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How to build an innovation ecosystem in enterprises -- taking 3nod as an example

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-- TAKING 3NOD AS AN EXAMPLE

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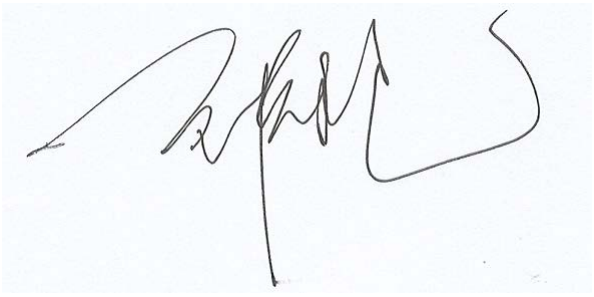
2022

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

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

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



Liu Zhi Xiong
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ABSTRACT

HOW TO BUILD AN INNOVATION ECOSYSTEM IN ENTERPRISES -- TAKING 3NOD AS AN EXAMPLE

LIU ZHI XIONG

In recent years, the global economy has been sluggish, especially affected by the Sino-USA trade war and the COVID-19, the harsh market environment and increased business uncertainty. In addition, China's manufacturing industry is facing the impact of disappearance of the demographic dividend and strict environmental protection policies, so they are facing tremendous pressure for survival. At the same time, a new generation of science and technology continues to sprout and gradually penetrates in to production and life. Therefore, under these conditions, the innovation activities of manufacturing enterprises are more important and urgent. How to construct systematic innovation activities for manufacturing enterprises is a basic problem that cannot be avoided. Therefore, the research in this dissertation focuses on how core firms build enterprise innovation ecosystems based on technological and non-technological innovation and other multi-dimensional innovation management elements.

Based on the micro perspective of the core firm in the enterprise innovation ecosystem, this dissertation first sorts out the definition of the core enterprise concepts in the enterprise innovation ecosystem. On this basis, from the different dimensions of enterprise innovation management, it carries out an

exploratory single-case study of the corporate innovation ecosystem constructed by the famous domestic enterprise 3nod Group.

Through the coding and analysis of the qualitative materials of realization nodes for the five innovative ecological unit of the unique OPM model of 3nod, this dissertation summarizes as follows: (1) Based on the external macro innovation environment, the core firm takes the user as the core, builds an innovation platform, and uses the technology synergy connection mechanism to establish different levels of cooperation relationship with technical resources parties and build an enterprise technology innovation ecosystem; at the same time, relying on the non-technical innovation peripheral support system with strategic innovation as the blueprint, cultural innovation as the guide, management innovation as the foundation, organizational innovation as the guarantee ,institutional innovation as the driving force and market innovation as the pathway, the core firm and related partners jointly establish an enterprise innovation ecosystem. (2) The core firm must effectively integrate the innovation management elements of technology, strategy, management, culture, organization, system, and market, so as to form a dynamic relationship with each other, and realize the continuous interaction between enterprises and users; and through build an innovation platforming, a fast and effective cooperation mechanism can be built between core enterprises and technical resource parties, the allocation of innovation resources within the system can be optimized , and mutual promotion and co-evolution among members in system can be realized .

The research conclusions of this dissertation supplement and expand the existing theories of enterprise innovation ecosystems, and provide references

for innovation enterprises that are exploring the practice of constructing enterprise innovation ecosystems with themselves as the core.

Keywords: Research on Internal and External Factors; OPM Model; Technology Innovation Ecosystem; Non-technology Support System.

CONTENTS

ACKNOWLEDGEMENT

Time flies, and with the gradual completion of the doctoral dissertation, the five-year study is coming to an end. From Cheung Kong Graduate School of Business to Singapore Management University, bits and pieces spread in my mind.

The author founded 3nod in 1996 with the passion of entrepreneurs and the unique temperament of the land of Shenzhen. After many years of management practice in the company, I constantly found that my knowledge structure needs to be broadened, so the author started a road of continuous learning, and from 2002 to 2003 I studied for an MBA at Royal Road University in Canada. From 2005 to 2007, I joined the CEO President Class II of Cheung Kong Graduate School of Business. In February 2014, I was fortunate to be awarded an honorary doctorate by the European University of Belgium. In 2014, I started the second phase of DBA of the Cheung Kong Graduate School of Business for the business management field. During this period, the individual's professional knowledge has been improved, and my international vision has also been opened up at the same time.

What is worth recalling here is the fate of I and Cheung Kong Graduate School of Business. When the Cheung Kong Graduate School of Business was established in 2002, I once remembered that Mr. Xiang Bing, the founder of Cheung Kong Graduate School of Business said: "We must make Cheung Kong Graduate School of Business a world-class business school." The academic atmosphere and broad vision of CKGSB make the author very yearning. So, I was fortunate to be one of them in 2005. During my studies, I served as the president of the Shenzhen Alumni Association of Cheung Kong Graduate

School of Business, and I had a lot of conversations with Liu Jin, the president of the Cheung Kong Graduate School of Business, and gradually understood the inheritance spirit of the Cheung Kong Graduate School of Business. Later, the DBA classes of Cheung Kong Graduate School of Business and Singapore Management University provided me with a broader international perspective, globalized teaching and cultivation, as well as excellent classmate resources, furthermore, I has ever obtained an honorary doctorate in law; and I inevitably feel that I need higher levels of learning to demonstrate the weight of this honor at the same time I am full of joy. The Cheung Kong Graduate School of Business and Singapore Management University's DBA doctoral program has realized my dream. Of course, from the perspective of the deeper level, DBA has a deeper and wider height than the CEO class. After participating in the study, I encountered elites from all walks of life, top entrepreneurs from all walks of life, and cross-industry thinking in subdivided industries. The international visions of the professors have a great impact on me, which makes me extremely grateful to them up to now.

For the reason that I chose the theme of “enterprise innovation ecology”, I remember that at the first theme seminar, I was encouraged by the class monitor of Fang Chao, and I made a speech on the theme of “enterprise innovation ecology”, which was unanimously affirmed by the students. Later, in the continuous practices of 3nod, we gradually and deep studied the knowledge and cases in this field. In addition to the tremendous changes in China’s domestic economy in recent years, the gradual maturity of 5G, Internet of Things, AI, and big data has had a big impact & challenge on China’s manufacturing industry, which prompted the author to study the construction of “enterprise innovation

ecology” under new conditions. Looking back on this learning period, I found that it played a very important role in the development of 3nod. In order to summarize this process, coupled with various opportunities, I have the full draft of the dissertation up to now.

I would like to thank Professor Tan Wee Liang from Singapore Management University and Professor Jianwen Liao from Cheung Kong Graduate School of Business for their guidance on the dissertation, especially Tan Wee Liang, who visited 3nod in Shenzhen, carefully guided the author's dissertation framework, research methods and key links through email, WeChat, and telephone. Professor Liao also asked about the progress of the dissertation many times, and put forward guiding opinions on the key issues of the dissertation. I would also like to thank Vivian Yao from Cheung Kong Graduate School of Business for her guidance on the procedures, the progress, and ethical review methods of the dissertation in the process of forming the dissertation. At the same time, I also express gratitude and respect to the colleagues of 3nod, who once supported 3nod's case researches, interviews and discussions.

Finally, I would like to express my gratitude to the family members who support my work. Without their support, the author may not be able to stick to it.

I would like to take this opportunity to wish all the mentors of Cheung Kong Graduate School of Business and Singapore Management University good health and happiness, although the doctoral dissertation has come to an end, there is no end in learning. As your student, I hope to have the opportunity to continue to be taught by you in the future. Thanks!

Chapter 1：The origin of the research

Research Background and Practical Guiding Significance

Since 2015, the internal and external environments faced by Chinese companies have undergone profound changes. It is mainly manifested in two aspects. First, the global political and economic landscape has undergone tremendous changes, especially in the past two years, due to the impact of the COVID-19, the international supply chain has become extremely fragile. Second, global technological innovation has ushered in new revolutionary changes; with 5G, Internet of Things, big data and Artificial Intelligence representing the new generation of information technology, they have gradually matured, which marks that human beings has entered the intelligent era from the information age and opened the Internet of Everything, and at the same time, they gradually penetrate into all aspects of industries and enterprises, and have a positive impact on the production, management and business models of enterprises.

SMEs are facing serious sustainable development dilemma:

Under the above new conditions, SMEs must find new development models and development methods, and choose to build an innovation ecosystem that suits themselves, which is a crucial strategic choice;

Due to the typicality of its industry, 3nod has been devoted to exploring and building an innovation ecosystem suitable for itself for many years. Therefore, analyzing the construction process of 3nod's innovation ecosystem is beneficial to the majority of SMEs for reference；

Raising the questions of research

In terms of regional innovation ecology, Silicon Valley in the United States, Zhongguan village in my country, and Nanshan High-tech Park in Shenzhen are all typical national and regional innovation ecosystems. They have greatly promoted technological innovation and rapid economic development. At the same time, Haier, Alibaba, Apple, Microsoft, Huawei and other companies have successively built an enterprise innovation ecosystem with themselves as the core, using their strong competitive advantages and advanced management concepts to continuously create disruptive products in a rapidly changing market, continue to grow and develop and gain sustainable competitive advantages. In academia circle, Adner (2006) first cited the concept of innovation ecosystem at the enterprise management level. He believes that the enterprise innovation ecosystem is the integration of innovation activities by various innovation entities to form a set of customer-oriented and mutual coordinated system[1]. Foreign scholars have carried out empirical research on the enterprise innovation ecosystem from various perspectives such as business ecology, innovation network, and platform ecology[2]. In China, the current research on the "innovation ecosystem" focuses on theoretical reviews and is at

① Adner R. Match your innovation strategy to your Innovation Ecosystem [J].Harvard Business Review.2006,84(4):98.

② Iansiti M，Levien R．Strategy as Ecology[J].Harvard Business Review,2004(3):51-62．Nambisan S, Sawhney M. Orchestration Processes in Network-Centric Innovation: Evidence Fromthe Field[J]. Academy of Management Perspectives,2011, August:40-57.Scholten S, et al. Platform-based Innovation Management: Directing External Innovational Effortsin Platform Ecosystems[J].Journal of The Knowledge Economy.2012(3):164-184.

an early stage[3]. And there is still a lot of room for imagination and research[4]. Most of the existing researches

Enterprise technology innovation ecosystems are based on the perspective of enterprises as well as from the perspective of technological innovation, and few scholars have comprehensively examined the construction of enterprise innovation ecosystems from the non-technological innovation management dimensions such as the enterprise's internal strategy, culture, system, market and so on. And few scholars analyze how multi-dimensional enterprise innovation management elements affect the construction mechanism of enterprise innovation ecosystems from the micro perspective of enterprise product innovation.

In industries and enterprises, the theory and practice of foreign companies building a global corporate innovation ecosystem is gradually emerging. There is a lack of research on corporate innovation ecosystems from a micro perspective in the Chinese context. Most domestic companies are still in the stage of partial innovation, even innovative companies. These enterprises are in urgent need of many successful local cases to provide guidance and assistance to the construction of its corporate innovation ecosystem. Therefore, it is urgent to trace the relevant international frontier theories and practices and vigorously carry out case studies of domestic enterprise innovation ecosystems based on local contextualization.

③Mei Liang,Chen Jin,Liu Yang.Innovation Ecosystem: Origin, Knowledge Evolution and Theoretical Framework[J].Research in Science of Science, 2004,12:1771-1780.

④ Zeng Guoping, Gou Youzhao, Liu Lei.From "innovation system" to "innovation ecosystem"[J].Science of Science Research,2013,01:4-12.[15]Yang Rong.The definition, characteristics and construction of innovation ecosystem[J]. Science and Management, 2014, 03:12-17.

To sum up, this dissertation starts from the micro perspective of the innovation ecosystem, takes core firms in the enterprise innovation ecosystem as the perspective and is based on the different dimensions of enterprise innovation management, and uses an in-depth analysis of the realization nodes of each value chain of innovation products to explore the construction mechanism of the enterprise innovation ecosystem from the perspective of core firms, that is, how core firms to build enterprise innovation ecosystems based on three levels of technological innovation and non-technical innovation systems and living environment.

Main Innovation Points

(1) Research methods. This dissertation adds and expands the influencing factors of the internal and external motivation models involved in the "Research on the Construction Motivation of Enterprise-Centric Open Innovation Ecosystem" by Professors Han Shaojie and Lv Yibo from the School of Economics and Management of Dalian University of Technology, making it more suitable for the actual situation of manufacturing enterprises, and making the internal and external factors evaluation system of the innovation system enterprises construct more perfect.

(2) Research content and conclusions. By analyzing the practice of 3nod innovation ecosystem construction, it is concluded that general manufacturing enterprises must build innovation ecosystem around their own technological innovation system (layer), non-technical support system (layer), living environment system (layer), among which the core difficulty lies in how to conclude and summarize the technological innovation ecosystem around the core abilities of manufacturing enterprises.

(3) The advantage of 3nod's innovation ecosystem lies in that it revolves around OEM and ODM enterprises and develops an OPM model suitable for its own development advantages to obtain its own competitive advantage on the basis of OEM and ODM. This model has been successful in 3nod's innovation practice, which has brought 3nod a competitive advantage. This is a new enlightenment for consumer electronics manufacturing industry.

The specific methods of research

The research methods of this dissertation mainly include:

（1) Method of literature research: Mainly through domestic and foreign literature research and review, this dissertation summarizes the current status of related research on corporate innovation ecosystem and analyzes the contributions and deficiencies of existing research, putting forward the research questions and main content of this research, and at the same time, it lays a theoretical foundation for the construction of the research analysis framework and the field investigation of follow-up case studies.

(2) Method of content analysis: Taking the relevant domestic and foreign literature as the research object, this dissertation analyzes and studies the concept of enterprise innovation ecosystem and the definition standard of core enterprise and ensures the scientificity and accuracy of this research.

(3) Investigation method: conducting on-site investigation of the case company of 3nod Group, we collected relevant original data and information through semi-structured interviews, structured interviews, direct observations, and participatory observations.

(4) Method of case study: On the basis of summarizing research data and analyzing and summarizing the coding of qualitative data materials, this

dissertation conducts an exploratory single Case study on the relevant theories of the case company's construction of an enterprise innovation ecosystem from two aspects of technological innovation and non-technological innovation, and explores the mechanism of constructing an enterprise innovation ecosystem from the perspective of core enterprises.

(5) Method of Grounded Theory Research: On the basis of the existing research, this research constructs the relationship between core enterprises based on the related concepts of technological innovation and non-technical innovation systems based on first-hand and second-hand case investigation data, and analyzes and refines the relevant theories of the construction mechanism of the enterprise innovation ecosystem.

Chapter 2：Key literature review

Open Innovation System of Enterprises Concept of innovation

American- Austrian Schumpeter (J.A. Schumpeter) first proposed the concept of "innovation" in 1912, that is, innovation is to obtain potential profits, and introduce a kind of " A new combination of elements" that has never appeared in this production system. "[5]. Since the concept of innovation, it has always been a hot issue of the domestic and foreign academic circles and the industry. Chinese scholar Chen Jin proposed in his "Innovation Management" that innovation is not only the entire process of from the generation of new ideas (creatives) to research, development, and trial production, manufacturing, and first commercialization, and also represents an ability to transform knowledge, foresight, and adventurous spirit into wealth[6].

Innovation is universal and manifests in various forms. Innovations can be made in many aspects such as products, services, processes, and business models, for example, manned space engineering innovation, social system innovation, market path innovation, and financial loan system innovation, etc. However, it should be emphasized that invention and creation are only the initial stage of innovation, and the commercialization process in the final stage is the most important part of the entire innovation process. If the original technology invention, product or service cannot be introduced to the market, it cannot be called a successful innovation. Therefore, by comparing the concepts of

⑤ Schumpeter's "Theory of Economic Development" He Wei, Yi Jia detailed translation. Commercial Press 1991. Preface P3, P4.

⑥ Chen Jin, Zheng Gang. Innovation Management[M]. Peking University Press. 2013.

"innovation" with "invention" and "creation", the following formula can be derived[7]:

Innovation = Creation + Development + Commercialization

Open innovation

With the increasing complexity of the innovation process and the increasing complexity and diversification of consumer demand, it is no longer possible for a single enterprise to have all the technologies and resources required for innovation, and it is gradually unable to meet the needs of consumers alone. At the same time, in the digital economy era, science and technology are changing rapidly, and the speed of product upgrading is constantly accelerating. Therefore, the closed innovation model of enterprises in the past is gradually replaced by the open innovation model. Successful corporate innovation increasingly depends on effective cooperation with various external organizations or individuals, and innovation entities jointly achieve breakthroughs in core technologies. Many large-scale innovative companies in the industry have also proved the importance and necessity of open innovation through practice. They use open innovation to establish and maintain their core competitiveness and strong competitive advantages, such as Procter & Gamble, IBM, Haier, Google, Apple, etc. Chesbrough put forward the concept of open innovation in 2003. In the process of technological innovation, companies use internal and external complementary innovation resources to achieve innovation, that is, companies can realize the commercialization of innovative products through internal technology

⑦ Chen Jin, Zheng Gang. Innovation Management[M]. Peking University Press. 2013.

pathways and other external channels. It is called a type of innovation model that dynamically cooperates with multiple partners from multiple angles at each stage of the innovation chain[8]. As the degree of openness in innovation continues to increase, more and more companies are beginning to use a completely open innovation model to establish a win-win model innovation with partners such as consumers, R&D institutions, universities, suppliers, distributors, and even competitors, sharing innovative resources, mutual benefit and reciprocity. Chen Yufen (2007) divides innovation into closed innovation, cooperative innovation, open innovation and network organization innovation based on the degree of openness of innovation. For details, see Figure 2.1 below[9].

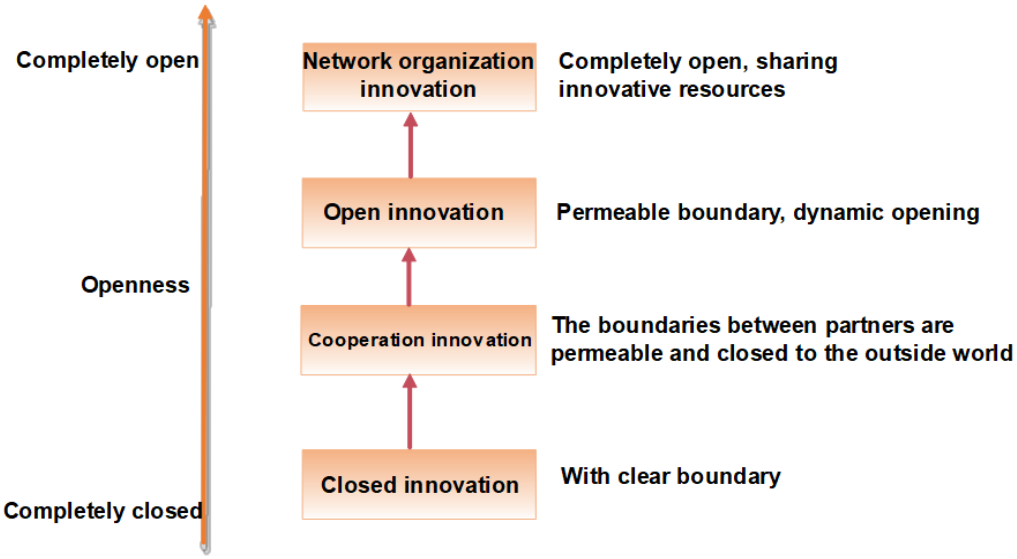

Figure 2.1 Comparison of openness and characteristics of innovation models

Completely closed, completely open, and network organization innovation. According to the current practice of the industry's openness to innovation and

⑧ Chesbrough H., Open Innovation: the New Imperative for Creating and Profiting fromTechnology[M], Harvard Business School Press, 2003.

⑨ Chen Yufen. Research on the Mechanism and Dynamic Model of Open Innovation[D]. School of Management, Zhejiang University, 2007.

the academic community's focus on open innovation theories, completely open innovation models can be divided into network innovation and innovation ecosystems, that is, from the perspective of the network system and the ecosystem, the evolutionary model that is becoming more and more fully open innovation is viewed.

Enterprise Network Innovation

Freeman first proposed the concept of Networks of Innovation in 1991, that is, an innovation network is an institutional arrangement to deal with systemic innovation, and its connection mechanism is the innovative cooperation relationship between enterprises, which promotes the effective absorption of resources between enterprises on innovation knowledge and other resources[10]. Gulati et al. (2001) believed that this dynamic and open system structure was conducive to accurate industry positioning, access to key resources, and cost savings in cooperation in enterprises[11]. Tracey & Clark (2003) proposed that the basic technology platform for technological innovation among enterprises is the main connection mechanism of its network architecture. In network alliances, flexibility and adaptability are key factors for solving problems and carrying out innovative activities among enterprises[12]. Nambisan (2011) studied how to manage the key process of network innovation carefully, and proposed that in the network innovation system, the core enterprise should start from the two dimensions of network structure and innovation design, and effectively manage the three key processes of network innovation: Management

⑩ Freeman C. Networks of innovators: A synthesis of research issues,[J].ResearchPolicy,1991,(20) :499-514.

⑪ Gulati R,Nohria N,Zaheer A,Strategic Network[J]. Strategic Management Journal,2000,(21).

⑫ Paul Tracey, Gordon L. Clark. Alliances, networks and competitive strategy: rethinking cluster ofinnovation[J]. Growth and Change. 2003, 34(1): 1-16.

of Innovation Lever, Management of Innovation Consistency and Management of Innovation Specificity[13]. From the perspective of two uncertain factors of technology and market, Cheng Yue (2011) et al. divided the innovation networks into six types: shrinkage, stability, strengthening, dynamic balance, contraction, and turbulence[14]. Xie Yongping (2012) analyzed the interaction mechanism between core enterprises and innovation networks on the basis of summarizing the status quo of domestic and foreign scholars' research on relationship governance and network governance[15]. Peng Huatao (2014) proposed that the corporate innovation network not only builds innovation alliances and innovation communities for startups, but also provides a favorable guarantee for startups to directly or indirectly obtain innovative resources and create value[16].

Concept of enterprise innovation ecosystem

Tansley first proposed the concept of Ecosystem in 1935. He believes that an Ecosystem is "a community or collection composed of organisms or the physical environment associated with it in a specific place"[17]. With the development of economy and society, the scope of application of ecosystem theory is continuously expanding, and it is gradually being used for reference by experts in the fields of economics, management, and sociology, making use

⑬ Nambisan S, Sawhney M. Orchestration Processes in Network-Centric Innovation: Evidence Fromthe Field[J]. Academy of Management Perspectives,2011, August:40-57.

⑭ Cheng Yue, Yin Lu, Li Tianzhu, etc.. Research on the Evolution of Enterprise Innovation Network under Uncertain Environment[J].Science Research Management, 2011,32(1):29-34,51.

⑮ Xie Yongping, Dang Xinghua, Mao Yanzheng,ect. Research on the leadership and network performance of the core firms of technological innovation network[J]. Forecast, 2012,31(5):21-27.

⑯Peng Huatao.Innovation network, strategic network and resource acquisition network embedding for the growth of entrepreneurial enterprises: a case study based on Haier[J].China Science and Technology Forum,2014,(1):88-93.

