whereby a participant was asked to complete 16 contexts simultaneously and score preferences for decision-making behavior.

Fifth, once the scale design was completed, we first distributed it on a small scale. We also asked the subjects to rank the Contextual factors in the pre-study course. In addition to completing the questionnaire, we also interviewed the subjects to identify the problems

thoroughly. The scale data collected was tested for reliability and validity, and, together with the suggestions made by the participants, the questionnaire was adjusted and amended in preparation for the large-scale distribution.

Sixth, after adjusting the questionnaire after the pre-study, we started the official mass distribution. The questionnaires containing 16 specific contexts were distributed to the participants in work form; they were asked to read the instructions and go through all the contexts before completing the questionnaire. Once we had a global understanding of the questionnaire, we asked the participants to start filling it out, scoring their preferences for innovative decision-making in different contexts.

Seventh, we record the whole process of completing the questionnaire, mainly for later review. If there is a conflict between the participant's understanding of the contexts, we will call back to ensure consistent decision-making. If the participant cannot re-understand the situation, the questionnaire will be considered invalid and will not be counted as part of the final.

Eighth, after the questionnaires were collected, we first summarized all the data and then analyzed the extracted data using descriptive statistics and Seeming unrelated regression (SUR) regression analysis. Based on the analysis study, the proposed hypotheses were formulated, and the conclusions of this work were drawn.

Annex B: Policy Capturing Questionnaire

Instructions for completing the New Area Enterprise Innovation Behavior Simulating Decision-making Form

Before filling out the form, please read the following instructions for filling out the simulating decision-making form carefully!

1. Assuming that you are a top manager of a firm resident in the new area.

2. According to how to handle the relationship with other subjects of innovation, we divide the innovation behavior of enterprises in the new area into two types: collaborative layout (which can be interpreted as innovation made in cooperation with others) and lead layout (which can be interpreted as proactively initiated innovation).

3. Simulation of decision-making scenarios consisting of business and enterprise position, determined by component complementarity (external componental relationships required by the business) and structural embeddedness (location in the business network of the enterprise, which affects the access of the enterprise to resources and information).

4. Each key element has two different states namely significant state and insignificant state. Significant (marked in black) means that the element is more obvious in the scenario and needs to be focused on, and insignificant means that it is in a general state.

5. Each scenario is followed by a preference scale for two innovative choice behavioral decisions, ranging from 1~7, with higher scores indicating a higher probability that you will ultimately choose the behavior or that it is more likely to occur.

6. Please complete the preference scale and choice scale for the two innovative choice behaviors based on the assigned values of the Contextual factors in each scenario and your knowledge and experience.

7. The questionnaire is accompanied by a demographic questionnaire, please fill out based on your business and your own situation, and the data is used only for calibration and study of simulated decisions and is not made public.

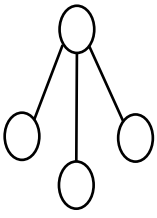
Description of scenario elements

❖ **Component complementarity:** the relationship between the external components required to realize the business

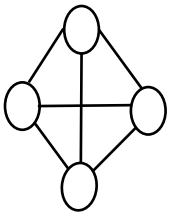
❖ **Structural embeddedness:** the position of the company in the business network, this position affects the access to resources and information

	Contextual factors	**Explanation**
Component complementarity	Hub and Spoke complementarity	There are independent structures in the external components required to realize the business
	Integrated complementarity	There is an interconnected structure in the external components required to realize the business
Structural embeddedness	Centrality	Companies are at the heart of business networks and are associated with many important subjects.
	Structural autonomy	Enterprises are the channel for other subjects to connect with each other, and can play the role of matchmaking
	Structural equivalence	The presence of companies in a similar position to yourself in the business network

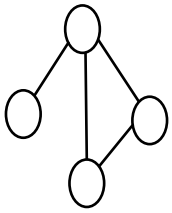
	Explanation
Collaborative layout	Companies respond to the innovation needs of others, seek supply and demand gaps, and collaborate
Lead layout	Companies initiate innovation goals, explore potential models, and lead



Significant Hub and Spoke complementarity
Insignificant Integrated complementarity



Insignificant Hub and Spoke complementarity
Significant Integrated complementarity



Significant Hub and Spoke complementarity
Significant Integrated complementarity

Significant Hub and Spoke complementarity
Insignificant Integrated complementarity

Insignificant Hub and Spoke complementarity
Significant Integrated complementarity

Significant Hub and Spoke complementarity
Significant Integrated complementarity

Scene 1

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity		√
Structural embeddedness	Centrality	√	
	Structural autonomy	√	
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 2

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity	√	
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 3

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity		√
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 4

	Contextual factors	Insignificant	Significant
Component Complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity		√
Structural embeddedness	Centrality	√	
	Structural autonomy		√
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 5

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity	√	
Structural embeddedness	Centrality		√
	Structural autonomy		√
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 6

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity	√	
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 7

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity	√	
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 8

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity		√
Structural embeddedness	Centrality	√	
	Structural autonomy		√
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 9

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity	√	
Structural embeddedness	Centrality		√
	Structural autonomy		√
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 10

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity		√
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 11

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity	√	
	Integrated complementarity		√
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 12

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity		√
Structural embeddedness	Centrality	√	
	Structural autonomy	√	
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 13

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity		√
Structural embeddedness	Centrality		√
	Structural autonomy		√
	Structural equivalence	√	

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 14

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity		√
Structural embeddedness	Centrality		√
	Structural autonomy	√	
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 15

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity		√
Structural embeddedness	Centrality	√	
	Structural autonomy		√
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Scene 16

	Contextual factors	Insignificant	Significant
Component complementarity	Hub and Spoke complementarity		√
	Integrated complementarity		√
Structural embeddedness	Centrality		√
	Structural autonomy		√
	Structural equivalence		√

Based on the above information and your knowledge and experience, how attractive to you are the following two behavioral options：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

Based on the above information and your knowledge and experience, how likely are the following two behavioral options to be realized：

	1	2	3	4	5	6	7
1. Collaborative layout：	□	□	□	□	□	□	□
2. Lead layout：	□	□	□	□	□	□	□

About Person:

1. Your name: _____

2. Your gender:

A: Male B: Female

3. Your working age:

A: less than 1 year B: 1-3 years C: 3-5 years D: 5-10 years E: more than 10 years

4. The department in which you worked last time:

A: Technical department B: Marketing and sales department C: Finance department D: Decision-making department E: Other departments

5. Your duty: _____

About Enterprise:

6. Number of employees:

A: 50 people or less B: 50-99 people C: 100-299 people D: 300-999 people E: 1000 people or more

7. The age of the enterprise

A: less than 3 years B: 3 years-5 years C: 5 years-10 years D: 10 years- 20 years E: more than 20 years

8. The industry the company belongs to is: _____

9. Enterprises landing in the new area are: _____

10. The degree of competition in the industry:

A: Very low B: Low C: Normal D: High E: very high

11. The influence of the company in the industry:

A: Very small B: Smaller C: Normal D: Larger E: very large

12. Do you have any experience in other new areas?

A: Yes B: No

13. The nature of the company

A: State-owned enterprise B: Private enterprise C: Foreign investment/Sino-foreign joint venture