⑰ Tansley A G.The use and abuse of vegetational termsand concepts［J］. Ecology，1935,16(3):284-307

of the dynamic evolution, co-evolution, and balance , diversity, adaptability and other basic characteristics in the ecosystem[18] to describe the development and evolution process of society, market, and even corporate systems, thereby forming major research paradigms such as organizational ecology and innovation ecosystems from different perspectives. The well-known American scholar Moore (1993) introduced the "ecosystem" into the field of business management for the first time, and proposed the new concept "economic association based on the interaction of organizations and individuals (the main body in the market economy)" as a Business Ecosystem[19]. Based on this, the concept of ecosystem has been gradually introduced into management circles in recent years. The birth of enterprise niche theory is the inevitable result of rapid social and economic development and enterprises' adaptation to the complex and changeable market environment. It is also the further development and improvement of enterprise management thinking. Based on the natural ecosystem view, it is similar to the development of biological species in nature, no enterprise organization can exist independently. It has complex and non-linear direct or indirect connections with other organizations and individuals and the environment in which it is located, and has certain interaction between enterprise behavior and the environment where it is located[20]. For any enterprise, the external environment it faces mainly includes other enterprises and social economic environment connected with it. Through the exchange of material and

⑱ Dai Ning. Research on Enterprise Technology Innovation Ecosystem[D]. Harbin Engineering University, 2010.

⑲ Moore J. F. Predators and prey: A new ecology of competition [J]. Harvard Business Review,1993,71(3):75-86.

⑳ Fan Jianping.Research on Management Based on Co-evolution of Enterprise Ecosystem[J].Economic Management,2009,31(06),168-171.

energy, the enterprise and its external environment realize the value-adding, and then constitute an organic whole[21]. Many scholars have involved the definition of the corporate innovation ecosystem in related research. This dissertation sorts out the definitions of some different scholars at home and abroad. For details, see Table 2.1.

Table 2.1 Conceptual literature review of enterprise innovation ecosystem

Perspective of definition	Scholars（time）	Definition of concept
Perspective of network	Tansiti&Levien (2004) Ginsberg（2010）[22]	A loose and open network system constituted by an enterprise and all individuals and organizations that affect the innovation and development of the enterprise. The entities within the system influence each other, depend on each other, and coexist.
Technology synergy	Adner（2006）[23]	In order to meet customer needs, companies need to promote technological innovation and provide valuable products and services through complementary collaborations with other companies. This complementary organization is called corporate innovation ecosystem.
	Chen Siqin，Gu Ligang（2008）[24]	In a certain period and space, the overall system formed by the compound organization of and the compound environment of enterprise technology innovation through the interaction and interdependence of innovative substances, energy and information flows.
	Zhang Yunsheng（2008）[25]	The enterprise innovation ecosystem is a coexistence, co-evolution innovation system formed by high-tech companies on a global scale, based on supporting technology and taking technical standards as a link.
Symbiosis strategy	Jin Hong（2011）[26]	Enterprises take the new development areas and the realization of new customer value as their common goal, and take a certain interest mechanism as a link to form an interdependent and co-evolving corporate strategy innovation system.
Innovation platform	Nambisan (2011,2013)[27]	Every enterprise cooperates around a certain innovation or innovation platform to form a loosely interconnected and interdependent enterprise network.

It can be seen from Table 2.1 that based on the network perspective, the corporate innovation ecosystem and corporate innovation network have similarities in conceptual definition, and both are regarded as the sum of the

㉑ Cao Lijun, etc. Research on the Evolution Model and Mechanism of Enterprise Ecosystem[J].Enterprise Economics,2012(3):56-59.

㉒ Ari Ginsberg, et al. Ecosystem Strategies for Complex Technological Innovation: The Case of Smart Grid Development[C].

㉓ Adner R. Match your innovation strategy to your Innovation Ecosystem [J].Harvard Business Review.2006,84(4):98.

㉔ Chen Siqin,Gu Ligang. Analysis of Enterprise Technology Innovation Ecosystem[J].Science and Technology Management Research,2008,07:453-454+447.

㉕ Zhang Yunsheng.Analysis of the Boundary and Structure of the Innovation Ecosystem of High-tech Enterprises[J].Soft Science,2008,11:95-97+102.

㉖ Jin Hong. Research on the Formation Mechanism and Evaluation of the Strategic Innovation Capability of Enterprises[D].Wuhan University of Technology,2011.Sun Bing,Zhou Daming.Review and Prospect of the Research Status of Core Enterprises of Foreign Innovation Networks[J].Foreign Economics and Management,2011,8 (33): 17-24.

㉗ Nambisan S, Zahra S A. Entrepreneurship in global Innovation Ecosystems [J]. Academy of Marketing Science,2011(1):4-17.Nambisan S, Baron R A. Entrepreneurship in Innovation Ecosystems: Entrepreneurs'Self-Regulatory Processes and Their Implications for New VentureSuccess[J].Entrepreneurship:Theory&Practice.2013, September:1071-1096.

relationships between the enterprise's innovation activities and all related organizations or individuals that affect the enterprise, that is, the overall structure of various formal and informal partnerships formed around the enterprise in the innovation process, and it has the characteristics of openness, dynamics, diversity, and complexity. However, the concept of the enterprise innovation ecosystem emphasizes the study of collaborative innovation networks between enterprises from the perspective of the ecosystem. In essence, it highlights the spontaneous creation of new value and energy between innovation entities within the system through cooperation at different levels, as well as the interdependence, coexistence and death of enterprises, which is similar to the process of survival and evolution between biological species in nature, emphasizing the dynamic evolution and interdependence of the ecological concept. The definition of enterprise innovation ecosystem based on technological synergy, symbiosis strategy, and innovation platform is based on different connection mechanisms between innovation entities. Therefore, this dissertation proposes that the enterprise innovation ecosystem is to meet the increasingly diversified and complex needs of customers, collaborate with other enterprises, organizations or individuals based on common innovation goals and innovation elements, and continuously carry out products or services innovation, and then build an open and dynamic networked innovation ecosystem with co-evolution, interdependence, co-evolution.

Definition of Core Firms in Enterprise Innovation Ecosystem

During the construction and operation of the enterprise innovation ecosystem, there are usually one or more core firms that play a leading role. They use their unique competitive advantages to develop and grow in the

system and establish different levels of cooperation relationship with system members, which plays a vital role in the healthy operation of the entire system. For the core firms in the innovation ecosystem, no scholars have defined it accurately and scientifically in the existing literature, and its phrase is different in different related studies, such as the hub firm, leading firm, focal firm. Foreign scholars define the concept of the core firm in the innovation network from the four main perspectives of scale, technology, knowledge, and system. In contrast, the definition of the core firm from the system perspective can better integrate the various elements of the innovation ecosystem, which is more in line with the actual situation[28], that is, the core enterprise is at the center of the system, has the ability to build and maintain an innovation network with itself as the core, share and integrate resources such as innovation knowledge within the system, select and decide the retention of other enterprises, have key and unique technologies or resources, and stimulate the creativity of the system to gain access to the external market[29].

Uniqueness of the characteristics of core firms.

In an enterprise innovation ecosystem, there are one or more core enterprises. They are at the core of the system and continue to create profits and value for the entire innovation ecosystem with their own strong strength advantages. Core enterprises play an important and irreplaceable role within the system. They provide an innovation platform for other members of the system to attract different innovative elements to the innovation process of products or

㉘ Sun Bing,Zhou Daming.Review of the current research status and future prospects of the core enterprises of foreign innovation networks[J].Foreign Economics and Management,2011,8(33):17-24.

㉙ Sun Bing,Zhou Daming.Review of the current research status and future prospects of the core enterprises of foreign innovation networks[J].Foreign Economics and Management,2011,8(33):17-24.

services. Although there may be multiple core enterprises in the corporate innovation ecosystem, its role is irreplaceable[30]. Creativity. The core firm is the strategic leader and guide of the entire innovation ecosystem. Through keen and rapid market insight and strong R&D advantages, it makes full use of internal and external innovation resources of the enterprise, shortens the production cycle of innovative products, and improves innovation efficiency, continuously provides creativity for the corporate innovation ecosystem. Creativity is one of the evaluation indicators for the healthy operation of the corporate innovation ecosystem[31]. By building an innovation platform, core firms gather technology suppliers and resources from around the world to continuously provide consumers with complex solutions. Therefore, core firms must use their own R&D advantages and management advantages to improve the creativity of the innovation ecosystem. Shareability. As the leader of the innovation ecosystem, core firms can propose shared business ideas, and their behavior has a certain demonstrative effect. Keen market insight is the "scout" of innovation activities. Core firms adopt platform-based business concepts, use innovation platforms to attract and integrate internal and external innovation resources, and creatively integrate innovation elements to achieve the optimization process under mutual competition and complementary advantages conditions, and the ultimate goal of integration is sharing. In the internet era of the 21st century, sharing is a process and means for companies to effectively create value, and sharing has become a symbol of networking. Coordination. The core firm has a regulatory effect on the overall operation of the innovation ecosystem. The core firm can

㉚ Li Jinyu, Ruan Pingnan. Research on the Role of Core Firms in the Evolution of Strategic Networks[J].Science and Technology Progress Countermeasures,2010,12:86-89.

㉛ Iansiti M，Levien R．Strategy as Ecology[J].Harvard Business Review,2004(3):51-62.

build differentiated and diversified partner roles through accurate market value positioning, and reduce cooperation transaction costs through a variety of different cooperation methods and levels, and then establish a system-based market access mechanism to prevent individual organizations from "free-riding". Core firms lead many enterprises to carry out systematic innovation activities [32] through some strategic mechanisms such as technological standardization, innovation incentives, complementary technology research and development, and conflict coordination, such as Apple, Microsoft, IBM, Haier and other enterprises. Different system governance methods can implement different operating mechanisms according to different system construction models. The ultimate goal is to achieve the coordinated and sustainable development of the system. Role changeability. The role of each innovation entity in the corporate innovation ecosystem is not static. As an independent innovation entity, the creation of profits and the development of scale are constantly changing with time. Therefore, the role of core firms in the innovation ecosystem does not always occupy the highest end of the value chain. In the initial stage of construction of the enterprise innovation ecosystem, core firms use their own advantages to attract partners, promote the development of small enterprises, and determine the direction of the overall development of the system. With the further development of the innovation ecosystem, core firms build an innovation platform to allow free cooperation between members of the system, and no longer affect the establishment and development of the

㉜ Zhang Lifei.Research on Leadership Strategy of High-tech Enterprise Innovation Ecosystem Platform[J].Finance and Economics Theory and Practice,2013,04:99-103.

relationship between other innovation entities too much, forming a business model similar to Taobao and other platforms.

Components of enterprise innovation ecosystem from the perspective of core firms

Scholars mainly analyze the components of the corporate innovation ecosystem from the perspectives of business ecology, innovation networks, and technological collaboration, and the components of the corporate innovation ecosystem of different perspectives have different focuses. For details, see Table 2.2 below.

Table 2.2 Division of Enterprise Innovation Ecosystem of Different Perspectives

Division of perspective	Scholars(time)	Main viewpoints	Focus of the dissertation
Business ecology	Moore(1996)[33]	The enterprise innovation ecosystem consists of core ecological elements (suppliers directly related to the enterprise, complementary product suppliers, customers and distributors, etc.) and extended ecosystem (suppliers indirectly related to the enterprise, complementary product suppliers, customers and distributors), complete ecological elements (government departments, risk-takers-investors and owners, etc., competitors, similar companies, etc.) and environmental elements of system (political, economic, social, cultural, technological and other macro-environments).	Highlighting the entire business ecology environment faced by enterprises
	lansiti&Levien (2004)[34]	The elements of an enterprise's innovation ecosystem include distributors, suppliers, outsourcing companies, complementary product manufacturers, R&D institutions, financial institutions, competitors, labor markets, customers, regulatory agencies, and media that affect the enterprise.	
Innovation network	(Ginsberg(2010)[35] Nambisan(2011)[36]	The enterprise innovation ecosystem is a loosely interconnected and interdependent network systems, with a core enterprise as the center, radiating to all suppliers, manufacturers, scientific research institutions, intermediaries, financial services, competitors and customers and other innovative entities, and formed by collaborative cooperation around some kind of innovation.	Highlighting the complex networked relationships between members of the system
Technology synergy	Ander(2006)[37]、ChenSiqin(200	The enterprise innovation ecosystem is a co-evolving technological innovation system formed in a certain range by core enterprises and	The main mechanism that

[33] Chen Jin. Wisdom Exhibition—Enterprises' Strategy Based on Business and Innovation Ecosystem[M]. Hangzhou: Zhejiang University Press, 2015.

[34] Iansiti M，Levien R．Strategy as Ecology[J].Harvard Business Review,2004(3):51-62.

[35] Ari Ginsberg, et al. Ecosystem Strategies for Complex Technological Innovation: The Case of Smart Grid Development[C]. Technology Management for Global Economic Growth (PICMET),2010Proceedings of PICMET '10:1–8.

[36] Nambisan S, Baron R A. Entrepreneurship in Innovation Ecosystems: Entrepreneurs'Self-Regulatory Processes and Their Implications for New Venture Success[J].Entrepreneurship:Theory&Practice.2013September:1071-1096.

[37] Adner R. Match your innovation strategy to your Innovation Ecosystem [J].Harvard Business Review.2006,84(4):98

	8)[38]、ZhangYun sheng(2008）[39]	other technologically complementary enterprises based on technological synergy.	highlights the connection between innovation entities is technological complementary cooperation
	Sun Bing（2011）[40]	The technology innovation ecosystem of enterprises is divided into 4 parts-Core enterprises, technology research and development and product application, innovation habitat and innovation platform.	

Regarding the components of the enterprise innovation ecosystem, existing studies have divided them based on different perspectives such as business ecology, innovation networks, and technological synergy, and highlighted different focuses. However, most studies analyze the components of the enterprise innovation ecosystem with the enterprise as an individual, and most of them are based on technological innovation as the main connection mechanism between enterprises, lacking an overall and comprehensive analysis of the core firm for technological innovation and non-technical innovation and other different innovation management dimensions from the perspective of the core firm. Therefore, this dissertation attempts to divide the components of the corporate innovation ecosystem constructed in the process of innovation activities by core firms from different dimensions of innovation management, and explores how enterprises construct the enterprise innovation ecosystem from different dimensions such as strategy, culture, system, management, market, and technology, and that what kind of connection exists between each system member, that is, the niche is composed of the enterprise innovation ecosystem from the perspective of core firms.

㊳ Chen Siqin,Gu Ligang.Analysis of Enterprise Technology Innovation Ecosystem[J].Science and Technology Management Research,2008,07:453-454+447.

㊴ Zhang Yunsheng.Analysis of the Boundary and Structure of the Innovation Ecosystem of High-tech Enterprises[J].Soft Science,2008,11:95-97+102.

㊵ Sun Bing,Zhou Daming.The construction of enterprise technology innovation ecosystem based on the perspective of core enterprise[J]. Business Economics and Management,2011,11:36-43.

Relationship management between core firms and system members

By sorting out the research conclusions of domestic and foreign scholars on the relationship management between core firms and internal members of the innovation ecosystem, it is concluded that in the construction of the enterprise innovation ecosystem, the relationship management between core firms and internal members of the system mainly includes the following four points: cooperation motivation, cooperation principles, cooperation methods, cooperation conflicts.

Cooperation motivation

Scholars agree that because of the dynamic and highly uncertain market competition environment, an enterprise can no longer complete a technological innovation activity alone. It needs to cooperate with other enterprises, organizations and even competitors to complete technological innovations to reduce innovation cost and innovation risk, build an innovation ecosystem, and provide consumers with complex technological solutions. Ander (2010) proposed that, based on the cooperation motives of technological complementarity between enterprises, the core firms facing the technological leader's upstream component supplier's innovation is conducive to enhancing the technological leader's competitiveness, and the downstream complementary suppliers' innovation will reduce external innovation risk of their competitiveness[41]. On this basis, Hu Jingbo (2013) proposed that in the process

㊶ Ander.Value Creation in Innovation Ecosystems: How The Structure of Technological Interdependence Affects Firm Performance in New Technology Generations[J].Strategic ManagementJournal.2010(31):306-333.

of enterprises' technological innovation of complex products, upstream component vendors in the system affect the ability of customers to fully benefit from consumer products by restricting product production capacity and downstream component vendors' ability to act on core companies' value creation[42].

Cooperation principles

Liu Zhiyun (2009), based on the cooperation motivation of technological complementarity between enterprises, proposed that core firms should consider key factors such as complementary advantages, strategic synergy, and cultural compatibility among members when choosing partners[43]. Zhang Yunsheng (2011) proposed that enterprise technology research and development capabilities, user base and market position, complementarity of technical resources, technical standard capabilities, compatibility between cooperative enterprises, and reputation and trust are the main factors influencing the selection of partners in the innovation ecosystem of high-tech enterprises[44]. Zhou Daming (2012) took Jiamusi Agricultural Machinery Factory as the research object, and proposed that the principles for choosing partners for cooperation are: information symmetry, resource and technology complementarity, and compatibility. Therefore, core firms must take supply safeguard measures in the four aspects of corporate culture, human resource supply, capital investment and technology supply to maintain the normal

㊷ Hu Jingbo, Ouyang Taohua, Tan Zhenya et al. Research on the evolution of the complex product innovation ecosystem with SF civil aircraft subcontracting manufacturers as the core firm[J].Journal of Management,2014,08:1116-1125.

㊸ Liu Zhiyun. Research on Innovation Ecosystem of Corporate Strategy [D]. Wuhan University of Technology, 2009.

㊹ Zhang Yunsheng,Tian Jishuang.Research on the selection of partners in the innovation ecosystem of high-tech enterprises[J].Technology and Economy,2011,05:21-26.

operation of the system[45]. Leten (2013) proposed that based on the method of intellectual property model, in the process of selecting partners, ultimate principle of the core firm is to promote partners to maximize the acquisition and sharing of common ownership, and also maximize the value distribution and technology supply of system members[46]. It can be seen that the cooperation principles established between the core firm and the internal members of the system are mainly technological complementarity and complementary advantages, so as to maximize the value distribution between the core firm and the internal members of the system, achieve the effect of win-win cooperation, and promote the operation of the entire innovation ecosystem.

Cooperation methods

According to different research perspectives and objects, scholars have put forward different opinions on how to establish cooperative relations between core firms and internal members of the system. See Table 2.3 for details.

Table 2.3 Cooperation methods between core firms and system members

Scholar（time）	Perspective of research	Object of research	Conclusion of research
Liu Zhiyun（2009）[47]	Technology synergy	None	When selecting partners, core enterprises can use fuzzy optimization methods to construct decision-making models of partner selection.
Williamson& DeMeyer (2012)[48]	Ecological strategy	Arm Apple Google,etc.	Core enterprises choose partners from the following three aspects: constructing a differentiated role of partners, stimulating investment from complementary partners, and reducing transaction costs of cooperation.
Zeng Deming	Pricing model of platform	High-tech enterprises	The free model of acquiring ant economic effects at zero price and selling other profitable products together, the model of price subsidy of external bundle-selling related products with the help of cross-network, the pricing model of technical standard based on cross-patent licensing and patent portfolio licensing, and the platform pricing model including one-way and two-way pricing.

㊺ Zhou Daming. Research on the Operation of Enterprise Technology Innovation Ecosystem[D]. Harbin Engineering University, 2012.

㊻ Bart Leten et al. IP Models to Orchestrate Innovation Ecosystems:IMEC, A Public ResearchInstitute in Nano-Electronics[J]. California Management Review.2013(4):51-64.

㊼ Liu Zhiyun. Research on Innovation Ecosystem of Corporate Strategy[D]. Wuhan University of Technology, 2009.

㊽ Williamson P J, Meyer D A. Ecosystem Advantage: how to successfully harness the power ofpartners[J].California Management Review.2012(4):24-46.

（2013）[49]			
Leten，Vanha verbeke（2013）[50]	Intellectual Property Model	Nanoelectronics Public Research Institute	The core organization establishes different intellectual property pricing models with partners at different levels to effectively manage intellectual property rights and maximize the distribution of benefits within the system.
Oliver(2013)	Disclosure of selective knowledge	None	The core enterprise chooses the following 4 knowledge disclosure strategies according to the innovation goal and the form of knowledge disclosure: Diffusion (to find a solution together); Setting agenda (the core enterprise leads its partners to formulate future plans); Product development (the mutual benefit of knowledge sharing between enterprises) Behavior); Market segmentation (finding and creating key technological innovation trajectories).

Cooperation methods between core firms and system members can be seen from Table 2.3. The relationship between core firms and system members is established, especially the establishment of relationship with technology providers, based on the different types of core firms and partners cooperation methods are diversified, and there are no fixed standards and paradigms. Therefore, it is necessary to explore the method and process of establishing the relationship between it and system members according to the specific category of core firms, and enrich and perfect the relevant theories of the enterprise innovation ecosystem construction mechanism.

Cooperation conflicts.

The research conclusions of domestic and foreign scholars on cooperative conflict management between core firms and internal members of the innovation ecosystem are shown in Table 2.4.

Table 2.4 Conflict management between core firms and system members

Researcher（time）	Perspective of research	Objects of research	Conclusion of research
Li	symbiosis	Canon Copier	Core enterprises occupy a leading position in the corporate innovation sharing mechanism, and manage the relationship with the node enterprises

[49] Zeng Deming, Zou Siming, Zhang Yunsheng.Research on the Pricing Model of High-tech Enterprise Innovation Ecosystem[J].Forum on Science and Technology in China,2013,05:30-35.

[50] Zhou Daming. Research on the Operation of Enterprise Technology Innovation Ecosystem[D]. Harbin Engineering University, 2012.

Yuqiong（2007）[51]	mechanism of innovation		through resource coordination, interest coordination, cultural coordination, obligation coordination, conflict management, communication management, and risk management.
Nambisan(2011)[52]	Product development and network theory	IBM, Boeing, Microsoft, Henkel	Establishing and maintaining networked relationships between enterprises from the three key processes of enterprise innovation activity management innovation lever, management innovation consistency and management innovation specificity.
Williamson& DeMeyer (2012)[53]	Ecological strategy	An Mou, Apple, Google, etc.	The core enterprise effectively manages the innovation ecosystem from the following 5 aspects: accurate market value positioning; reducing cooperative transaction costs; maintaining system flexibility; promoting common learning; establishing and operating an access mechanism-preventing members from "free-riding".
Zhou Daming （2012）[54]	Technical complementation	Jiamusi Agricultural Machinery	The core enterprise shall take safeguard measures from the four aspects of corporate culture, human resource supply, capital investment supply and technology supply to maintain the normal operation of the system.
Zhang Lifei(2013)[55]	leadership strategy of platform	Apple、Microsoft、IBM, etc.	Platform enterprises lead mass complementary companies to carry out innovation activities through the implementation of strategies such as technology standardization, innovation incentives, complementary technology R&D, and conflict coordination.

Core firms are in the leading position of the enterprise innovation ecosystem and has a certain decisive effect on the construction of the system and the selection of partners. Existing studies have proposed different system governance methods and processes based on different research perspectives, but most of them regard the enterprise as an individual and wholly analyze the relationship conflict management between it and its partners, and rarely involve the non-technical innovation system of the enterprise, which will how to influence the core firms on constructing the enterprise innovation ecosystem and the relationship management between the core firms and system members.

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[51] Li Yuqiong.Study on the Construction Method of Enterprise Innovation Symbiosis Mechanism--Taking Canon Copier Ecosystem as an Example[J].Journal of Hunan University of Science and Technology,2007,07:79-82.

[52] Nambisan S, Sawhney M. Orchestration Processes in Network-Centric Innovation: Evidence Fromthe Field[J]. Academy of Management Perspectives,2011, August:40-57.

[53] Williamson P J, Meyer D A. Ecosystem Advantage: how to successfully harness the power ofpartners[J].California Management Review.2012(4):24-46

[54] Zhou Daming. Research on the Operation of Enterprise Technology Innovation Ecosystem[D]. Harbin Engineering University, 2012.

[55] Zhang Lifei.Research on Leadership Strategy of High-tech Enterprise Innovation Ecosystem Platform[J].Finance and Economics Theory and Practice,2013,04:99-103.

Even though some scholars elaborate on the above issues from non-technical perspectives such as conflict management, communication management, corporate culture, and market positioning, there is no comprehensive and holistic analysis of the interaction between the firm's strategy, culture, system, management, organization, and market. Therefore, on the basis of the existing research conclusions, this dissertation attempts to explore how the non-technical innovation system of the enterprise affects the relationship management in the process of relationship management between the core firm and the internal members of the system.

Framework of enterprise innovation management

In order to quickly realize the commercialization of ideas, an enterprise's innovation management needs to be paralleled-implementation from multiple dimensions such as strategy, organization, resources, culture (system), etc., based on the external innovation environment of the enterprise, it continuously and continuously promotes the evolution of the enterprise. In general, innovation requires "Vertical and Horizontal Theory", horizontal management requires the integration of vision and creativity, R&D, manufacturing, and sales, and vertical management requires the synergy of strategy, organization, resources, and cultural (institutional) thinking systems, as shown in Figure 2.2 below[56].

[56] Chen Jin, Zheng Gang. Innovation Management[M]. Peking University Press. 2013.

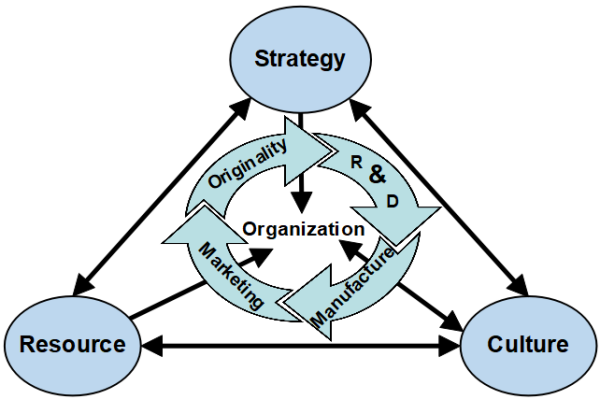


Figure 2.2 Framework diagram of enterprise innovation management

To achieve high-performance innovation management, an enterprise needs the leadership of its innovation strategy, strengthens its strategic management ability and strategic innovation ability, and realizes the perfect match and good interaction between enterprise strategy and technological innovation, which is an important condition for improving the efficiency and effectiveness of enterprise management innovation. At the same time, based on its own development and the internal and external innovation environment in which the enterprise is located, it continuously strengthens the transformation and innovation of the enterprise organization, and provides a good process platform for the value creation of the enterprise. Under the open innovation system, enterprises not only rely on limited internal resources to achieve innovation, but the ability to obtain external information, funds, talents, brands, intellectual property and other innovative resources has become particularly important. The innovation culture is called "the other side of the technological innovation coin." In order to achieve efficient innovation management, enterprises need to pay attention to the four dimensions of innovation culture: values, institutional systems, norms of behavior, and physical carriers.[57]

㊲ Chen Jin, Zheng Gang. Innovation Management[M]. Peking University Press. 2013.

Influencing factors of enterprise innovation management

For the innovation system, the innovation management of an enterprise must comprehensively consider the influencing factors of the entire process of enterprise innovation. The influencing factors mainly include the following six points. First, the different innovation project portfolio management and the innovation level and characteristics involved in the project management process; second, the technological innovation environment of the stage and track of enterprise technology development; third, the constantly changing consumer demand, the high volatility of increasingly complex and personalized markets environment; fourth, the macro-environment of innovation such as policies and regulations, social culture, and political forces, especially multinational enterprises; fifth, the competitive environment such as suppliers, distributors, competitors, and potential entrants will Indirectly affect the performance of corporate innovation management; sixth, the internal corporate environment such as strategy, organizational structure, management system, salary system, incentive system, and information management system will directly affect the performance of enterprise innovation management[58].

Comprehensive enterprise innovation management

The connotation of comprehensive innovation management is understood as: the enterprise aims at creating value, centering on enhancing core competitiveness, and under the leadership of strategy, it carries out collaborative innovations putting technology, organization, market, management, culture, and systems together, and through certain innovations

㊽ Chen Jin, Zheng Gang. Innovation Management[M]. Peking University Press. 2013.

management mechanism and approach, the enterprise strives to realize the full-staff innovation , full-time innovation, global innovation in the enterprise, as shown in Figure 2.3 below[59].

Figure 2.3 Diagram of Enterprise Innovation Management Framework

The management element dimensions of the overall innovation of an enterprise are: strategic innovation, management innovation, organizational innovation, cultural innovation, technological innovation, market innovation, and institutional innovation. Among them, the relationship between the internal element dimensions of the overall innovation of an enterprise is described as follows: the key is to achieve technological innovation; collaborative innovation is an auxiliary means; strategic innovation is a direction guide; market innovation is an effective pathway; management innovation is the foundation, and organizational innovation is a favorable guarantee , concept and cultural innovation is the forerunner, and institutional innovation is the driving

㊾ Xu Qingrui, Zheng Gang, Yu Zida et al. Total Innovation Management (TIM): A New Trend in Enterprise Innovation Management--Based on a Case Study of Haier Group[J].Science Research Management,2003,05:1-7.

force; the time and space dimensions of comprehensive innovation are: full-time innovation, full-process innovation, networked innovation, and value-chain innovation; the type dimensions of comprehensive innovation are: product or service innovation, technological process innovation, organizational structure innovation, business model innovation, etc.; the method dimensions of comprehensive innovation: independent innovation, introduction of innovation, cooperation innovation and other open innovation; the entity dimensions of comprehensive innovation: technology, production, marketing and other departments, as well as full-staff innovation & everyone innovation including relevant stakeholders such as users, suppliers, even competitors[60].

The theory of internal and external factors for enterprises to build an innovation ecosystem:

Han Shaojie and Lv Yibo from the School of Economics and Management of Dalian University of Technology, put forward a motivation model for enterprises to build an open innovation ecosystem in their paper "Research on the Motivation of Enterprise-Centric Open Innovation Ecosystem Construction", as shown in the following table:

Type	Category	Concept	Keywords
Motivation of external ecology context	Level of technical context	C_1 Technical complexity	Interdisciplinary |Subject complexity | Multidisciplinary |Technology Convergence | High technical complexity | Structural complexity |Many parts|Technical complexity | Complex manufacturing process
		C_2 Technical dynamics	Fast technology updates |Fast technology changes | Short product cycle | Short technology cycle | Rapid emergence of new technologies | Rapid emergence of new disciplines|Unpredictable technological changes |Fluctuating technology
		C_3 Technology lagging	Backward technology| Backward enterprise |Technology introduction| Technology purchase | Imitation learning | Newbie in the industry | New entrant |Weak foundation | Reverse engineering

[60] Xu Qingrui, Zheng Gang, Yu Zida et al. Total Innovation Management (TIM): A New Trend in Enterprise Innovation Management——Based on a Case Study of Haier Group[J].Science Research Management,2003,05:1-7.

	Level of market context	C_4Market demand diversity	Product customization | More product series |Customer commissioning | More customer requests | Demand specialization |Demand personalization |Special device
		C_5Systematization of market competition	Industry chain competition | Technology System | Group competition | Full industry chain | Full technology chain | Competition system | Network competition
	Level of institutional context	C_6Formal Institutional opportunity guidance	National policy | Tax preferences | Financial support | Key projects | Special planning| Government subsidy | Fund support| National procurement| Government certification
		C_7Informal institutional pressure drive	Leader inspection | Leader care | Leader matchmaking| Government model projects | Government-enterprise relationship | Potential rule | Political capital | NPC member
Motivation of internal ecology context	Level of entrepreneurs' attention	C_8 Internal entrepreneurial attention	Internal resources of enterprises| Enterprise talent | Level of enterprise technology | Financial strength | Production efficiency | Quality of staff | Profit margin | Internal management
		C_9External entrepreneurial attention	Latest development of new technology | Market share of enterprises | National policy trends | Technology talent | Industry position of enterprises | Customer demands | Competitive environment| Change of government leaders
	Level of entrepreneurs' cognition	C_{10}Economic cognition	Reduction of operational cost | Increasement of corporate profitability | Reduction of R&D expenditure | Increasement of new products | Increasement of turnover
		C_{11} Non-economic cognition	Technology standard | Discourse power of industry | Sustained competitive advantage | Complementation of resources | Mutual benefit
	level of entrepreneurship	C_{12}Challenge consciousness	Advance against hardship| Challenge industry overlords | Face the competition | Ambitious goal | National industry | Becoming an industry leader | Not afraid of hardships
		C_{13}Innovation mind	New technology | New methods | Development of new products | Pay great attention to R&D | Exploring new models | Adaptive adjustment | Flexibility | Product innovation | Organization innovation
		C_{14}Risk-taking awareness	Seeking wealth in risks | coexisting of risk and benefit | Risk means opportunity | Taking risks

The main research conclusions are as follows: (1) The motivation for the construction of the enterprise-centric open innovation ecosystem comes from different levels inside and outside the enterprise. Among them, the motivation of external context construction comes from the level of technology context, the level of market context and the level of institutional context; the motivation of internal entrepreneur construction comes from the level of entrepreneurs' attention, the level of entrepreneurs' cognition and the level of entrepreneurship. The construction of an enterprise-centric open innovation ecosystem can be induced only when different source levels show different characteristics. (2) Fourteen types of characteristics at six levels from inside and outside of enterprises induce the construction of an enterprise-centric open innovation ecosystem. At the level of technical context, it shows three types of

characteristics of technological complexity, technological dynamics and technological lagging; at the level of market context, two types of characteristics of market demand diversity and competition systemization are shown; at the level of institutional context, two types of characteristics of formal institutional opportunity guidance and informal institutional pressure drive are shown; at the level of entrepreneurs' attention, two characteristics of internal attention allocation and external attention allocation are showed; at the level of entrepreneurs' cognition, two types of characteristics of economic cognition and non-economic cognition are showed; at the level of entrepreneurship, three types of characteristics of challenge consciousness, innovation mind and risk-taking awareness are showed. (3) The motivation for the construction of an enterprise-centric open innovation ecosystem appears along the transmission path of " level of technology, market and institutional context → entrepreneurs' attention level → entrepreneurs' cognition level → entrepreneurship level". Specific characteristics drive the construction of an enterprise-centric open innovation ecosystem. Among them, the external context level of the "first order" and the entrepreneurs' cognition level of the "third order" do not require all features to appear, and the appearance of a certain type of features can complete the transmission of construction motivation for an enterprise-centric open innovation ecosystem. In the "second order" level of entrepreneurs' attention and the "fourth order" level of entrepreneurship, all characteristics need to be showed at the same time to complete the transmission of construction motivation for an enterprise-centric open innovation ecosystem.

Conclusions of literatures' theory analysis

The existing literature theories have penetrated into all aspects of the construction of enterprise innovation ecosystem, mainly focusing on five aspects: open innovation, concept of enterprise innovation ecosystem, characteristics of core firms, enterprise innovation framework, and comprehensive enterprise innovation theory. Theoretical opinions involved are fragmented compared to the construction of enterprise innovation ecosystems. Enterprises need a new system architecture to comprehensively summarize them in the operation process in order to form an innovation ecosystem that suits the actual needs of enterprises. It needs to be pointed out here that Professor Han Shaojie and Lv Yibo "On core firms to build the innovation ecosystem internal and external factors research model" needs to be supplemented and improved. In terms of external factors, there are no factors involved in the changes of external conditions that the manufacturing industry is facing; in terms of internal factors, the factors proposed are not involved in the adaptability of enterprises' own abilities, especially in the new era when enterprises face the influence of new factors such as industrial Internet and intelligent manufacturing. The knowledge system of the senior management is flawed, and a large number of new managers need to be supplemented, and the enterprise will face the introduction of new executives (new knowledge system). The cooperation between them is also a big test for the enterprise, so the impact factor of entrepreneurs and senior management cooperation is very important. This dissertation will supplement and improve this deficiency according to its own practice.

Existing theories are limited by time and space, and it lacks a systematic summary in the understanding of the innovation logic and innovation system of the manufacturing in the intelligent era. Therefore, the exploration of the enterprises' innovation ecosystem under the characteristics of the Internet of Everything in the intelligent era is very urgent and at the same time has a huge research space.

Innovation logics followed by 3nod

This dissertation follows Professor Chen Gang's statement that invention and creation are only the initial stage of innovation, and the commercialization process in the final stage is the most important part of the entire innovation process. It cannot be called a successful innovation if the original technological inventions, products or services cannot be introduced into market. With the innovation formula: Innovation = Invention + Development + Commercialization, it guides 3nod's innovation practice.

3nod's understanding and practice of innovation industrialization and commercialization: while adhering to independent innovation, implement open innovation, link the world's top industry-university-research forces and innovation resources (0-1 breakthrough), build innovation accelerators, engineering testing and verification centers, realization base for the industrialization of innovation power (1-100), on which a large-scale supply chain and production capacity are formed, and the market (100-10000+) is

linked around application scenarios, and innovation power is connected with industrial power to form commercial power. As shown in Figure 2.4:

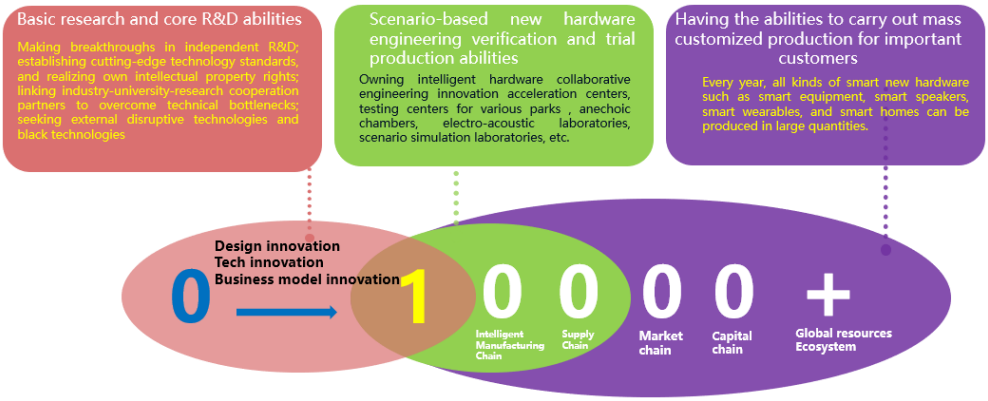


Figure 2.4 3nod's definition and understanding of innovation

Chapter summary

This chapter mainly summarizes the main theoretical literatures involved in the process of 3nod's construction of an innovation ecosystem. It mainly focuses on the related concepts of innovation in academia and the depth and breadth of concept research at all levels in the enterprise innovation ecosystem. Through sorting it out, the starting point and theoretical basis of 3nod's research innovation ecosystem can be found.

Chapter 3：3nod Group and the Innovation Ecosystem in the Primary Stage of the OPM Model

The abstract of this chapter

This chapter introduces the development process of 3nod Group and the development process of its innovation system from OEM-ODM-OPM. With the gradual maturity of 3nod's OPM innovation model, its competitive advantage has begun to be significantly different from the past OEM and ODM model. This is due to the improvement of the OPM model on the basis of ODM model. Nonetheless, 3nod's OPM model still has many challenges.

The innovation ecosystem with OPM as the core formed by 3nod at this stage mainly focuses on the design capability module and the coral group innovation platform. This innovation ecosystem corresponds to the market requirements for enterprises to respond quickly and scale manufacturing capabilities. At the same time, the Internet economy is in a stage of rapid development in China. This kind of performance still needs evolutionary development under the condition of new generation information technology.

Introduction to the basic situation of case enterprises

3nod Group was established in Shenzhen in 1996. It is an overall solution provider with "smart life" as its core, committed to improving people's quality of life through valuable innovation and science & technology. 3nod Group mainly involves four major fields, including audio-visual entertainment, information technology and smart home, medical beauty and health. At the same time, it is also a platform-based industry group that conducts investment synergy with the smart life industry chain.

Four innovation stages 3nod Group experienced

3nod's development history can be divided into four main stages, and according to the characteristics of different periods, its growth history can be divided into: the sailor, the explorer, the intelligent creator and the creator. 3nod Group has used "design thinking" proficiently in its innovative development with design and technology as its dual engine. It is not limited to industrial design of products, but drives enterprise innovation and development with design strategic thinking. 3nod's design innovation mainly revolves around the four dimensions of "product, user, organization, and society", and continues to expand and upgrade. As shown in Figure 3.1 for details.

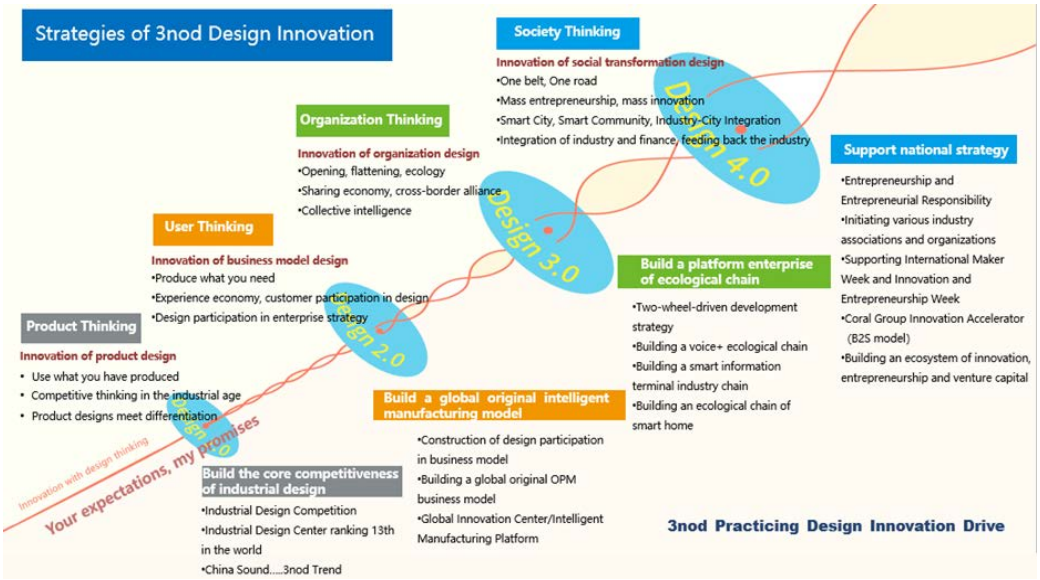


Figure 3.1 3nod Design Innovation Strategy

The four dimensions have been reflected in different history periods, but they only have different emphasis. At the stage of Design1.0, it took "products" as the core and seeks breakthroughs from differentiated industry design. At the Design2.0 stage, it took "users" as the core, created a global original business model of OPM, and in order to seek external support for the OPM model, the Shenzhen Industrial Design Association was established in 2008. It has now

become international and more influential industrial design association. At the Design3.0 stage, it focused on "organization" and broke the traditional closed organizational structure, and used a two-wheel-driven development strategy to carry out the forward-looking layout and coordinated development in the three major industrial chains of smart life (smart education, smart furniture, audio-visual entertainment) through cross-industry, alliances and links, and gradually transformed into an ecological chain platform enterprise. At the Design4.0 stage, it focused on "society", used social life transformation and national strategy design to build a complete ecosystem of innovation, entrepreneurship and venture capital, and assists the government to gather global innovation forces through the integration of industry and finance and feeding back the industry.

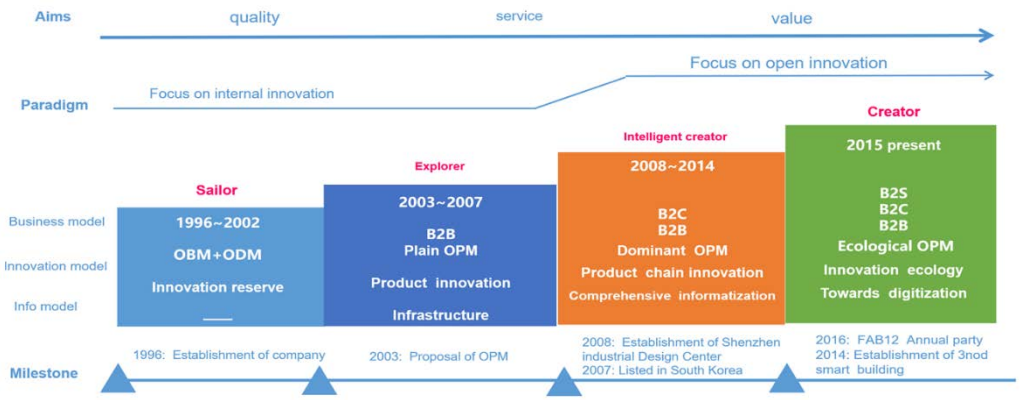


Figure 3.2 3nod's transformation and development history and the advancement of the OPM model

The first stage--Sailor（1996~2002）

3nod Group was founded in 1996. At the beginning of the business, 3nod Group had no funds, no talents, no venues, no customers, no products, and only provided customers with the supporting services of professional mold making and plastic molding.

In 1997, the business aims of "Quality • Service • Value" was gradually established. At this stage, 3nod Group took the OEM as business model. At the same time, it focused on future development trends and got rid of the bottom of the industry chain for better development, and promoted design innovation and technology innovation in audio product field, and launched a variety of multimedia speakers with its own brand and independent intellectual property rights. China's first "synthetic cinema" with digital control technology was its representative product, and obtained a high industry status.

In the age of traditional industrialization, demand exceeds supply, and the technology has a relatively limited impact on products, and the products on the market show the characteristics of “what is produced” means “what is used”. The design value of the product is highlighted and becomes the key to product differentiation competitiveness. 3nod Group's "Design1.0" has gradually developed, focusing on product dimension. This period is still in the stage of innovation reserve, and the informatization of this stage has basically not been established.

The second stage--Explorer（2003~2007）

From 2003 to 2007, the company's management organization was initially formed, and the leadership had a strong sense of goal. It is hoped that 3nod Group will become a leader in the industry, and it will become a provider of overall solutions from appearance design to overall solutions. At this stage, 3nod Group creatively proposed a unique OPM business model, successfully moving from domestic to international, and becoming a partner of many well-

known brands around the world. 3nod started its informatization process according to its actual needs.

Product differentiation design and maturity of OPM model: with the development of technology, the great enrichment of products, the market segmentation and the improvement of people's life needs, the product concept that is user-oriented is deeply rooted in the hearts of the people. At this time, while 3nod focused on the product dimension, it also put more emphasis on user participation, and the design began to gradually penetrate into the corporate strategy level. Before 2008, it focused on product innovation, and emphasized design differentiation and technological innovation. At this stage, mainly based on the B2B business model, 3nod Group provides personalized products for corporate customers through its own design innovation. And its products are mainly audio-visual entertainment audio-visual entertainment category. On the basis of OEM, 3nod has created an upgraded B2B model, that is, the OPM business model. OPM means to provide customers with a one-stop integrated solution for differentiated products from market research, product definition, industrial design, R&D, manufacturing to marketing, and channel sales with the product design concepts of personality, daily life and artistry, and create value for customers (see 3.3 for details). It is this unique model that distinguishes 3nod Group from other manufacturing enterprises, gains an unprecedented competitive advantage, and successfully moves from domestic to international.

Information infrastructure: When informatization is at the stage of infrastructure construction, in the early days of its establishment, the IT department belonged to 3nod’s audio subsidiary, which was mainly responsible for the construction, operation and maintenance of IT systems. Later, with the

expansion of 3nod Group, the subsidiaries, such as information technology company emerged. In order to serve the IT system of the entire group, the original information department of the audio company has been transformed into a process and information center under the group, and coordinated with the IT departments of various subsidiaries to jointly undertake the maintenance and construction of the entire IT system of 3nod Group. Both the enterprise itself and the information system are in the process of development. The main role that the IT department plays in the enterprise is to passively respond to demands from all aspects. These needs of informatization may come from the issues and needs raised by the executives of the group, various branch companies and the business layer during the IT implementation process, as well as the requirements of major customers for informatization in the manufacturing process. Therefore, at this stage, the IT system exists as an infrastructure supporting enterprise operations, and the IT department also plays a basic role in system development and maintenance.

The third stage--Intelligent creator（2008~2014）

In 2007, 3nod was listed in South Korea and became the world's first foreign company to be listed in South Korea. This was a way for 3nod to obtain capital support, at the same time, it also represented that 3nod’s development has entered a new stage. In 2008, 3nod initiated the establishment of the Shenzhen Industrial Design Association (SIDA), which is now China's largest professional organization in the industry. SIDA adheres to the path of brand, internationalization and high-end, and vigorously promotes the projects of “Six Ones”, namely: one prize, one festival, one exhibition, one forum, one park, and one fund. It has successively hosted Shenzhen International Maker Week,

National Entrepreneurship and Innovation Week and FabLab large-scale events such as annual party. In 2009, 3nod entered the computer industry and mobile infotainment terminal industry on a large scale.

Open and shared industrial chain innovation. At the initial stage, 3nod attaches great importance to innovation in the organizational dimension, and its most important feature is an open, flat, and shared economy. At this stage, companies are no longer fighting alone. Through cross-industry, alliances, and collective wisdom, they built an industrial ecological chain and formed a symbiotic and benign industrial ecosystem. 3nod Group has formulated a "two-wheel drive" development strategy of "smart industry + industrial investment" based on "design and innovation driven", and comprehensively constructed the "Sound +" ecological chain, smart information terminal industry chain, and smart home ecological chain. Following product innovation, 3nod Group gradually began to create industrial chain innovation, and the B2C business model was also introduced. Taking audio entertainment products as an example, 3nod Group does not regard it as a separate product, but builds a sound ecosystem based on sound technology, that is, "Sound+". In addition, in the term of the information industry, through the strategic orientation of "Cloud + Terminal, Software + Hardware", a smart information industry chain has been built. In recent years, 3nod Group has been committed to developing the ecological chain of the smart life industry. Standardized and systematic information system construction. After the establishment of the information technology subsidiary, 3nod Group is oriented to new businesses and customers, and there is also a need for new IT system construction. Unlike the audio industry, the manufacture of laptops has mature industry standards and the

requirements of delivery time. At this time, the IT department learned from the experience of the audio subsidiary's IT construction and proactively proposed the goal of a comprehensive informatization reform.

At this stage, the IT system not only provides an infrastructure for business operations, but also improves the efficiency of business operations through the construction of IT systems and IT capabilities, so as to gain a competitive advantage in a standardized and efficient market. Therefore, at the second stage, 3nod Group's goal is to achieve comprehensive informatization and to improve operational efficiency in existing businesses through informatization. The IT department has gradually changed from passively responding to demands to actively guiding business development, so as to create core competitiveness for the enterprise. In addition, focusing on future development, only with the foundation of informatization, can we further realize digitalization, and use the idea of big data to guide and control the development of enterprises from a strategic level.

The fourth stage--Creator（2015 to future）

In 2014, with the completion of 3nod Smart Building, it marked that 3nod launched its smart life strategy and became an overall solution provider of smart life. In the process of continuously cooperating with international customers, it has established experiences and has gradually formed our own knowledge system and has become an industry leader.

The construction and innovation of an ecosystem: 3nod Group's design innovation is not only reflected in industrial design innovation, but also lies in its construction of an industrial ecological chain platform driven by design innovation. 3nod Group adheres to the "two-wheel drive" development strategy

of "smart industry + industrial investment". On the one hand, it continuously improves and upgrades the "Voice +" ecological chain, the intelligent information terminal industry chain, and the intelligent home ecology chain. On the other hand, in the idea of capital thinking, it focuses on the investment layout based on artificial intelligence and the Internet of Things, and promotes the deep integration of industry and finance to reconstruct value and feedback the industry. At the same time, under the theme of the current era of "mass entrepreneurship and innovation", 3nod Group launched the "3+ plan" of "Creative +, Maker +, Creator +". "Creative+" aims to build a design platform for global makers. Industrial design innovation is one of 3nod Group's core competitiveness. Its rich industrial design experience will provide practical guidance for global makers; "Maker+" aims to build an innovation incubation platform for global makers to connect smart manufacturing, capital, and markets, so as to help makers realize their dreams; "Creator +" refers to 3nod group's positioning as a "smart life creator" with unlimited creativity, unbounded imagination, creating and imagining beautiful lifestyles and products in the future, and building a smart life industry chain platform.

3nod Group initiated the creation of the "Coral Group Innovation Accelerator", and integrated global innovation resources through this platform, and made use of its own design platform, market platform, smart manufacturing platform, capital platform and other comprehensive advantages to serve the makers from China and the world as the one-stop, full-chain entrepreneurial innovation ecological chain with international influence , so as to help entrepreneurs accelerate their success, thereby cultivate more "small and beautiful" innovative enterprises. Under the B2S business model, large

companies open up the resources of the industrial chain to support small entrepreneurial enterprises. Small enterprises overcome the innovation points of large enterprises to achieve the goal of perfecting the innovation chain. At this stage, 3nod Group focuses on innovation in the social dimension, and closely integrates the national strategic design under the current background of global industrial transformation, involving social transformation, national strategy, such as "mass entrepreneurship and innovation", "Made in China 2025", "Smart city", etc. In this dimension, 3nod Group has also done a lot of work. It has cooperated and exchanged with global design institutions on behalf of the government, hosted International Maker Week and Entrepreneurship and Innovation Week, introduced Fab12 to China for the first time, initiated industry alliances, and promoted the cluster development of the smart home industry. "This year's 13th Five-Year Plan will launch the Creative+, Maker+, Creator+, 3+ plans to create a one-stop comprehensive maker and innovative service platform and the development method of two hands catching and two legs walking."

Building an innovation ecology platform for smart manufacturing: Currently, a technological revolution and industrial transformation represented by emerging industries such as the Internet of Things, artificial intelligence, and smart manufacturing are taking place. In the future, there will be a massive "soft + hard, cloud + terminal" smart terminal equipment market demand greater than the Internet. However, in Mainland China, local brands upstream have begun to rise, and key component suppliers downstream have become increasingly mature. However, the system integration industry that connects upstream and downstream has been dominated or even monopolized by Taiwanese companies.

In recent years, these Taiwanese companies have begun to relocate overseas, and mainland suppliers and brands have been forced to relocate and shift their industries. This presents both opportunities and challenges for Chinese whole-machine manufacturers.

OPM Model

OPM (Original planning manufacturer), as a provider of original product planning and design, refers to a cooperative way, where a manufacturing company entrusted by customers, or actively seeking cooperation, to provide customers with (or jointly with customers) original product planning, and to design and produce products accordingly, and products are eventually sold under the customer's brand. The OPM model aims to efficiently provide customers with a one-stop service of differentiated products and overall solutions, adopt a sustainable differentiated innovation strategy, and create more value for customers.

OPM is a new type of cooperation model created by 3nod Group for the internationalization division of manufacturing. Since the concept was formally put forward in 2003, it has undergone 13 years of development and evolution and has become the core business model of 3nod Group's global B2B business. Before the emergence of OPM, the mainstream division of labor in the manufacturing industry included OEM and ODM. OEM (Original equipment manufacturer) means that the manufacturing company carries out the production according to the product and processing index requirements of the entrusting company, and the products are sold under the entrusting company's brand, which is what we usually call "OEM". ODM (original design manufacturer), the original design manufacturer, is a processing cooperation

method in which the entrusting company uses the entrusted party's product design and production in whole or in part, and conducts product sales under its own brand name. The comparison of these three modes is shown in Table 3.1.

Table 3.1 the Comparison of OEM, ODM and OPM models[61]

	OEM	ODM	OPM
Service content	Manufacturing	R&D+ Manufacturing	Plan+Design+R&D+Manufacturing+Collaborative marketing
Service object	Excellent brands in the industry	Excellent brands in the industry	Excellent brands in the industry + Excellent brands in the other industries
Requirement of competence	Manufacturing capacity	Specialized innovation ability (design ability, manufacturing ability)	Comprehensive innovation capabilities (market analysis and prediction capabilities, cross-border capabilities, marketing capabilities, design capabilities, manufacturing capabilities...)
Relationship with the client	Subordination	Subordination	Partnership
Bargaining ability	Weak	Middle	Strong
Cost input	Low	Middle	High
Profit margin	Low	Lower	High

Features of OPM

On the surface, OPM is an expansion and extension of the ODM model. ODM companies provide customers with two aspects of design and manufacturing services, while OPM has an extra link of product planning, extending to the front end of the product "smiling curve", and obtaining higher added value. But at a deeper level, because the OPM model has added product planning, there are three essential differences from the ODM model, which are discussed separately below.

（1）Process integrity

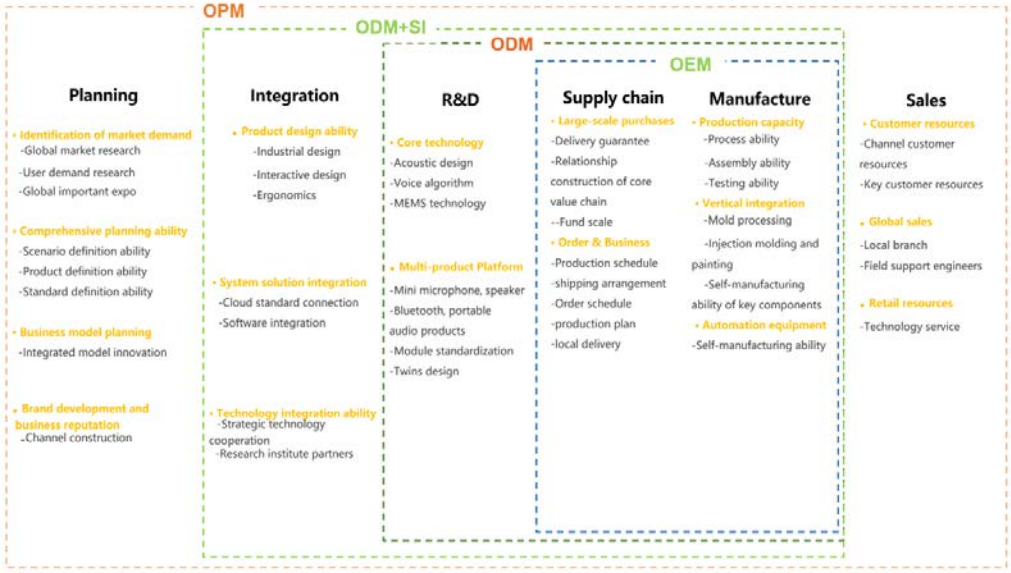
Process integrity refers to the OPM model to provide users with a one-stop product overall solution, so the overall product process needs to be planned. The work of product planning directly determines a series of content such as

[61] Prepare it according to public information

product positioning, target population, and price strategy, and is the basis for subsequent design, supply chain, manufacturing, and sales links. Compared with the "Design" in ODM, "Planning" covers more abundant and comprehensive content, from the initial planning, market research, market analysis, to design and manufacturing, supply chain coordination, to model design such as sales, after-sales service and value-added services. It provides an overall product solution for the enterprise in an all-round way (as shown in Figure 3.3). The "Planning" in OPM also includes PI. 3nod group will design products with a unified style for customers, and help customers strengthen their brand image based on the tone and personality of the customer's brand. In addition, in terms of technology, 3nod group will plan new products based on industry technology iterations, development trends, and the application of future technology scenarios. This is another meaning of "Planning". Therefore, in the OPM model, if companies want to provide customers with successful product planning, they are required to look at products from a holistic perspective. They are no longer simply designing and manufacturing based on demand, but considering the overall product process from concept to finished product, even marketing and after-sales. Under this holistic perspective, the needs of enterprises are no longer just from the requirements of customers, but are obtained through comprehensive analysis of customers, markets, and consumers. In this model, the relationship between consumers and OPM companies has become closer. Companies not only need to serve their direct customers, but also treat the terminal consumers of their products as indirect customers. The OPM model requires companies to change the specialized division of labor that focuses on design and manufacturing. Instead, based on

the results of market research and market analysis as a whole, combined with the needs of consumers and the characteristics of the customers themselves, they should launch a complete set of product planning program that meets customer needs and the needs of consumers, and then follow up design and manufacturing based on this. It can be said that although OPM is a kind of B2B business model, in fact, based on the requirements of process integrity, OPM companies' emphasis on consumers and the market is similar to that of B2C companies that develop their own brands.

Figure 3.3 the process comparison of ODM and OPM



(2) Customer cross-border

The cross-border feature of customers means that OPM companies' customers come from other industries and manufacture products through cross-border cooperation. Under the OEM and ODM model, the core competence of an enterprise lies in R&D and manufacturing. Therefore, in order to focus on the design and technology R&D of the industry, and to obtain more growth due to the spillover effect, the cooperation objects chosen by the enterprise are generally the excellent industry Brand owners. The entrusting party provides

well-known brands, strong channels and marketing capabilities, and the entrusted party provides excellent design and production capabilities to meet their respective needs and achieve a win-win cooperation model. Under the OPM model, the scope of the target customers of the enterprise has been significantly expanded. OPM requires companies to provide customers with overall product solutions. Product positioning and planning are completed by the company under the guidance and requirements of customers. This kind of one-stop overall solution means a better understanding of users' needs, scenarios experience, and the innovative technologies and innovative processes the industry chain. Therefore, OPM companies' customers are not limited to the scope of ODM, including leading brands in other industries. Through the sale of cross-border products, they can explore higher customer value and further increase brand influence or improve its ecosystem layout. Under the OPM model, customers provide loyal consumer groups, strong brand influence, and complete marketing and channels. OPM companies can sort out and absorb the experience, thinking, and advantages of many customers to form a new understanding of multiple industry forms. Looking back, based on the actual situation of the industry, using long-term accumulated data and resources, and analyzing the characteristics of customers and their consumers in different industries, OPM companies can tailor unique product plans for customers, and implement the subsequent industrial design and production after communicating with customers to make corrections. Finally, cross-border products of the customer's brand will be presented on the market.

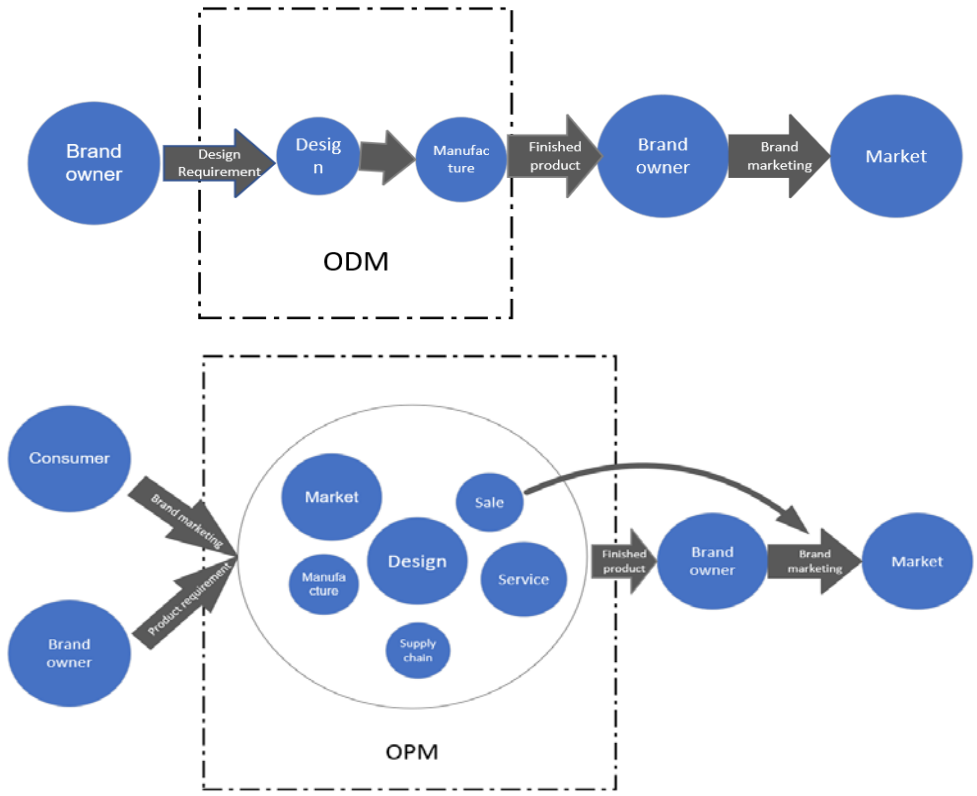


Figure 3.4 the process comparison of ODM and OPM

（3）Relative dominance

Relative dominance means that OPM companies are in a dominant position in cooperation. This dominance position is relative and will be affected by various factors such as product category, company's own capabilities, customer needs, and industry. However, compared with the ODM model, OPM companies generally have a relatively high dominance position. Although ODM companies are paying more and more attention to independent R&D and emphasize on maintaining independent intellectual property rights in cooperation, they are still in the position of "designing and producing according to the needs of customers" in cooperation with customers, which is a kind of relationship for upstream and downstream division of labor. In the cooperation of OPM model, product planning is jointly completed by the entrusted company

and the entrusting company, which determines that the OPM company has a certain right to speak in this kind of cooperative relationship, and the bargaining ability has been improved, and due to participation in product planning, The company has a holistic understanding and planning of the product itself. In the subsequent design and production process, it is also more active and proactive in team selection and resource allocation, and can make appropriate plans based on its own resources and capabilities, thereby ensure that the subsequent design, manufacturing and other processes are smoother.

So why is the entrusting company willing to change the cooperative relationship of the ODM model and hand over the dominant position of cooperation to the OPM company? This is because the core competence of an ODM enterprise is the design and production, and its goal is to efficiently design and produce products that meet the needs of the client. The OPM model requires the entrusted company to have a deep understanding of the market and consumers. Because the entrusted company does not make its own brand, it may even know the layout of the industry and the customer's competitors better than the customer itself. It is also because of this advantage that in the case of cross-border cooperation, this kind of dominant position is even more obvious.

From OEM to OPM

Companies that adopt the OEM model are usually small and medium enterprises (**SMEs**). They utilize this model to quickly enter the international value chain system. Due to the "spillover effect" of technology and management, they can make profits while producing products, and learn advanced technical knowledge and management methods from large multinational companies to improve their abilities in all aspects. With the continuous improvement of

innovation and R&D capabilities of small and medium-sized enterprises, the OEM model is gradually upgraded and evolved into an ODM model. Manufacturing companies have undertaken the work of product design to increase the added value of products and obtain higher profits. OPM is another model upgrade carried out by manufacturing companies based on the ODM model.

According to the comparison of the three models in Table 3.1 and the analysis perspective provided by the existing literature, there are three differences between the two upgrades:

First, OPM achieves a higher level of enterprise upgrade. According to foreign scholars' research on enterprise upgrading and global value chains, there are four models of enterprise upgrading: process upgrade, product upgrade, function upgrade and cross-industry upgrade. The transformation from OEM to ODM is mainly the upgrading of processes and products. The core is to improve production efficiency, expand product lines, and strengthen independent R&D capabilities; while the transformation from ODM to OPM focuses more on functional upgrades and cross-industry upgrades. The core is to provide customers with overall solutions, understand and develop consumers' potential needs, and create additional value for cross-border cooperation.

Second, OEM-ODM is a technical upgrade, and ODM-OPM is a strategic upgrade. Compared with OEM, ODM companies have strong R&D and design capabilities and independent intellectual property rights. However, the core of realizing the ODM model is still centering on the goals of the manufacturing industry, improving standardization and specialization, reducing costs, improving efficiency, and improving design capabilities and production

capabilities. From ODM to OPM, companies need to change their strategic positioning, develop and cultivate comprehensive innovation capabilities, and expand their strategic vision from two links to the entire product. The target customers, competitors, strategic layout, and integration of resources and capabilities will all change. This kind of transformation and upgrading is not only an upgrade that can be accomplished by cultivating a strong design team.

Third, OEM-ODM is an upgrade driven by spillover effects, and ODM-OPM is an upgrade dominated by strategy. Regarding the impact of spillover effects, as early as the end of the 20th century, scholars put forward a technological learning process model from the perspective of “learning by doing”. It is believed that through technical learning in the OEM process, OEM companies can develop or enhance product development capabilities, and ultimately extend their business to the fields of design and research and development. It can be said that the OEM-ODM process is gradually realized by the OEM enterprises in the OEM process based on the accumulation of experience and the improvement of capabilities, coupled with the goal of pursuing higher profit margins. However, ODM companies cannot be transformed into OPM companies only through the promotion of spillover effects, because the experience and capabilities brought by spillover effects have certain limitations and cannot escape the scope of design, production, and process management. Therefore, they cannot meet the requirements of OPM’s cross-border and integrity. To realize the resource capabilities required for OPM, it needs to be actively cultivated and developed based on the experience and capabilities accumulated by ODM under the guidance of a clear strategy. It can be said that the development from OEM to ODM is a process of "spillover" and

"emerging", and the path from ODM to OPM is more like a strategic realization process which is carefully designed.

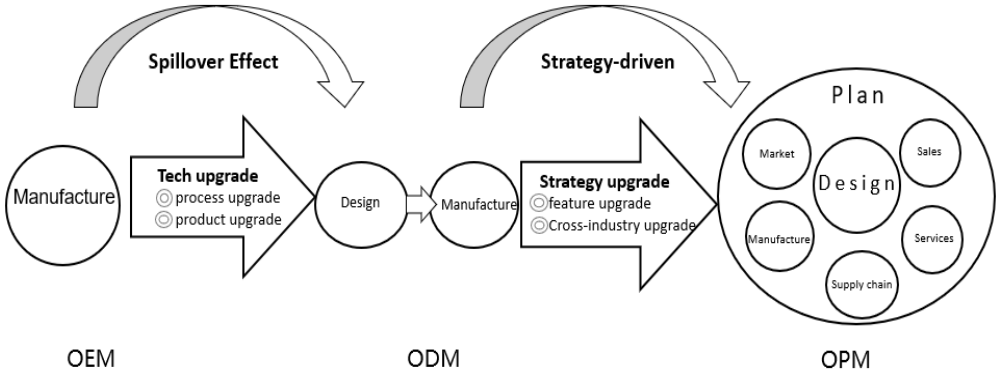


Figure 3.5 Two upgrades from OEM to OPM

Based on the above analysis, this dissertation summarizes and compares the two upgrades from OEM to OPM. As shown in the figure, compared with the upgrade from OEM to ODM, the realization of OPM is a complex and difficult process. Correspondingly, the final OPM business model also has unique competitive advantages and strategic value.

Advantages of OPM Mode

Because the OPM model has the characteristics of process integrity, customer cross-border and relative dominance, it determines that OPM has unique advantages that other models do not have. Specifically, compared with ODM, it has the following four advantages (see Figure 3.6):

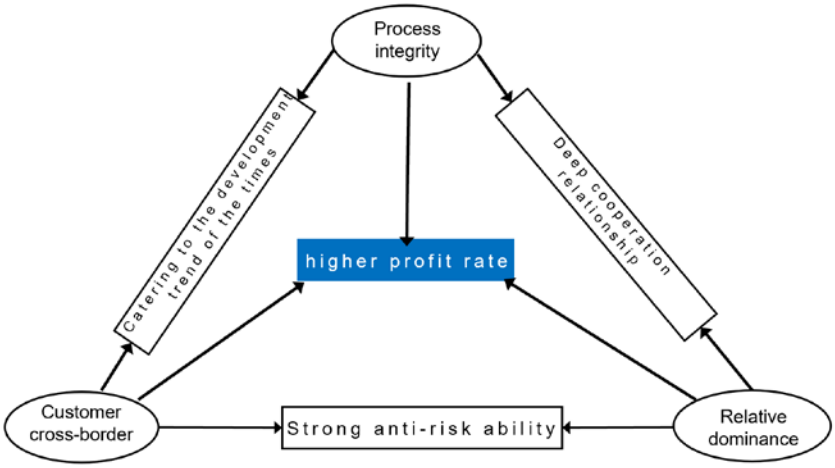


Figure3-6: Features and Advantages of OPM Model

(1) Higher profit rate

At present, the three characteristics of OPM jointly determine that this model can obtain higher profits compared with OEM and ODM models. First of all, the integrity enables the OPM model to fully capture the added value of the front end of the smile curve, and enterprises can rely on business model innovation, design innovation, efficient production, supply chain integration and other aspects to create more profits. Secondly, to be cross-border itself makes the OPM model more adept at exploring the value of cross-border innovation, providing customers with original product planning, developing potential consumer needs, and launching targeted differentiated products for a niche market. Finally, on the one hand, dominance significantly improves the position of OPM enterprises in cooperation, thereby improving the bargaining power of enterprises, on the other hand, it enables enterprises to better control the entire product production process, reducing unnecessary communication costs and potential risks. No matter what kind of R&D investment, model innovation, and transformation & change an enterprise undertakes, its ultimate goal is to obtain higher profits. Faced with this toughest inspection standard, the

OPM model clearly meets the requirements, which is the fundamental reason why 3nod has been developing and firmly continuing to develop the OPM model for more than ten years. The director of the audio department of 3nod Group compared the profit difference between ODM and OPM:

"In the early days of 3nod, it started from ODM. In the process of transformation, we found that the business is getting bigger and bigger. But the competitiveness is getting worse and worse. From the years of 2006, 2007 and 2008, OEM and ODM basically accounted for 60-70% of the company's share, but the contribution to our company's profit is getting lower and lower, and there are even many projects that have loss. Our OPM is reversed, and the profit is very high...so we increased the share and investment of OPM."

2) Strong anti-risk ability

The cross-border of the OPM model determines that its customers come from various industries. A large number of cross-border customers, practices and innovations in different industries can enable enterprises to make full use of the influence and marketing channels of various brands, and its own profits will not be affected by fluctuations in a certain industry or the recession led to a significant reduction in orders. This idea of "serving the world's brands" enables companies to excel in their areas of expertise, thus segmenting the customer's value chain and avoiding the potential danger of "putting eggs in the same basket". In addition, because OPM companies are in a relatively dominant position in the cooperation, they have a certain right to speak to the conception and planning of products. OPM companies can make full use of their own advantages and plan products according to their own resources and abilities, thus minimize the risks of own operations, resource allocation, etc. due to the increase or change of customer demand. In the case of insufficient orders, OPM

companies can also seek cross-border cooperation and find more customers by proactively providing product planning. When introducing the OPM model, 3nod executives also emphasized its ability to resist risks:

"We are now treating the world brands as our own brand, what's the benefit? It is that the company's ability to resist risks is stronger. For example, during the financial crisis in 2008, 3nod maintained a 100% growth. In recent years, it has basically maintained 30%-50% growth."

(3) Catering to the development trend of the Internet era

With the advent of the Internet era, the ecological economy has become the development trend of leading companies. Internet companies such as BAT, LeTV, and Xiaomi are scrambling to build their own enterprise ecology. Under the development trend of this era, the OPM model is easier to obtain customers from different industries, and more likely to obtain high added value of products. The strong cross-border cooperation ability of enterprises meets the requirements of ecological economy, which can help ecological enterprises to expand the influence of their brands and further explore the potential value of consumers. It is also a convenient and effective way for ecological enterprises to improve their ecosystem. In the environment of ecological economy, enterprises with OPM abilities will be favored by major brands. The enterprise ecology is a huge and complex system. A single enterprise cannot fully operate every part of the contents or things. At this time, OPM provides a one-stop product solution for companies, which is an option worth considering. When the era of the Internet of Things comes, products will not only be traditional terminals, but an entrance and smart terminals and smart solutions that combine software and hardware, and integrate hardware and contents. Such products have higher requirements for customization, differentiation, personalization and

quality. The OPM model needs to fully understand the market and consumers, and conduct differentiated product planning according to the customer's brand and special scenarios or situations. Because of the emphasis on originality and overall planning, the products are more in line with the consumers' needs in the IoT era, and are more popular with the market and customers.

(4) Develop deep-level cooperative relationships

Facing the diverse and complex needs of different customers, OPM companies provide a complete set of product solutions. Compared with foundry and design, such services require more frequent and in-depth communication with customers. When a successful cooperation is over, the relationship and trust established by both parties are also deeper. Since it does not have its own brand and does not compete with customers, 3nod can obtain comprehensive industrial information, and may even know the layout of the industry and its competitors better than the customers themselves. The OPM model itself does not have its own brand, but makes appropriate product planning based on the customer's brand, which will not compete with customers, and can bring huge value to customers. In addition, the relative dominance of OPM companies in cooperation also enables companies to have the ability and willingness to develop deeper cooperative relationships with customers. This strategic level cooperation cannot be achieved by the ODM model. When it comes to the cooperation with customers, 3nod executives described the relationship with customers as follows:

"Having enough willingness and sufficient ability is the most basic premise of cooperation for us. With these two aspects, basically everyone will have a clearer understanding of the goal. I always believe

that when we have the common goal with the customers, the execution is better. After cooperation and tempering, it will lead to a better and better cooperative relationship."

Key Factors for Achieving OPM

The previous analysis has shown that the OPM model has its unique advantages, so how to implement the OPM model is the next issue to be discussed. For the transformation and upgrading of manufacturing enterprises, "dual abilities" of efficiency and innovation are always an indispensable condition. On the basis of dual abilities, this dissertation proposes five key factors to realize OPM based on the previous analysis of the OPM model, and the logical relationship is shown in the figure. Each key factor is discussed below:

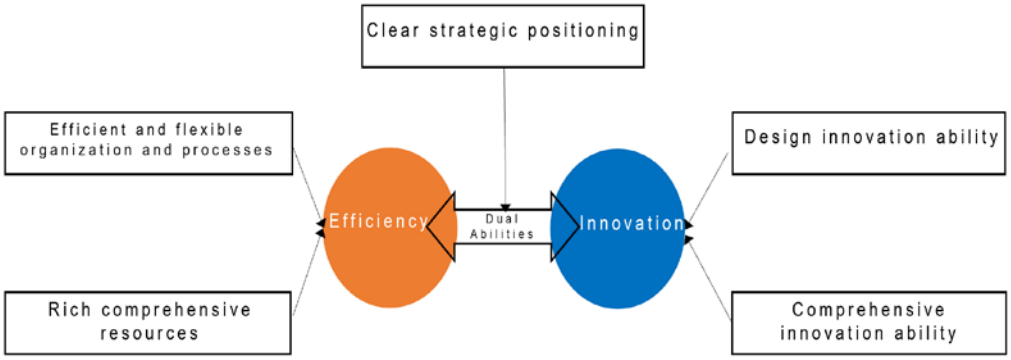


Figure 3.7 Five Key Factors for Implementing the OPM Model

First, the ability of design innovation. The core of the OPM model is to carry out differentiated innovation, and design innovation is the key to innovation. For manufacturing companies, design innovation is their core competitiveness, especially for OPM companies. Without strong design innovation abilities, enterprises cannot meet the diversified product needs of customers from various industries, and cannot meet the differentiated and personalized consumption needs of consumers, so they cannot make customers

feel at ease through this one-stop service model, which will make customers conduct an entrusting production of their products with OPM model.

Second, comprehensive innovation abilities. The process integrity of the OPM model requires enterprises not only to be outstanding in the design process, but also to emphasize innovation in all aspects, which determines that a company itself needs to have strong comprehensive innovation abilities, including market analysis and research, and selection and planning of business model, product design and development, resource integration of supply chain and other aspects of innovation, especially technological innovation abilities. compared to ODM. OPM emphasizes the spirit of originality, encourages innovation and creation, tries to avoid homogenization and mediocre products, and is committed to producing products that bring surprises to the world.

Third, efficient and flexible organization and processes. OPM enterprises need to face the dual needs of customers and consumers. Their customers come from different industries, and they have also different purposes in OPM cooperation. In order to successfully realize OPM, the entire organization must have strong learning ability and adaptability, perfect incentive mechanism and knowledge management mechanism, and at the same time, it is necessary to continuously optimize, manage and control the process, so as to improve efficiency and enable enterprises to be efficiently and flexibly respond to changing needs from multiple fields.

Fourth, rich comprehensive resources. From the perspective of resource-based view, if an enterprise wants to gain a long-term competitive advantage, it must try to acquire or cultivate scarce resources and abilities. For manufacturing enterprises, efficiency is the basis for satisfying customer needs and an essential

competitive advantage. For OPM companies, coordinating the entire process from concept to production requires the integration of industry resources, market resources, supply chain resources and other resources, so as to respond to customer needs in a timely manner and complete complex whole-process collaboration.

Fifth, a clear strategic positioning. The realization of OPM largely depends on whether the enterprise has a clear strategic positioning. Because the transformation from ODM to OPM requires strategic leadership to ensure its important position as the core competitiveness and driving force of the enterprise, and to develop corresponding resources and abilities, while matching the overall strategic layout of the enterprise in the future. If OPM is to be successfully realized, it is necessary to clarify its own strategic positioning according to its own situation, and give full play to the strategic value of OPM.

Difficulties and Challenges of OPM

(1) Difficulties in implementing OPM model

Although the OPM model has its unique advantages and value, it is more difficult to realize this model. Any of the five key factors mentioned above requires long-term accumulation and preparation. Although the competitive advantage brought by the realization of OPM is strong, how to successfully realize the OPM transformation is indeed a difficult problem. Compared with the traditional model, this new business model requires greater investment and also has greater risks. Specifically, the implementation of the OPM model mainly has the following three difficulties:

First, long-term industrial accumulation. OPM is another upgrade based on ODM. The successful transformation from ODM to OPM requires a process

from quantitative change to qualitative change, and requires a comprehensive improvement of the dual abilities of enterprise innovation and efficiency. Without the experience, resources, and partners accumulated in a long-term OEM and design in a certain industry, it is impossible to meet the higher requirements of the OPM model in terms of ability, experience, scale, etc., thus neither forming a good reputation in the industry, nor building the capital of customers' trust and cooperation. The development of OPM is a long-term process that is highly related to the enterprise's culture, genes, talents, etc. It is not something that can be quickly realized by a simple strategic decision by senior executives.

Second, the big investment in market research. As a design and manufacturing enterprise that has been focusing on the B2B model before, it needs to have a sufficient understanding of the market and consumers if it wants to transform into the OPM model, which requires the enterprise to build an additional team, put time and money to conduct market research and analysis. For an enterprise that does not have its own brand, it is more difficult to coordinate with the enterprise's own resources and organizational structure. In addition, once the planning has been done fails to satisfy the customer and resulting in cooperation fail, it will directly become a sunk cost, which is higher than the cost of no orders caused by the customer's dissatisfaction with the designed product.

Third, the costs of customer acquisition are high. Compared with ODM, OPM model is more difficult to acquire customers. The reason why the ODM model is still the mainstream cooperation model is that the design and R&D abilities are easier to judge by the number of patents, successful cases, and third-

party organization certification rankings. The work entrusted by customers includes only design and production, and cooperation is easier to achieve. To allow customers to recognize the abilities of OPM enterprises and hand over the entire contents of a product to OPM enterprises for planning, it requires OPM enterprises to have strong strength and the ability to acquire customers. In order to develop VIP customers with the OPM model, 3nod sometimes makes a complete set of plans first, and then submits them to customers to seek cooperation opportunities. The costs of such customer acquisition are very high.

(2) Challenges to the development model of traditional manufacturing enterprises

Scholars at home and abroad have carried out a lot of detailed research on the model upgrading of manufacturing enterprises. The current consensus is that manufacturing enterprises usually choose to further develop towards their own brand manufacturers (OBM, Original Brand Manufacturer) after the ODM has matured. This kind of upgrade model of "OEM-ODM-OBM", that is, the evolution process of "processing & manufacturing-design & development-own brand", is a development model generally recognized by scholars at home and abroad. As a new development model of manufacturing enterprises, OPM is another choice for mature manufacturing enterprises. Compared with the widely recognized traditional model, OPM has both advantages and disadvantages.

Its advantages lie in: First, the OPM model can reduce investment and risks in channel and brand building. The idea of "brands in the world, utilized by me" makes full use of the influence of high-quality brands and saves the huge cost of creating a well-known brand. Second, there will be no loss of customers due to competition between own brands and customers. Vigorously developing its

own brand, on the one hand, diversifies the resources and energy of the enterprise, on the other hand, it may affect the previous ODM business, thus it will change the relationship with customers from a collaborator to a competitor, and such a decision has greater risks, but under the OPM model, customers do not have such concerns, and enterprises can maintain a deep cooperative relationship with customers. Third, the OPM model has actually changed the formation of the enterprise itself, and evolved into a platform organization that can provide services to many enterprises in many industries, so it has more room to choose customers.

Its disadvantages lie in: First, it cannot achieve complete independence. Compared with OBM, which develops its own brand, OPM still cannot break away from the category of "OEM". Although it may have a higher right of speech than ODM, market selection and product development should still be based on customer needs. Second, they lack their own brand influence among consumers. Consumers' brand cognition mainly comes from brand owners who have direct contact with them and conduct a large number of marketing activities. OPM manufacturers are not well known to the public, which may affect the development of enterprises' B2C business and the construction of ecosystem. Third, the model is not mature enough. The OBM model is widely recognized by domestic and foreign scholars and the industry. There have been many successful or failed cases for enterprises to learn from. The OPM model, as an original business model of 3nod, is still in its infancy, and there is no pioneering experience for reference, so it takes more cost and energy to explore and improve the model.

Table 3.1 Comparison of internal and external conditions for the formation of 3nod OPM model

	External conditions	Internal conditions	Design and Manufacturing Innovation	Non-technology support system	Innovation environment
OPM model	When consumer electronics are in the stage of rapid development, the market requires rapid response and rapid delivery. From OEM to ODM, 3nod is mainly to build relevant capabilities around the requirements of brand owners at this stage.	3nod has formed rapid and large-scale delivery abilities to meet the requirements of brand manufacturers.	3nod established its own innovation design center, and won domestic and foreign design awards in the field of product design, and achieved a certain position in the industry, so the profit rate of products has been greatly improved.	With the initial formation of the OPM model, 3nod has gradually stepped into a more independent development model after following the needs of major customers. So as to form the innovation culture of 3nod and improve the corresponding management system.	Early industrial policies mainly focused on applications for high-tech enterprises to obtain tax subsidies, export subsidies, and applications for industrial land for enterprises. At that time, the external economic environment was good, and the enterprise was in a period of rapid development of large-scale manufacturing. Its living environment mainly considers the market environment, cultural environment and policy environment.
	The domestic demographic dividend has not disappeared, and the labor cost of enterprises is relatively low.	3nod's manufacturing equipment and mold manufacturing abilities have developed rapidly, and R&D of products can be carried out according to customer needs.	In terms of manufacturing, the supply chain management, large-scale production of products, and product trial production and testing have been strengthened.	3nod has carried out its own construction in terms of system, organization and human resources, and has formed a management system supporting OPM.	
	The market demand is strong, and the product competition becomes more intense. As an ODM, 3nod needs to seek breakthroughs and new models to obtain higher profits.	3nod began to work hard in product design, and gradually established design abilities in the field of audio product manufacturing.	The products gradually penetrate into the fields of PC, tablet and fashion consumer electronics with audio products, and gain corresponding market share.	3nod began to cooperate with colleges and universities, using the systematic knowledge of colleges and universities to shape the cultural system of 3nod.	
	The Internet economy is gaining momentum, and 3nod's consumer electronics products are internationalized in sales channels.	Using the Internet to expand product channels, 3nod has gained the trust of domestic and foreign brand manufacturers.	the company's products and production are gradually internationalized by using the internet to communicate with customers and provide services.	3nod began to set up factories in Guangxi, Vietnam and other places to achieve diversified development, and use local culture and human resources, and tax policies to expand the company's influence.	

The above table accurately reflects the budding state of the innovation ecosystem in the infancy stage during the formation of the 3nod OPM model.

3nod Primary Innovation Ecosystem

3nod's primary innovation ecology mainly focuses on the construction of the core technology ability system. At this stage, it mainly focuses on the actual needs of brand manufacturers. 3nod's own product design center + external innovation accelerators in the primary stage + traditional manufacturing

suppliers constitute 3nod's basic innovation form in the primary stage of OPM ability, the quantity and quality of the links between internal innovation elements and external innovation elements and the form of cooperation in this stage are relatively single, as shown in Figure 3.8 below:

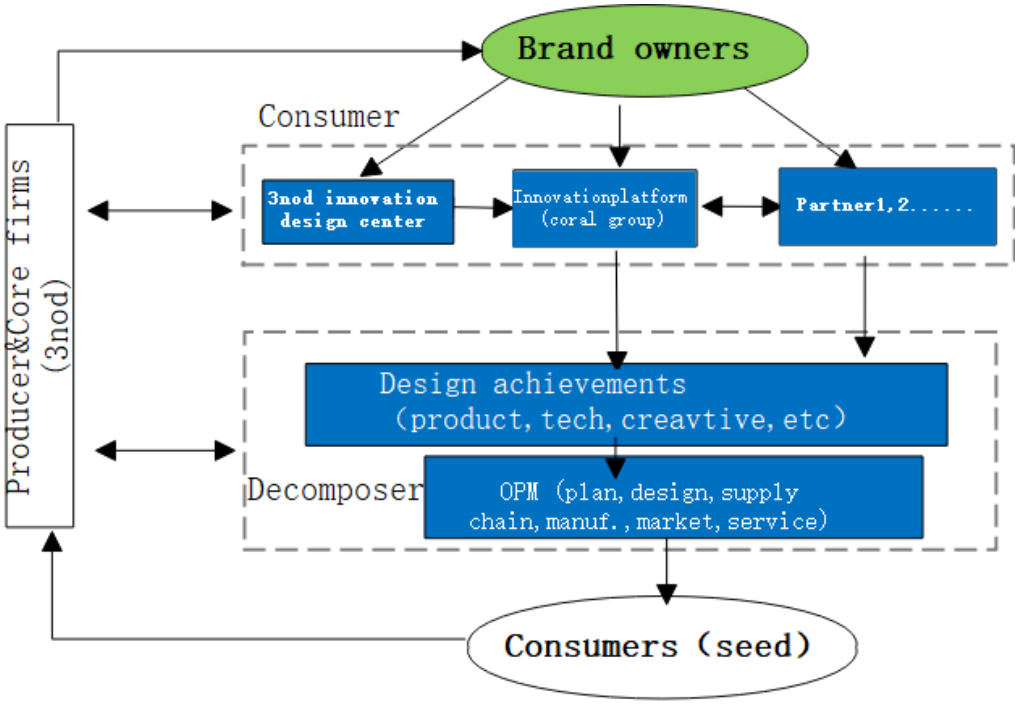


Figure 3.8 Ecological framework of the initial stage of 3nod's innovation ecology

Chapter summary

The main purpose of this chapter is to describe the budding state of 3nod's early innovation ecosystem under the initial formation of the OPM innovation model, which is the basic condition for the subsequent evolution of the 3nod innovation ecosystem to a higher stage. The whole process of OEM-ODM-OPM development of 3nod Group was reviewed. At this stage, the core of 3NOD innovation ecosystem mainly revolves around the design innovation capability module. 3nod has gradually formed an internal innovation platform in the process, because 3nod's manufacturing capabilities (quick response and large-scale manufacturing capabilities) have entered a mature stage. In this

process, the core of 3nod's main innovation ecosystem is an innovation ecosystem centered on 3nod's internal innovation platform rather than an enterprise. The formation of the Coral Group Innovation Accelerator also makes up for the insufficiency of 3nod's own innovation platform in terms of creative design (design vision and design inspiration). This process is determined by 3nod's internal and external innovation environment. Therefore, 3nod's innovation ecosystem rarely involves new technologies, new manufacturing technologies and application scenarios. This is the response of 3nod's new ecosystem under the changing conditions of the new generation of information technology.

Chapter 4：Research Design

The abstract of this chapter

The starting point of the research in this chapter is to evaluate the construction of innovation ecosystem with the design innovation capability module as the core in the initial stage of the formation of 3nod's OPM model, and start the research design. We investigate methods to determine whether the design designed in Chapter 3 was appropriately implemented by 3nod and identified the challenges enountered. We interviewed 3nod’s key personnel involved in the implementation. We ascertained and coded their interviews to verify that 3nod is evolving the innovation ecosystem based on method design and challenges faced. Therefore, new challenges (industrial Internet technology and advanced manufacturing technology) have been added to the changes in the internal and external environment of 3nod. In terms of OPM innovation model, technology innovation modules, manufacturing innovation modules, and application scenario innovation modules have been added. The design of these three modules has enriched the inadequacy of 3nod's past OPM mode under new conditions. This is the starting point for the upgrade and evolution of the 3nod current OPM model.

Adaptability of case enterprises research

This research follows the principle of "theoretical sampling"[62] and selects the innovation ecosystem of smart voice hardware led by Shenzhen 3nod

㉒ Referring to Juliet M. Corbin, Anselm L. Strauss "The Foundation of Qualitative Research: Procedures and Methods for Forming Grounded Theory (3rd Edition)", translated by Zhu Guangming. Chongqing University Press 2015.

Electronics Co., Ltd. (hereinafter referred to as 3nod) as the case research object. The specific reasons include:

(1) Industrial typicality. The consumer electronics manufacturing industry where 3nod is located involves many disciplines such as acoustics, linguistics, machinery, communications, and digital signal processing, electronics, computers, testing, and software, and the disciplines intersect with each other. The interdisciplinary nature determines that the research, development and production of smart voice hardware cannot be completed by a single company alone, and need to be jointly completed by related organizations.

(2) Enterprise typicality. The 3nod's enterprise typicality is shown in: ① 3nod Group was established in Shenzhen in 1996. It is an overall solution provider with "smart life" as its core, and is committed to improving people's quality of life through valuable innovation and technology. 3nod mainly involves three major areas, including audio-visual entertainment, information technology and smart home. 3nod Group has become the world's leading provider of multimedia audio products and a leading provider of smart life products and overall solutions. It is also a platform-based industry investment group with smart homes as its core. ② 3nod led the construction of a smart voice hardware innovation ecosystem with OPM as its core capability (as shown in Figure 1). 3nod takes its own OPM capabilities and smart voice hardware as the core. With the support of relevant departments, it unites several scientific research institutions of universities such as the University of Electronic Science and Technology of China and Nanjing University, and hand in hand with intermediary organizations such as Shenzhen Industrial Design Association and Shenzhen Internet of Things Association to build a smart voice hardware

innovation ecosystem with OPM as the core, at the same time, promotes the efficient flow of technologies, talents and other elements in the ecosystem through a variety of methods such as technology alliances, and ultimately benefits related entities in the ecosystem. Therefore, the smart voice hardware innovation ecosystem led by 3nod can represent the successful practice of the enterprise-centric open innovation ecosystem.

(3) Content adaptability. The development history of 3nod can be roughly summarized into four main stages. According to the characteristics of different periods, 3nod's growth is divided into: sailor, explorer, intelligent creator and creator. In the innovative development with design and technology as the dual engine, 3nod has used "design thinking" proficiently. It is not limited to the field of industrial design of products, but to drive enterprise innovation and development with strategic thinking of design. 3nod's design innovation mainly focuses on the four dimensions of "product, user, organization, and society", and continues to expand and upgrade. These four dimensions have been reflected in different historical periods, but the emphasis is different. In the Design 1.0 stage, with "products" as the core, 3nod found breakthroughs in differentiated industrial design. In the 2.0 stage of design innovation, the “user” is the core and built a global original OPM business model. In order to seek external support for the OPM model, the Shenzhen Industrial Design Association was initiated in 2008 (now it has become an internationally influential Industrial Design Association). The 3.0 stage of design innovation focuses on "organization", breaks the traditional closed organizational structure, uses a two-wheel drive development strategy, and through cross-industry, alliances and links, the three major industrial chains of smart life (smart

education, smart furniture, audio and video entertainment) are carried out with foresighted Layout and coordinated development, and 3nod is gradually transformed into an ecological chain platform enterprise. The 4.0 stage of design and innovation focuses on "society", builds a complete innovation, entrepreneurship and venture capital ecosystem with social life transformation and national strategy design, and helps the government to gather global innovation forces through the integration of industry and finance, feeding back the industry. Therefore, 3nod is suitable for the construction research for an enterprise-centric open innovation ecosystem.

(4) Data availability. The author of this paper, Chairman Liu Zhixiong, has witnessed the entire process of 3nod’s growth, development and expansion. Therefore, in the process of data acquisition and in the form of interviews, questionnaires, and other methods, the senior management team and external ecosystem partners that have participated in the 3nod innovation ecosystem have provided great convenience for collecting materials needed for research.

Collection of case data

Abundant data sources are helpful for the multi-angle description of research objects and research problems. Data from multiple sources can use "triangulated verification" to avoid the one-sidedness of opinions formed in case studies and improve reliability and validity. The case data in this paper mainly includes two types of first-hand data and second-hand data. Specifically: the methods of first-hand data acquisition include face-to-face interviews, questionnaire surveys, and focus group discussions. The collection of first-hand data is mainly carried out between October, 2020 and April 2021. The interviewees included the chairman, general manager, assistant to the chairman,

head of R&D, CIO, heads of production BUs, head of HR, etc. of 3nod, and the total of 16 interviews were conducted, which were implemented in three stages. The first stage of the interview was the interview with the senior management of 3nod, such as the chairman and assistants of 3nod, with the purpose of searching for potential research topics. After analyzing the interview recordings and the initial collected data, it was discovered that the smart voice hardware innovation ecosystem built by 3nod based on the open innovation strategy is a question worthy of in-depth discussion. The interview in the second stage is called in-depth interviews. The research team conducted in-depth interviews with the chairman, general manager, assistant to the chairman, technical person in charge, and market manager around the research topics determined after the interview in the first stage. Based on the interview framework and guiding questions, the research team further focused on obtaining relevant information about the construction of the 3nod innovation ecosystem. The third stage interview is called supplementary confirmatory interview, which is mainly to supplement and cross-validate the case data collected in the previous period with the relevant parties to ensure the reliability and completeness of the data. Finally, the interview data with a total of about 120,000 words was collected. The second-hand data is mainly collected through news reports, archive materials (corporate brochures, internal files, etc.), academic papers and official websites. The descriptive statistics of the interviewees in this study are as follows: Table 4.1.

Table 4.1 Summary of Case Interview

No.	Name	Department\Position	Contents of interview	Date of interview	Time of interview

1	Qiao	Product innovation center and R&D center\Vice General Manager	R&D of products	2021.3.2	115min
2	Peng	Vietnam Base\General manager	Layout of overseas manufacturing	2021.4.8	95min
3	Xia	Special Assistant to the President	Enterprise Strategy and Supply Chain Management	2021.3.15	85min
4	Zheng	Maxypro Planning\General manager	Design and development of products	2021.3.10	105min
5	Zhai	HR\Director	Business organization	2021.3.12	65min
6	Zhao	Smart products BU-SPG\Director	Product development	2021.3.13	73min
7	Jiang	PC system BU\Director of R&D center	Product development	2021.3.13	82min
8	Zhu	Assistant to General Manager	Supply chain of Manufacturing	2021.4.8	65min
9	Huang	Special Assistant to the Chairman	Design of Enterprise Strategy	2021.4.8	68min
10	Nie	Management center of HR\HR Director	Human resources and enterprise culture, enterprise organization construction	2021.3.15	60min
11	Dong	Information Management\CIO	Digital factory	2021.4.10	95min
12	Lu	Smart center of digital factory\ Chief Engineer of Intelligent Manufacturing & Head of Special Factory	Digital factory construction of Enterprises	2021.4.10	85min
13	Zeng	Innovation platform of Coral group\Head	Construction and operation of innovation platform	2021.3.25	65min
14	Yi	Manufacturing BU\Head	Manufacturing process and automation	2021.4.12	75min
15	Liu	The Chairman of 3nod Group	Enterprise overview and development strategy	2021.4.15	120min

In order to screen out the effective case information needed for the research topics, the research team conducted a comprehensive search on 3nod's relevant information. About 370 news reports about 3nod were collected through Baidu and industry-related websites, and 12 archives about 3nod were collected through field investigation and research. At the same time, the research team also collected 3nod-related materials on 3nod’s official website. In the end, 220 pages of second-hand materials were formed, with a total of more than 200,000 words. The collection of second-hand data preceded the interview and research and was accompanied by the first-hand data collection throughout the entire process. The conflicting data in the second-hand data was verified with relevant personnel during the interview to ensure the accuracy of the information.

Internal and external factor coding of 3nod innovation ecosystem construction

In this dissertation, relevant factors are added to the research model of internal and external factors of core enterprises building innovation ecosystem by Professor Han Shaojie and Lv Yibo of Dalian University of Technology. In terms of external motivation, adding the concept category of common problems faced by the external manufacturing industry, please refer to the C4 level-concept coding for details. In terms of internal motivation, the two influence categories of adaptive change of enterprise manufacturing capacity and cooperation between entrepreneurs and senior management are added. For details, see C16, C17: Level-Concept Coding. The main reasons for consideration are as follows:

(1) External factors:

In recent years, China's manufacturing industry has been affected by environmental protection, the disappearance of the demographic dividend, the increase in labor costs, and new technologies. At the same time, the national policy clearly supports the encouragement of green and low-carbon manufacturing, and supports domestic enterprises to carry out digital and intelligent transformation with specialization and innovation. In the above aspects, the manufacturing industry has rarely faced such common problems in the past. In the related research, Professor Han Shaojie and Professor Lv Yibo did not cover the influence factors of this level due to the limitation of time and space environment. In the current research process, the trouble of these problems cannot be avoided, so the research in this dissertation has been expanded.

(2) Internal factors:

Entrepreneur's cognition dominated the manufacturing system in the past. With the change of new manufacturing situation, senior management needs to participate in the entrepreneurship and cognition level, so as to better cooperate with the construction of innovation ecosystem. According to 3nod's actual situation, the spirit and cognition of the senior management are listed on the same level as the entrepreneurs, and the main reason is to reduce the cost of communication.

For manufacturing enterprises to carry out digital and intelligent transformation, and build in line with personalized customization and flexible manufacturing, enterprises must objectively evaluate their own internal manufacturing abilities to correspond to the analysis of the maturity of intelligent manufacturing. Only then can enterprises find a breakthrough direction for new manufacturing. Therefore, the influence of this level is very obvious, and the influence of this block is not covered in the original model.

In order for manufacturing enterprises to successfully implement the digital intelligence strategy, the original manufacturing system must be adjusted and adapted. It is difficult for the original system to achieve breakthroughs by relying on its own strength. Enterprises have to seek help from external forces, and it is very important to introduce relevant new talents. The new executives represent the new knowledge system of intelligent manufacturing and industrial Internet, and the original large-scale manufacturing capability system of manufacturing enterprises, friction and cooperation are inevitable in enterprise practice. Therefore, the cooperation between entrepreneurs and senior

management needs to be considered, and this is not covered in the original model, so this dissertation adds a factor to this.

In the process of coding, this dissertation applies Atlas. ti7.0 Qualitative analysis software to perform auxiliary encoding. This step is carried out by the author and research assistant of this dissertation at the same time: ① They independently retrieved keywords related to the motivation for the construction of the open innovation ecosystem from the data, and carried out keyword labeling on the citations one by one, and eventually a total of 385 keywords were formed; they exchanged keywords formed by encoding and conducted mutual examination. After discussion, the keywords that could not reach a consensus were deleted. After conducting this link, a total of 348 keywords were formed. ②Conceptualizing (Cx) the determined keywords. The keywords that the two parties agreed on are directly conceptualized. For the keywords that the two parties disagreed with, they need to discuss with the third author to determine their attribution. ③Categorizing the concept, which means further refining the formed concept to form a category, and for the concept that cannot reach a consensus, the author needed to discuss with his instructor to determine the attribution. Finally, 8 categories, 16 concepts, and 709 three-level entry libraries were determined (the encoding results are shown in Table 4.2).

Table 4.2 Structure of coding

Type	Category	Concept	Keywords	Quantity
Motivation of external ecology context	Level of technical context	C_1Technical complexity	Interdisciplinary |Subject complexity | Multidisciplinary |Technology Convergence | High technical complexity | Structural complexity |Many parts|Technical complexity | Complex manufacturing process	289
		C_2Technical dynamics	Fast technology updates |Fast technology changes | Short product cycle | Short technology cycle | Rapid emergence of new technologies | Rapid emergence of new	48

			disciplines | Unpredictable technological changes |Fluctuating technology	
		C_3Technology lagging	Backward technology| Backward enterprise |Technology introduction| Technology purchase | Imitation learning | Newbie in the industry | New entrant | Weak foundation | Reverse engineering	35
	Common external problems manufacturing industry is facing	C_4Complexity of manufacturing	Environmental protection and green manufacturing| Demographic Dividend |Intelligent manufacturing| Digital transformation| Industrial software| Automation | Integration of Informatization and Industrialization | Technical talent | Labor cost |	24
	Level of market context	C_5Market demand diversity	Product customization | More product series |Customer commissioning | More customer requests | Demand specialization | Demand personalization |Special device	18
		C_6Systematization of market competition	Industry chain competition | Technology System | Group competition | Full industry chain | Full technology chain | Competition system | Network competition	10
	Level of institutional context	C_7Formal Institutional opportunity guidance	National policy | Tax preferences | Financial support | Key projects | Special planning| Government subsidy | Fund support| National procurement| Government certification	8
		C_8 Informal institutional pressure drive	Leader inspection | Leader care | Leader matchmaking| Government model projects | Government-enterprise relationship | Potential rule | Political capital | NPC member	5
Motivation of internal ecology context	Attention level of entrepreneurs and executives	C_9 Internal entrepreneurial attention	Internal resources of enterprises| Enterprise talent | Level of enterprise technology | Financial strength | Production efficiency | Quality of staff | Profit margin | Internal management	15
		C_{10} External entrepreneurial attention	Latest development of new technology | Market share of enterprises | National policy trends | Technology talent | Industry position of enterprises | Customer demands | Competitive environment| Change of government leaders	8
	Cognition level of entrepreneur and executives	C_{11} Economic cognition	Reduction of operational cost | Increasement of corporate profitability | Reduction of R&D expenditure | Increasement of new products | Increasement of turnover	12
		C_{12} Non-economic cognition	Technology standard |Discourse power of industry | Sustained competitive advantage | Complementation of resources |Mutual benefit	14
	Spirit level of entrepreneurs and executives	C_{13} Challenge consciousness	Advance against hardship| Challenge industry overlords | Face the competition | Ambitious goal | National industry | Becoming an industry leader | Not afraid of hardships	8
		C_{14} Innovative mind	New technology | New methods | Development of new products | Pay great attention to R&D | Exploring new models | Adaptive adjustment | Flexibility | Product innovation | Organization innovation	15
		C_{15} Risk-taking awareness	Seeking wealth in risks | coexisting of risk and benefit | Risk means opportunity | Taking risks	11
	Change level in internal manufacturing capabilities of enterprises	C_{16} Evaluation of Enterprise Manufacturing Capability	Quick response of mold| Injection molding| Modularization of production unit| Assembly link| Process link| Automation| Lean production| Informatization | Industrial platform |Design ability |OPM| Application scenarios of products|	225

	Relationship level of entrepreneurs and executives	C_{17} cooperation situation of entrepreneurs and executives	Entrepreneur's Personal Charm | Enterprise Platform Attraction | Enterprise Institutional Pressure | Enterprise Development Potential | Enterprise Development Dividend Sharing |	5
Total				714

Note: In a Boolean search, it indicates a logic or data source:

（1）Coding of construct structure

The first step mentioned above is to summarize the collected qualitative data to the conceptual level based on the relevance to the theme, forming a conceptual expression and an item database. The next step is to theorize these conceptual data, that is, to classify the conceptualized expressions and divide them into constructs related to the subject of this research. This research uses the value realization node of each innovative product/technology as the main coding classification basis. The names of the constructs involved are all from relevant important documents. At the same time, according to the main research questions involved in this research, the names of the constructs have been classified and summarized.

（2）Theoretical structure coding. After the construct structure is coded, the corresponding constructs are classified into the corresponding theoretical conclusions, and the theoretical model is further analyzed and constructed, and the copy rule of multiple cases is explored. Since the research team has an in-depth understanding of the research problems and can have a high degree mastering of the data. Therefore, the opinions are basically the same in the theoretical structure coding.

Motivation analysis of external situation construction in 3nod innovation ecosystem

(1) Analysis on the source of motivation. According to the coding results, the external context motivation comes from the technical context level, the market context level and the institutional context level. Among them, the technical context refers to the technical background and characteristics of the industry in which the technical activities of the enterprise occur. The market context refers to the market demand and competitive environment of the relevant industry in which the company is engaged. Institutional context refers to the formal or informal institutional environment constituted by the laws and regulations, social norms, values, and culture of the country or region where the enterprise is located. And the external context composed of technology, market, system, etc. will have an impact on the strategy and behavior of the enterprise.

(2) Analysis of typical events. Applying Atlas.ti7.0 to search the original documents of the second-level citation library corresponding to 486 valid codes related to technical context, market context, and institutional context, the research team found that there were 16 typical events at the level of technical context, 14 typical events at the level of market context, and 8 typical events at the level of institutional context. According to the logic of "Condition→Action→Result", the research team further analyzed the performance characteristics at different levels that trigger the construction of 3nod's innovation ecosystem. Table 4.3 shows the typical event analysis of the motivation of external context construction.

Table 4.3 3nod's Typical Practice Analysis on the External Context of Building an Innovation Ecosystem

Level of sources	Description of typical events	Process of analysis		
		Condition	Action	Result
Technical context	Head of 3nod's R&D and technology department: Under the influence of the global economy by COVID-19, how to identify new technologies and establish R&D supply chains are important issues that 3nod must solve in the future. Especially in the fields of voice technology, artificial intelligence, big data and algorithms, etc.	Technical complexity	Cooperation with university institutes	Cooperating with Nanjing University, University of Electronic Science and Technology of China, Shenzhen Institute of Advanced Technology of the Chinese Academy of Sciences, Goertek Inc. and Foxconn Industrial Internet Co., Ltd to carry out technical cooperation, building technology alliances, and carrying out technology introduction, so as to promote enterprises to build an open innovation ecosystem with themselves as the core
	3nod CIO: The acoustic application scenario products defined by 3nod in the future need to strengthen the identification ability of the enterprise technology department. This requires external cooperation to make up for 3nod's own shortcomings in technical capabilities. 3nod implements digital transformation, and enterprises need to continue to strengthen in advanced manufacturing technology and industrial Internet.	Technical dynamics	Building a technology sharing alliances	
	Head of 3nod Digital Factory: The construction of 3nod Digital Factory is inseparable from the support of industry cases, especially the reference and absorption of mature experience in the same industry or similar industries, and targeted transformations. For example, the successful experience of Goertek and CVTE in the Digital Factory , these experiences can save 3nod the costs of technical trial and error.	Technology lagging	Introducing the technology of technologically advanced enterprises to digest and absorb	
Manufacturing context	Head of the manufacturing department of 3nod: The labor cost of enterprises has risen, and the industry has begun to explore the transformation into digital factories and unmanned workshops. Industry 4.0 has brought a huge impact to enterprises.	External context of enterprises	Actively learning industry benchmarks outside the enterprise, and actively reserve the development elements of enterprise digital transformation	The digital transformation of the enterprise is formed both inside and outside of 3nod, and the pressure of transformation has prompted 3nod to actively deploy its own digital capability ecology around the digital economy, which is also the dual driving force for 3nod to build an innovation ecosystem.
	Special assistant to the chairman of 3nod: 3nod's own manufacturing involves product design, mold manufacturing, injection molding, CNC, and assembly. In the past, it has formed OPM abilities. Whether the OPM manufacturing abilities will be industrialized or not in the future, this will be the central axis of 3nod for the construction of an innovation ecosystem.	Internal context of enterprises	Start investing in the construction of digital factories inside, implement partially automation, informatization, and intelligent construction, and learn from industry leaders to reserve talents for the digital transformation of enterprises	
Market context	Chairman of 3nod said: In recent years, consumer electronics industry has entered the Red Sea market, and has been facing the overall demand for fragmented and personalized products. Flexible production and personalized customization will be the basic trends consumer electronics manufacturing is facing in the future. The construction of 3nod's innovation ecosystem must consider the dual factors of digital economy and intelligent manufacturing.	Diversity of market demand	Using the information platform to communicate with users, capturing the invisible needs of consumers, and jointly developing products together with users	The diversity of market demand and the competition systemization make it difficult for a single enterprise to meet market demands. Therefore, enterprises need to innovate with users and suppliers in order to respond in a timely manner, thus promoting enterprises to build an open innovation ecosystem with themselves as the core.
	Head of the marketing department of 3nod: Smart hardware is used in consumer electronics, smart home, smart transportation, smart industry, smart medical and other fields. Among them, products in the fields of consumer electronics and other fields are mainly based on C-end consumer services, with a high degree of popularity; smart home,	Systematization of market competition	Building an industrial Internet platform with upstream and downstream companies in the supply chain to quickly respond to user needs	

	intelligent transportation and other fields serve both C-end consumers and B-end enterprises; smart industry and smart medical terminal products are mainly provided to B-end enterprises, such as factories, hospitals and other institutions.			
Institutional context	Chairman of 3nod said: From the country to the province and city, China has clear industrial policy support for smart hardware, as well as smart education, whole-house intelligence, smart health-care products, and smart medical beauty products.	The guidance of Formal Institutional opportunity	Following the government's industrial policy direction (consumption upgrade and digital transformation, digital economy products)	The guidance of formal institutional opportunities and the pressures drive of informal institution encourage companies to cooperate closely with government departments, thereby promoting enterprises to build an open innovation ecosystem with themselves as the core
	Chairman of 3nod said: In recent years, 3nod has actively responded to the national entrepreneurship and innovation policy, and jointly established the Coral Group Accelerator with Internet company T, aiming to incubate and support smart hardware start-ups, and provide productized services such as trial production and pilot testing for their product ideas, as well as corresponding services of investment and financing, absorb ideas from each other, use 3nod's own manufacturing resources to support the formation of an industrial chain for start-ups to grow and develop, and to cultivate innovation factors that are in line with 3nod's innovation ecosystem.	The pressure drive of Informal institution	Working closely with the government to make achievements in the field of smart hardware applications	

(3) Analysis of the manifestation characteristics of the motivation. Corresponding to the level of technological context sources, typical event analysis identified three types of manifestations, namely technological complexity, technological dynamics, and technological lagging, which together urged 3nod to build an innovation ecosystem. ① the development and production of products involve different technical fields. For smart voice-related hardware products, a single enterprise cannot have all technical abilities due to its specific background, technology, experience, and resource limitations. So, the complexity of technology forces companies to conduct technical cooperation with leading technology organizations. ②with the development of science and technology, new technologies and disciplines are constantly emerging, technology updates are accelerated, and cycles are shortened. The limitation of enterprises' own attention makes it difficult for enterprises to capture, track and respond to all the latest technologies involved in products in

a timely manner. Therefore, the dynamic technological environment requires the division of labor and collaboration between enterprises and related leading technology units, and enterprises mutually use their own and the other's superior technical resources to realize the sharing of advanced technologies, so as to help enterprises keep up with the dynamic development direction of technology and realize quickly marketization. 3nod is a typical consumer electronics manufacturing company. It has gone through the whole process of OEM-ODM, and has shortcomings in the identification and absorption of technology. In order to strengthen its adaptability to the current market environment, it is necessary to continuously absorb new technologies to fill the functions and connotations of its products. For example, 3nod led the establishment of the "Shenzhen Industrial Design Association" in an attempt to increase 3nod's ability to grasp the market for product design. This is an inevitable choice for the transformation and upgrading of consumer electronics to absorb the dual drive from appearance design and intrinsic technical connotation. ③ Technology lagging refers to the characteristics of weak technical foundation and lack of core technology compared with the leading technology in the industry, and it is in the stage of learning and catching up technology. The lagging of technology determines that it is one of the efficient ways for companies to achieve rapid technological catch-up by introducing advanced technologies of leading companies, and complete digestion and absorption with the help of scientific research institutions and other organizations. For example, learning Goertek's acoustic design technology, digital intelligent technology of Foxconn Industrial manufacturing, and learning related technologies from the Shenzhen Advanced Technology Institute of Chinese Academy of Sciences,

Nanjing University and other scientific research institutions. Therefore, the complexity, dynamics, and lagging of technology at the technical context level make companies with limited resources have to carry out technical cooperation, build technology alliances, and introduce technology, together with leading technology companies, scientific research institutes of universities, and thus promote the construction of an open innovation ecosystem of enterprises with themselves as the core. Corresponding to the level of the market context source, the analysis of typical events identified two types of manifestation characteristics, namely, the diversity of market demand and the systematization of market competition, which promote the construction of an enterprise-centric open innovation ecosystem. On the one hand, for enterprises, the market demand of homogenization only needs relatively low requirements, which can be met by mass production of a single product. However, for diversified and individualized market demands, companies need to transform their “buy-sell” relationship with users into a strategic partnership of mutual innovation and mutual benefit. For example, Internet company T Jingle developed by 3nod and Internet company T, and DuSmart Speakers developed with Baidu, are just typical cases of collaboration between customers, markets, and innovation. On the other hand, market competition has changed from the original competition between individual companies to the competition of the entire industry chain. The key to market competition is that companies seize user needs and then cooperate with suppliers to respond in a timely manner. This requires a seamless connection of needs between enterprises and users, and close cooperation between enterprises and suppliers. For example, in order to cooperate with international customers and consider labor costs, 3nod established factories in

Beihai city, Pingxiang city, Guangxi Zhuang Autonomous Region, and Vietnam, all of which are inseparable from the cooperation and collaboration of upstream and downstream supply chain companies. In a word, the diversification of market demand and the systematization of competition at the market context level make it difficult for a single company to meet market demand. Therefore, companies need to innovate with users and suppliers in order to respond to market demand in a timely manner, thereby promoting the establishment of an open innovation ecosystem of the enterprise with itself as the core. Corresponding to the level of institutional context sources, the analysis of typical events identified two types of manifestation characteristics, namely the guidance of formal institutional opportunity and the drive of informal institutional pressure, which promote the construction of an enterprise-centric open innovation ecosystem. On the one hand, the formal system directly shapes market opportunities for various economic activities through formal laws and policies. These formal systems can guide the development of related industries through policy support, tax incentives, government subsidies, and fund support. These formal systems provide companies with opportunities to obtain external resources. Therefore, enterprises try to follow the lead of the formal system as much as possible to obtain more external resources. For example, 3nod is actively deploying the industry clusters in the fields of people's livelihood technology, such as the smart education, the whole-house intelligence, the rehabilitation therapy mentioned in Shenzhen's 14th Five-Year Plan, and has obtained a lot of development space for its own future. On the other hand, the informal system refers to the shared mode of thinking and unwritten codes of conduct that the public abide by, such as the traditions, customs, and norms.

Maintaining a good relationship between government and enterprise in the informal system is the key to promoting enterprises to obtain more resource support. In this process, the sunk cost pressure of these resources invested by the government and the enterprise drives the close alliance between the enterprise and the government. For example, 3nod and Internet company T have established a well-known accelerator coral group in response to the national mass entrepreneurship and innovation policy. While adhering to open innovation, they have provided more resources for start-ups and obtained more government resources for their own development. Therefore, at the institutional context level, the guidance of formal institutional opportunities and the drive of informal institutional pressures prompt 3nod to work closely with government departments, thereby promoting enterprises to build an open innovation ecosystem with themselves as the core.

Manifestation characteristics at different levels of the external context promotes close cooperation between 3nod and related organizations such as scientific research institutes of universities, technology-leading companies, users, suppliers, and governments, thereby promoting the construction of its own innovation ecosystem.

Motivation analysis of internal situation construction in 3nod innovation ecosystem

(1) Analysis on the source of motivation. According to the encoding results, the motivation of internal entrepreneurs and senior management comes from the attention level of entrepreneurs and senior management, the cognitive level of entrepreneurs and senior management, and the spiritual level of entrepreneurs and senior management. Among them, the attention of entrepreneurs and senior

management refers to the process in which entrepreneurs and senior management input time and energy to pay attention to and explain knowledge and information.

The cognition of entrepreneurs and senior management refers to the knowledge framework and belief system that entrepreneurs and senior management gradually form and continuously strengthen under the influence of context. The spirit of entrepreneurs and senior management refers to the most dynamic and creative activities to open up new roads, with the spirit of creativity and the courage of taking risks. The adaptive change of the internal manufacturing ability of an enterprise refers to the evaluation of the readiness and maturity of its own manufacturing ability to adapt to the conditions of digital intelligence. The cooperation between entrepreneurs and senior management refers to the cooperation and conflict between old and new knowledge in the process of realizing digital intelligence. The above conditions will affect the behavior output of enterprises.

(2) Analysis of typical events. Applying Atlas.ti7.0 to search for the correlation between the attention of entrepreneurs and senior management, the cognition of entrepreneurs and senior management, the spirit of entrepreneur and senior management, the adaptive change of enterprise manufacturing capacity, and the cooperation between entrepreneurs and senior management. The original document of the secondary citation database corresponding to the valid code, it is found that there are 8 typical events at the attention level of entrepreneurs and senior management, 15 typical events at the cognitive level of entrepreneurs and senior management, and there are 15 typical events at the cognitive level of entrepreneurs and senior management. There are 9 typical

events on the spiritual level. Furthermore, according to the logical analysis of "condition→action→result", it induces the manifestation characteristics of different levels constructed with 3nod as the center of the open innovation ecosystem. Table 4.4 shows the analysis of typical events of the construction motivations of entrepreneurs and senior management.

Table 4.4 3nod's Typical Events Analysis on the Internal Motivation of Building an Innovation Ecosystem

Level of Sources	**Description of typical events**	**Process of analysis**		
		Condition	**Action**	**Result**
Attention level of entrepreneurs and executives	Chairman said, How do 3nod products implement adaptability innovation and carry out digital transformation in the new era? It lacks too many technologies and resources. How to identify and judge new technologies and models that match the development of 3nod, and how to introduce, digest and absorb to make up for 3nod's disadvantages.	Allocation of internal attention	Paying attention to the internal status quo and considering how to solve their own shortcomings and develop	The allocation of internal and external attention prompts enterprises to scan and absorb internal and external resources and abilities, laying a foundation for entrepreneurs to lead enterprises to build an open innovation ecosystem
	Chairman: In the future, 3nod will be positioned as a comprehensive solution provider for acoustics + application scenarios and intelligent hardware, and actively embrace intelligent manufacturing. This requires a large number of new talents to join.	Allocation of external attention	Keeping an eye on external benchmarks and key talents and reaching cooperation	
Cognition level of entrepreneurs and executives	Chairman: 3nod is a private enterprise. In order to survive and develop in the market, it must increase revenue and reduce expenditure. Future development needs to cooperate with others, especially for the investment of R&D resources, this must require 3nod cooperate with research institutes. This will help reduce its own investment, and facilitate the risk control of investment.	Economic cognition	The construction of 3nod's innovation ecosystem requires open rather than closed innovation	The good expectations formed by economic and non-economic cognition can provide the core motivation for the construction of an open innovation ecosystem that entrepreneurs lead enterprises to implement
	Chairman: Establishing a connection with the Institute of Acoustics of Nanjing University can obtain relevant knowledge accumulated in the field of acoustics. Nanjing University can also obtain the market ability of 3nod's technological achievements. Two parties all can get development.	Non-economic cognition	Building a technical alliance	
Spirit level of entrepreneurs and executives	Chairman: The future of acoustics is the main entrance to the intelligent world. Many livelihood application scenarios can be entered through acoustic hardware, such as smart education, smart homes, Internet of Vehicles, and rehabilitation equipment. The integration of acoustics, artificial intelligence, and big data will bring tremendous changes for the future social life. 3nod has passion to lead the software and hardware companies in the acoustics	Challenge consciousness	Leading companies and partners to challenge industry predicaments	Challenge consciousness, innovation mind and risk-taking awareness play the role of "catalyst" and provide action for the construction of an open innovation ecosystem that entrepreneurs lead

	industry to strive for the happiness of people's livelihood.			enterprises to implement
	Special assistant to the chairman of 3nod: in case Chinese products want to be recognized by brand manufacturers, enterprises must work hard on design. For this reason, Shenzhen Industrial Design Association has been established, and it participates in and holds industrial design competitions to absorb innovative design elements for enterprises.	Innovative mind	Uniting research institutes to solve industry bottlenecks	
	Head of Coral Group Accelerator: 3nod and Internet company T jointly build accelerators, which exactly use the advantages of Internet company T's open-source creative community and 3nod's manufacturing advantages to realize the risk-sharing for start-ups. At the same time, 3nod also encourages internal entrepreneurship and takes corresponding risks.	Risk-taking awareness	Taking the risk of core technology leakage and establishing a corresponding technology alliance	
Changes in internal manufacturing capabilities of enterprises	Head of the manufacturing department: Head of the manufacturing department: In recent years, the development and evolution of consumer electronics has been fierce, and large-scale manufacturing is no longer suitable for the current market demand. 3nod needs to sort out its own manufacturing capabilities through digital transformation.	Awareness of adapting to external changes	Pay attention to the changes and adaptability of enterprise manufacturing capabilities in different market stages	Only by accurately sorting out the core abilities of the enterprise can we find the direction of innovation and absorption of the enterprise.
Cooperation relationship of entrepreneurs and executives	Many persons in charge: Chairman Liu is a leader who is soft on the outside and rigid on the inside. When the company reaches strategic opinions, it can fully reflect democracy and actively absorb the opinions of all parties. But for the determined strategic actions, It is more severe for the enterprise to implement them, and it is more common to have inconsistent strategic opinions with the senior management.	Strategic understanding and trusting cooperation	The trust and cooperation between the new force and the original backbone of the enterprise in the process of enterprise transformation	The trust and cooperation between entrepreneurs and senior management is an important guarantee force for the establishment of a new stage of enterprise innovation ecology, and the direction of their relationship determines the quality of the innovation ecology relationship.

(3) Analysis of the manifestation characteristics of the motivation. Corresponding to the level of the attention source of entrepreneurs and executives, typical event analysis identified two manifestations, namely, the internal attention allocation of entrepreneurs and executives and the external attention allocation of management, which promoted the construction of the 3nod innovation ecosystem. On the one hand, the internal attention allocation of entrepreneurs and executives refers to the process in which entrepreneurs and

executive pay attention to the internal technology and management of the enterprise and continuously consider how to improve it. The internal attention allocation of entrepreneurs and executives helps entrepreneurs understand the internal status quo of the enterprise, thereby promoting the enterprise to accurately obtain scarce resources from the outside. At the same time, the internal attention allocation of entrepreneurs and executives also promotes the digestion and absorption of externally acquired resources within the enterprise. For example, Lu Qiliang, who had rich experience in manufacturing digitalization at Goertek and CVTE, was employed by 3nod to digitally and intelligently transform quick reaction ability of 3nod's mold, injection molding, and assembly links, and this made 3nod factories improve efficiency greatly. On the other hand, the external attention allocation of entrepreneurs and executives refers to the process in which entrepreneurs and executive pay attention to the external technology, market, and policies of the enterprise and continuously consider how to promote the development of the enterprise. The finiteness of internal resources and abilities of enterprises determines that companies need to continuously obtain required resources and abilities from the outside, while the external attention allocation of entrepreneurs and executives ensures that the management continuously scans the abilities of external innovation resources, so as to promote cooperation between enterprises and external organizations. For example: 3nod has initiated Shenzhen Industrial Design Association and regularly holds innovative design competitions (3nod Cup) to absorb innovative designs. As the Chairman, Liu Zhixiong serves as the president of Shenzhen Internet of Things Association and actively cooperates with member companies to carry out innovation activities. The above behaviors

are all examples for 3nod maintaining open innovation cooperation with external innovation activators. Therefore, at the level of attention of entrepreneurs and executives, internal and external attention allocation prompt enterprises to scan and absorb internal and external resources and abilities of the enterprises. This laid the foundation for the chairman of 3nod to lead the senior management to in the construction of 3nod's open innovation ecosystem.

The manifestation characteristics of internal entrepreneurs at different levels provide the foundation, core motivation and action for entrepreneurs to lead enterprises and external organizations to build an open innovation ecosystem.

Citation of 3nod core technology units coding

For the analysis of the realization nodes of the above-mentioned 3nod Group's innovation ecosystem based on OPM. Firstly, this research made the first-level coding to case data according to the data source; secondly, according to the literature sorted out, making the conceptual coding to the core elements of the technological innovation ecosystem, and forming a second-level entry database based on the characteristic differences of the six innovative products/technology R&D processes; Finally, the second-level code is further classified to form a third-level code. The specific coding process and content are shown in Table 4.5 below.

Table 4.5 Code Table of 3nod's Enterprise Technology Innovation Ecosystem

Data code / Data classification	Typical citation (concept code)	Entries	Structure of construct	Theoretical structure
Innovation design	Insight into the needs of brand owners and contacting consumers to explore their concerns in aesthetics, fashion, and technological trends are the starting point for 3nod to help brand owners and 3ond itself develop new products(A1)	12	Guide of user	Building an innovation platform with

	3nod continuously draws design inspiration from industry design competitions and conducts professional exchanges, which is 3nod's main way to keep up with design trends.(A2)	18	Industry competition	user as a core
	One of the functions of 3nod OPM model is to help the realization of product development of excellent start-ups. For start-ups' product ideas, product marketization, 3nod can play a key supporting role, as well as provide funding and project assistance.(A3,a1)	13	Start-ups	
R&D of technology	3nod uses sound technology as the entrance, and the involved scenario fields require a lot of technical R&D. It is far from enough to only rely on 3nod's own technology. It will also affect the speed of 3nod's product development. It is a reliable way for 3nod to cooperate with universities, research institutes and enterprises of technology innovation.(B1,b1)	15	Partners University and Research institutes	Open innovation cooperation
	3nod needs to effectively filter technology maturity and new product design absorption in the design and R&D process. This process must involve the participation of middlemen and intellectual property institutions.(B2)	5	Middleman Intellectual Property Agency	
	3nod's newly-developed products involve multiple fields and disciplines, among which software and hardware, access networks, and the application of emerging technologies require the support of upstream and downstream technology-based enterprises(B3)	9	Technology enterprise	
Manufacturing Scale delivery	The key link that affects production and delivery is intelligent transformation of factory, such as quick reaction ability of molds.(C1)	4	Diverse types of partners	Open innovation cooperation
	Manufacturing involves close cooperation between the upstream and downstream of the supply chain. 3nod also has many outsourcing factories, and management and cooperation between them are also the main pathway for rapid delivery.(C2)	6	Diverse cooperation modes	
	In the construction of smart factories, 3nod involves the participation of partners in many fields such as automation, industrial software, AGV, smart warehousing, and industrial IOC.(C3,c1)	5	Wide range of partners	
Innovation platform	In the construction of the Coral Group platform, 3nod mainly considered the national entrepreneurship and innovation policy at that time. Secondly, with the maturity of 3nod's OPM abilities, it has the ability to provide comprehensive services for various brands in the consumer electronics field. Among B2B\B2S\B2C, S means Start-ups, especially those with novel product designs, whose designs require product realization, are very compatible with 3nod. (D1)	11	Partners	Open innovation cooperation
	Through the coral group innovation platform, 3nod has also realized the output of OPM capabilities. Start-ups and 3nod can cooperate to obtain entrepreneurial assistance and production of samples. 3nod can also jointly develop new products with them. Entrepreneurs of the start-ups are mostly young people and returned talents with foreign technical backgrounds, the ecological cooperation relationship is very good. (D2)	16	Startup company Mutual absorption Entrepreneurial assistance	Open innovation cooperation
	Coral Group's innovation platform currently has many companies settled in, including smart home, wearable, creative design and other fields, and some companies continue to contact and cooperate with 3nod (D3, d1)	3	Wide fields	Open innovation cooperation
Application of scenario	3nod has already started scenario application of smart education in Guangxi, Jiangxi and other provinces and cities.(E1)	2	Application of technological innovation achievements	User-centric
	3nod currently has a wide variety of categories such as tablets, speakers, and medical beauty products. In cooperation with content service providers, in addition to the original audio-visual entertainment field, it has gradually penetrated into education, new conference systems, games and other fields.(E2)	5	Scenario penetration Scenario service Scenario shows	User-centric Application scenario innovation
	3nod's scenario application abilities have been verified in the domestic market and during the COVID-19 pandemic, and have been recognized by customers. Especially during the COVID-19 pandemic, it quickly resumed production, and switched to production of anti-epidemic materials, which was praised. （E3,e1）	3	Application of scenario	customer service market development

Support System of 3nod's Enterprise Non-Technical Innovation

According to existing research and based on the collection and analysis of 3nod Group's primary and second-hand data, this dissertation will make the research data classified and coded on the basis of different aspects of the enterprise's non-technical innovation, namely, the strategy, management, culture, system, organization, and market of 3nod Group, and will explore how 3nod's non-technological innovation system supports its technological innovation ecosystem. For details, see Table 4.6 below.

Table 4.6 Code Table of 3nod's Enterprise Non-Technical Innovation System

Data code / Data classification	Typical citation (concept code)	Entries	Structure of construct	Theoretical structure
Strategy	It is necessary to continuously communicate with brand owners to gain insight into their product definitions, and to establish an open-source community in contact with consumers. 3nod's insight into consumers is essentially a key role in guiding brand owners' product definitions.(A1,B1,F1)	23	Guide of user	Strategic planning
	Continuously interacting with users during product development and design（A1,B1,B2））	18	Interaction of user	
	3nod group encourages us to develop disruptive technologies and products（A2）	9	Group strategy	
Management	Our teams are assembled and disbanded according to project orders. Each of us has different specialties and complements each other's strengths, therefor, form a team with strong core competitiveness. We establish different teams based on different projects. A kind of competitive atmosphere is formed inside employees, allowing everyone to fight for more projects and create more value（C1,C2））	12	management model of "Consistency of people and orders", that is to say, the person who obtains the order is responsible for mobilizing and coordinating internal resources to ensure service & delivery.	Fundamentals of Management
Culture	Many enterprises choose to merge the technology resource parties, but we think this is not conducive to the growth and development of the resource parties. We implement open innovation and hope that they will grow by themselves and retain their own source of innovation. We provide them with the resources and platforms they need（B1,C1,b1））	8	Open innovation concept	Leading of culture

	The Coral Group platform plays a key role. It can find resources globally, and can release innovation needs and latest technologies, quickly realize the matching of technology and resources, and accelerate the product innovation process（B1）	12		
	3nod constantly emphasizes the active play of the role of the individual, and respects the spirit of everyone being the owner of the business, so that the enthusiasm of the employees can be brought into full play.	4	Everyone is a CEO	
Mechanism (System)	3nod Group gradually implements the reversing mechanism of users, that is, each employee faces his own user directly, and thus forming the whole process reversing mechanism from the internal business to the external supplier is（d1）	6	Reversing mechanism	Institutional dynamics
Organization	By supporting internal employees to start their own businesses, front-line employees are allowed to implement self-management based on market and needs of users, which can accelerate the entire product innovation process（Cl）	5	Flat organizational structure	Organizational Guarantee
Market	In order to prepare to meet individual customization, enterprises are also carrying out intelligent transformation and the construction of intelligent factories.(C2,A2)	16	Personalized customization	Production route

Living Environment of 3nod's Enterprise Innovation Ecosystem

3nod Innovation Habitat is composed of market environment, resource environment, human environment, social environment and natural environment. Combining existing research and collecting and sorting out the primary and secondary data of 3nod Group, this dissertation proposes that enterprises carry out innovative activities based on macro-environments such as market environment, policy environment, cultural environment, and resource environment. This macro-environment is an indispensable component of the enterprise innovation ecosystem, and is the prerequisite and foundation for the operation of the enterprise innovation ecosystem. First of all, the market environment directly determines the innovation process of the enterprise innovation ecosystem, especially the final stage of commercialization, which is the main indicator and decision-making point for measuring the innovation

performance of the enterprise. A good market environment can promote the construction of an enterprise innovation ecosystem. Market demand is the main power and driving factor for enterprise innovation. For example, 3nod Group regards user pain points as the main power source of design innovation. At the same time, the fiercely competitive market environment forces enterprises to build or join the innovation ecosystem of various enterprises. Secondly, the policy environment is a favorable guarantee for the healthy operation of the corporate innovation ecosystem, which has an important impact on corporate technology innovation. For example, fiscal policies can supervise and promote important decisions such as corporate financing and investment. The Intellectual Property Protection Law provides legal support and protection for enterprise technology innovation and innovation, and promotes the flow of knowledge and human resources among enterprises from being violated. At the same time, national policies and laws also actively regulate the imbalanced market environment to provide protection for the development of enterprises. Thirdly, the cultural environment indirectly affects the construction and operation of the corporate innovation ecosystem. Culture has the characteristics of far-reaching and extensive historical experience and accumulation, which directly affects the behavior of employees and even the entire enterprise. A good cultural environment can promote the conduct of enterprise innovation activities, especially the innovative culture, which can subtly improve the innovation awareness of enterprise employees, thereby promoting the innovation of various enterprises and even the society. For example, the current slogan "Mass Innovation, Mass Entrepreneurship" can promote the construction and improvement of the internal entrepreneurship platform of 3nod Group. The

coral group innovation platform built by 3nod and Internet company T will attract more makers and encourage them to incubate more small and micro companies, so as to drive the entrepreneurial climax and cross-industry integration of the entire industry. Finally, the resource environment plays a vital supporting role in the operation of the enterprise innovation ecosystem, and is also an indispensable part of enterprise innovation activities, including tangible and intangible resources such as human, finance, information, and technology, etc. In innovation activities, enterprises continue to exchange and interact with the outside world, such as technological innovation talents recruited by 3nod Group, financial intermediaries for 3nod Group financing, and technology transfer institutions for technology purchase of 3nod Group, etc. Sufficient resources can only provide indispensable material and energy for the operation of the enterprise innovation ecosystem.

Relationship management between 3nod and system members is based on the components of 3nod's corporate innovation ecosystem, the relationship between 3nod and system members mainly includes the relationship with users, the innovation platform, and technology partners. Due to the actual needs of this research, and that Section 5.1 has described the relationship management between 3nod and brand owners, and between 3nod and the innovation platforms, this section mainly analyzes the relationship management between 3nod Group and the technical resource parties. Through the collection and analysis of the primary and secondary data of 3nod Group, this section will carry out the qualitative coding and analysis of the research data based on the cooperation process between 3nod and the technical partners (cooperation motivation, cooperation principles, cooperation model, and cooperation

conflicts) and explore the relationship management between 3nod Group (as a core enterprise) and technical resource parties. See Table 4.7 for details.

Table 4.7 Code table of the relationship management between 3nod Group and technical resource partners

Data code / Data classification	Typical citation (concept code)	Entries	Structure of construct	Theoretical structure
Cooperation motivation	The core technology involves new materials and structures, requiring long-term qualifications of R&D to achieve it. 3nod cannot successfully develop it alone in the short term (B1)	12	Shortening the innovation process	Complementation of technology
	Generally speaking, technological innovation requires higher R&D costs, so we can find technology providers to reduce our R&D costs and accelerate the launch of new products (C1)	15	Saving innovation costs	
	Disruptive technological innovation has a high risk, so we choose to cooperate with other partners to make good use of each other's strengths and core abilities (B1)	8	Reducing innovation risk	
Cooperation principles	We often consider the laboratory equipment of universities, research institutes, large innovation enterprises and R&D centers, the research experience of professors（B1）	12	strength of R & D	Complementation of technology, non-technological compatibility
	We often consider whether the prototype product provided by the start-up company can be mass-produced and whether prototype has the potential for commercialization（D1）	7	feasibility of technology	
	For R&D product projects, project delays are very common. Therefore, the execution of the other party's team is an important factor we consider（D1）	4	Team execution	
Cooperation model	In the development of Baidu DuSmart speaker and Internet company T Doraemon, 3nod used its advantages in design, mold development, and mass production, and makes the use of Internet company T and Baidu's platforms, driving other software and hardware suppliers to achieve success of product development（B1）	6	Joint development	Diversified and varying by project
	The two parties define the achievement output of each stage and pay the fees based on the stage (C3)	8	Entrusted development	
	For component modules, some are direct suppliers and some become secondary suppliers. If the supplier is an overseas company, a one-time purchase generally will be chosen.(C3)	10	Direct supply	
Manufacturing	3nod has its own standardized workshop. As long as the core technology is verified to be feasible, mass production of related products is available（C1）	5	Management of communication	The supporting function of the non-technical innovation system of enterprises
Cooperation conflicts	Especially when we cooperate with foreign technical parties, due to different cultural backgrounds, there are often conflicts in remuneration calculations and signing of cooperation procedures（B2,C1）	8	Management of culture	

For the relationship management between core firms and technical resource parties, the following points should be paid attention to according to the analysis of survey data:

Cooperation motivation: When looking for technology providers, we need to focus on how to shorten the innovation process, reduce our R&D costs, and accelerate the time to market of new products; for new materials, structures, and new technologies, we need to focus on the R&D qualifications of partners, which can save innovation costs. , which is very important for the development of new products. When absorbing disruptive technological innovations, it is necessary to cooperate in advance, so that the advantages and core capabilities of each other can be brought into play, and innovation risks can be reduced.

Cooperation principles: It is necessary to focus on the research and development strength of the cooperation object (research equipment + talent structure + successful cases, etc.). The market prospect, technical feasibility and technical maturity of the partner technology need to be considered.

Cooperation models: Considering the impact of the COVID-19 epidemic, the global supply chain has been shut down, and the partners will focus on domestic substitution. The cooperation model is mainly based on joint development and entrusted development. For essential international technologies or raw materials, one-time purchases are considered.

Cooperation conflict: When cooperating with foreign technical parties, due to different cultural backgrounds, it is often necessary to focus on communication management and cultural management due to conflicts arising from compensation accounting and signing of cooperation processes.

Analysis of case data

Coding and analysis of qualitative data

This research analyzes and categorizes the survey data of the case study in accordance with the general steps of the case study, that is, categorizing primary

and secondary data such as interview records, internal documents, meeting records, newspapers and books, and forming qualitative data. And it performs coding and analysis, and constructs the data structure diagram of the research. The analysis and coding of the qualitative data of this study includes three main steps:

Concept coding of qualitative data

Firstly, the collected qualitative materials are coded at the first level. The author found out the materials related to this research subject from a large number of interview data, documents, written data, etc, and summarized them to the conceptual level. At the same time, in order to ensure the reliability of this research, during the encoding process, this dissertation asked two research members to encode the original data. One of them was responsible for recording and translating the text, and the other was responsible for sorting and proofreading to ensure the accuracy and integrity of the original data. Based on the research theme of this dissertation, the two research members have read a lot of classic literature on enterprise innovation ecosystems, and jointly discussed the connotation and dimensions of the constructs involved in the research. According to the research needs of this dissertation, 3nod's five innovation abilities based on OPM are regarded as the basis for data classification. The coding source and data classification are shown in Table 4.8.

Table 4.8 Code source classification and data classification of this case

Data Sources	Data Classification	Coding					
		OPM	Design unit	Technology unit	Manufacture unit	Innovation platform	Application scenario
Primary data	Data obtained through structured interviews	A1	B1	C1	D1	E1	F1
	Data obtained through semi-structured interviews	A2	B2	C2	D2	E2	F2
	Data obtained through the seminar	A3	B3	C3	D3	E3	F3

Secondary data	Data obtained through corporate websites, corporate internal publications, and books	A1	B1	C1	D1	E4	F1

Secondly, the sorted effective case information is encoded at the first level according to the data source. Among them, the repeated information from the same source is normalized, and the repeated information from different sources is merged and classified as one source. Through the first level encoding of the case information, a first-level citation library containing 247 citations was obtained. Secondly, the citations in the first-level citation library are associated with events to complete the second-level encoding. After repeated discussions by the three authors, 79 typical events (Ex) were determined. According to the relevance of the citation description and the typical events, the citations were treated with a single association mark to form a secondary citation library containing 258 citations. After secondary encoding, the association mark of each citation and event is completed. For example, E1S3-2 means that the citation No. S3-2 in the first-level citation library is related to the event (E1). Finally, concept tagging is carried out on the citations in the second-level citation library to form a third-level encoding library.

Thoughts of case analysis

According to the consensus of case study experts, the core of case study writing is through the "triangular verification" between interview data and archive data, a more true, objective, and complete explanation of the research question can be provided, and the research conclusions as general can be further

summarized[63]. Therefore, combined with existing research methods, and after completing case studies and data sorting out for Five innovation abilities, this research finds similar constructs in each evidence chain, and makes the related concepts refined by the realization nodes of the value chain of each innovative product/technology compared in pairs, distinguishing the similarities and differences between the two, and avoiding one-sided and incomplete research conclusions. Based on the replication logic of multiple case studies, this dissertation refines the interpretation framework for the case study questions, re-examines the reliability and universality of the data, and confirms that the case study conclusions can accurately reflect the value realization process of each innovative product/technology and try to use different charts to describe the case study, so as to compare the similarities and differences between multiple cases and refine the research conclusions. The specific analysis process of this case: Firstly, according to the innovation source of innovative products/technology, selection channels of technical resource, the process of cooperation with technical resources parties, product manufacturing and product sales, etc., this dissertation performs data classification and coding of qualitative data and explores 3nod's components of technological innovation ecosystem; secondly, according to the value realization process of innovative products/technology and the different dimensions of non-technical innovation management of enterprises (strategy, management, culture, system, organization, market), this dissertation performs data classification and coding of qualitative data , at the same time, Combined with existing research, it also

[63] Xu Hui, Feng Yongchun, Xu Shouren. The construction and evolution of the relationship between suppliers and key customers from the perspective of dynamic matching: A case study of 12 key customers developed by Lishen[J].Management World,2014,04:107-123+ 188.

explores the supporting role of 3nod's non-technological innovation system on the technological innovation system; thirdly, combined existing research, it analyzes the external macro environment faced by the process of value realization of innovative products/technologies, and analyzes 3nod's niche of innovation macro-environment; finally, this dissertation performs coding and classification of qualitative data according to the cooperation process between 3nod and technical resource parties (cooperation motivation, cooperation principles, cooperation mode, cooperation conflicts), and makes a discussion on relationship management between 3nod and system members, especially for the relationship between 3nod and technical resources parties.

Reliability and validity strategies for case studies

According to Yin (2004), the criteria for judging the quality of case study design are mainly divided into four criteria: construction validity, intrinsic validity, extrinsic validity, and reliability. And the specific case study strategy is: to test the validity of the construction based on multiple data sources and evidence chain; to test the internal validity based on pattern matching, trying a certain explanation, using logical models, etc.; to test the external validity based on the theory to guide multiple case studies, using the copy rule and repeated verification to conduct multiple case studies; to test the reliability based on the adoption of case study drafts and the establishment of a case study database[64]. Accordingly, this research combines the previous literature review and sorts out the theoretical framework of the enterprise innovation ecosystem. First, through the analysis and coding of the qualitative data of the primary and secondary data

[64] Yin R K. Case Study Research: Design and Method[M], 4nd ed, 2004, Sage Publications, LosAngeles.CA

of the 3nod Group, the relevant evidence chains are established and the research problems are also refined in depth; based on the first phase of interviews, direct observations and other data collection methods, this dissertation provides tentative answers to the case study questions; based on the second phase of semi-structured interviews, it conducts detailed and complete investigation and analysis for multiple nested sub-case studies of the case study objects, and performs analysis and coding of qualitative data and establishes a complete evidence chain to improve the reliability and universality of the case study conclusions, and to ensure the internal and external validity of this case study. The specific reliability and validity strategies of this case study are shown in Table 4.9.

Table 4.9 Strategies and methods to ensure the reliability and validity of this case study

Testing	Strategy of case study	The stages at which the strategy takes place
Extrinsic validity	Using existing innovation ecosystem related theories to guide this case study; Research on five sub-cases of innovation units through repeated and replicated methods.	R&D and Design R&D and Design
Reliability	Adopting the case study draft, refining the research questions through the survey data, establishing a case study database: to ensure the same conclusions of the same research.	Data collection Data collection
construction validity	Use of multiple data sources: combination of primary and secondary data; Forming a chain of evidence: the entire process of R&D and design of different innovative products; Report verification: Submitting to the relevant person in charge of 3nod for approval.	Data collection Data collection Data analysis
Intrinsic validity	Pattern matching: the conceptual model matches the research conclusions Analyzing the corresponding competitive explanation	Data analysis Data analysis

Chapter summary

We use research methods to determine how the design in Chapter 3 performed when implemented by 3nod. We interviewed key personnel of 3nod involved in the implementation. We ascertained and coded their interviews to

ascertain if any designs were implemented according to the design and the challenges, if any faced. One of the challenges is the advent of new information technology and advanced manufacturing technology.

The specific design expands from the innovation ecosystem of 3nod centered on the design innovation module (the early OPM innovation ecology model) to the technological innovation module, manufacturing innovation module, and application scenario innovation module (the new expansion of the OPM model). This is the main direction of the evolution from the primary innovation ecosystem to a more advanced stage: In the following chapter, the further development of 3nod OPM model in the light of a new generation of information technology, is described.

Chapter 5：Advanced Evolution of 3nod Innovation Ecosystem

The abstract of this chapter

This chapter mainly expresses the transformation of 3nod's OPM model under the conditions of industrial Internet technology and advanced manufacturing technology. It not only affects the original design capability module, but also promotes the design innovation capability module, with the application scenario as the starting point (under the condition of the new generation of information, product design needs to focus on the deep-level needs of the scenario, and deep interaction with the environment, And based on the ability of artificial intelligence, big data and other technologies to provide users with intelligent services), and absorbs the new generation of information technology (network interface technology, software and hardware technology, and artificial intelligence, 3D printing, etc.) that has become mature. And, it is necessary to use Industrial Internet Technology and advanced manufacturing technology to meet the personalized customization needs and flexible manufacturing capabilities of the market. At the same time, the connotation of the innovation platform has been expanded, so that its functions are not only centered on design innovation capability modules in 3nod, but also need to provide more innovation elements to cooperate with other capability modules for innovation.

Advanced evolution of 3nod OPM innovation ecosystem

3nod OPM Innovation Ecosystem Coordinate

In the analysis of 3nod's previous product development process, with design innovation as the horizontal axis and technological application innovation as the vertical axis, product development is defined as four quadrants, that is, an intelligent hardware product that meets the needs of the future market must include industrial design, application technology, manufacturing implementation, application scenarios four dimensions. The gray part of the coordinates (quadrants one and three) represents the mature capability sector within 3nod. The industrial design and manufacturing capability points in the figure are relatively concentrated, and the application technology and scene application are relatively scattered, indicating that the capability in this area is relatively weak. Therefore, in the future, the advanced evolution direction of 3nod's innovation ecology will be mainly promoted in terms of application technology and application scenarios. The red dots in the figure represent the design elements of a product, the blue dots represent the technical elements of a product, the black dots represent the manufacturing implementation elements of the product, and the green dots represent the scenario requirements that need to be considered for a future-oriented product. Combining the above four elements is the basic logic of 3nod's future product innovation. See Figure 5.1 for details.

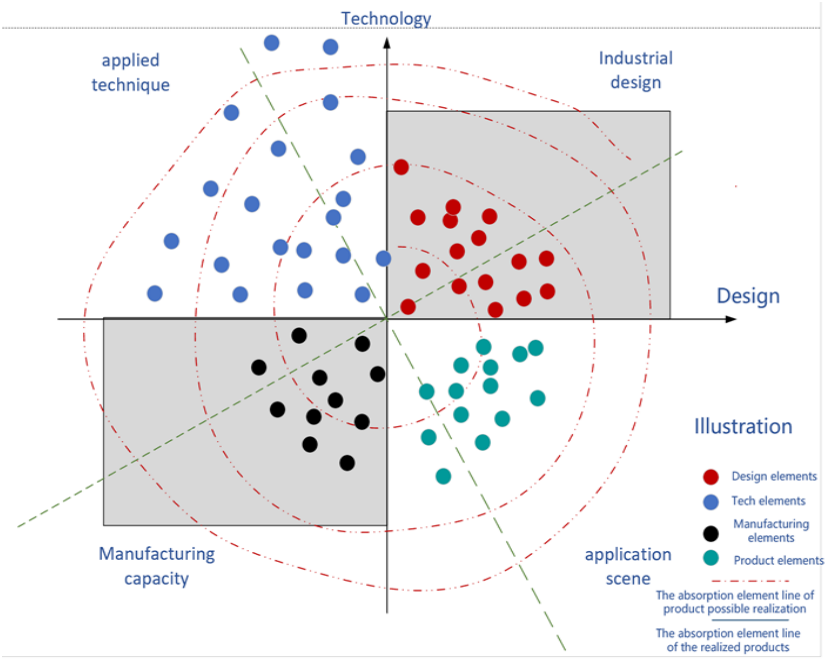


Figure 5.1 Coordinate system constructed by 3nod innovation ecosystem

Ecological Unit of Product Application Scenarios

Transformation from Consumer Internet to Industrial Internet is one of the main manifestations of the current digital economy. It mainly relies on the industrial Internet platform to realize the link upgrade. In the past, under the economic conditions of material shortage, consumer products mainly solved the basic living security problems of consumers, such as clothing, food, housing and transportation. The consumer Internet has made great contributions to personalized consumption, intelligent life, and digital entertainment, and it has also brought many social problems. The industrial Internet is a new direction for the evolution of the consumer Internet of Things. The application scenarios of future products will change from the basic living needs of food, clothing, housing and transportation to work, life, learning, entertainment and other scenarios, in terms of linking new brands, new products, new manufacturing, new retail, etc. Efficient collaboration, precise matching, and integration of production and sales are required. Therefore, future products and their

application scenarios show very strong social attributes. See Figure 5.2 for details.

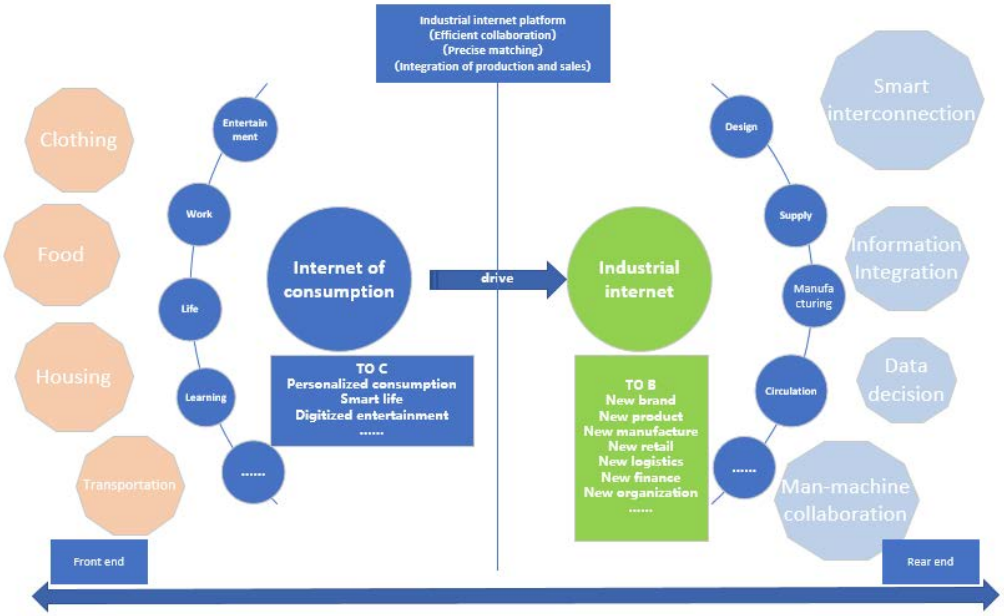


Figure 5.2 Logic basis for the evolution of the ecological innovation unit of 3nod manufacturing application scenarios

3nod positions future product application scenarios as smart life, smart home, smart work, smart travel, smart education, etc., which conforms to the basic logic of product definition in the smart era. 3nod's current product scene ecology is shown in Figure 5.3.

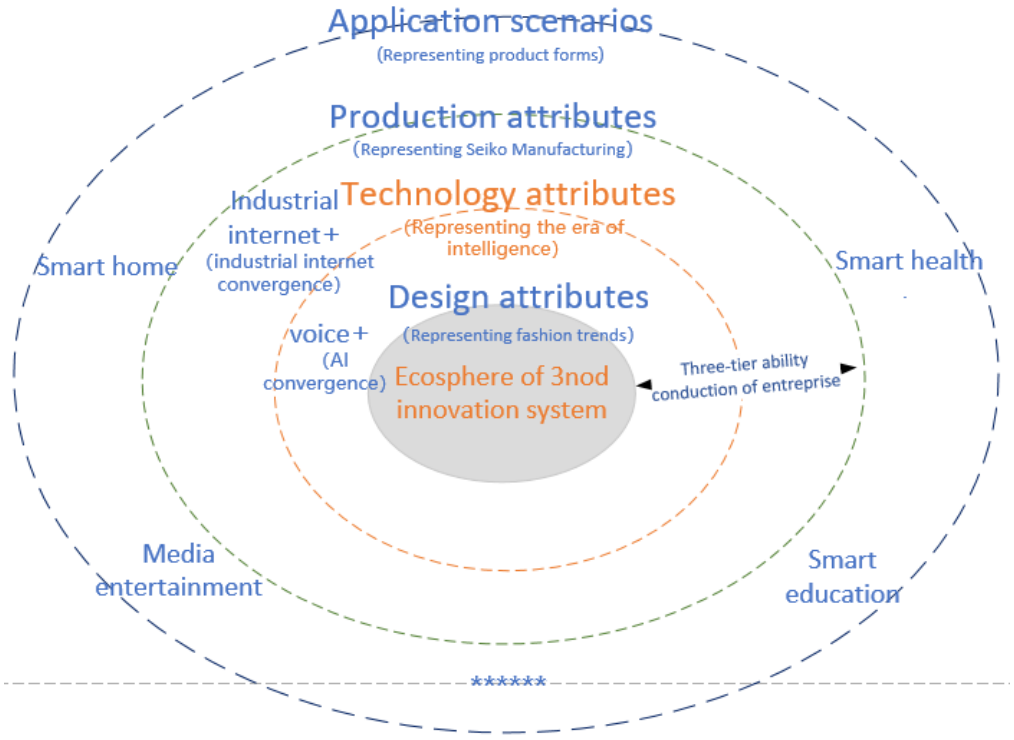


Figure 5.3 Diagram of product application scenarios of 3nod

The first dimension is the design attributes. The connotation includes (representing fashion trends, being able to represent the aesthetics of the times, being able to express life in the intelligent age, being able to use new materials, etc.), which is specifically expressed as "Design +";

The second dimension is technical attributes. Products in the future era are no longer independent foolish closed and semi-closed ones, but need to be able to connect to the new intelligent infrastructure (5G network) and be able to interact with data and language. Therefore, the connotation of the technical attributes of future products will be richer and multi-dimensional than the past product types;

The third dimension is manufacturing attributes, in addition to retaining the precision manufacturing attributes of traditional products, it also undertakes the mission of transforming future production methods. It is the main direction for the improvement and upgrading of the industrial Internet and intelligent

manufacturing. Its connotations mainly include (excellent manufacturing, industrial software, equipment networking, data center construction, smart logistics, smart warehousing etc.), the specific expression is "Industrial Internet+";

The fourth dimension is that products interact with application scenarios, and future products will be replaced by scenarios. This dimension represents the direction of in-depth integration of products and scenarios in the intelligent era, so product and scenario integration definition and the corresponding customer service will be the ultimate way. The connotation of this scenario includes (learning, entertainment, life, work, etc.), and the specific expression is "life scenario+". The four dimensions can accurately express the product capabilities that 3nod group has formed over the years and the future development discoveries. Table 5.1 is a detailed description of the relationship defined by the scenario.

Table 5.1 Summary Table of Ecological Relationship of Product Scenario Ability Unit of 3nod "audio+"

Core competence	Evaluation dimension	Ecological effect	Scenario field	Successful cases	Evolution direction
OPM competence realization of“audio+”products Definition of product scenarios	Design attributes	Outward output	Education Home Medicine	Smart classroom Epidemic prevention materials family entertainment BAR	Scenario-oriented Smart
	Technology attributes				
	Production attributes				
	Scenario attributes				

Remarks: Brand manufacturers often have the right to define product application scenarios. 3nod has weak understanding of scenarios and related research capabilities. The scenarios formed by products belong to the initial stage of scenario definition, and how to use products to form corresponding

scenario services requires the support of informatization platform and software abilities. Now, 3nod’s scenario definition abilities in education, medical beauty and other aspects are still in the initial stage. For the stage of hardware + content + platform + intelligent service, 3nod’s current scenario abilities are still unattainable.

Innovation units of product design

3nod group's planning exploration and self-positioning in the design innovation unit

3nod positions the design unit under the OPM model as: gathering many international design masters and institutions, attracting strong venture capital and financial power, and constructing an international-level design ecology gathering place, 3nod can fully absorb its creative works and thinking concepts, which are reflected in its own product design and product innovation. 3nod Design Innovation Unit used to focus on brand manufacturers and insight into consumer needs, while also focusing on the impact of disruptive technologies on new product forms, which is the starting point for our design innovation.

The structure, material and ID appearance of the dark green oval circle in the picture are the strengths of 3nod's design abilities. The gray oval circle in the figure indicates that 3nod needs to focus on three aspects in design in the future, namely software and hardware and access network. 3nod's internal design capabilities are mainly concentrated on the (Maxypro) industrial design platform, and external design abilities are mainly obtained through industry competitions, start-ups, industrial design associations, and some software and hardware suppliers for product design services. With the maturity of new

abilities, 3nod has obvious advantages in developing new customers in the cross-border field. Construction ideas and processes for 3nod innovation design ecology（See Figure 5.4）

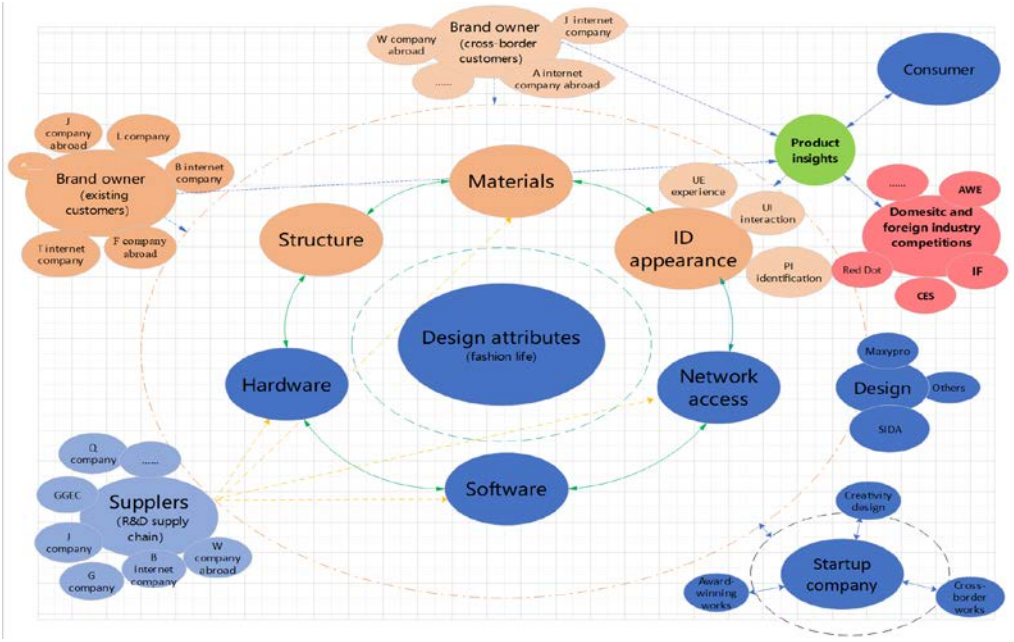


Figure 5.4 Ecological unit structure diagram for 3nod design innovation

A. In-depth insights into customer

The essence of 3nod group’s OPM model is to gain advantages in brand manufacturers’ right to define new product development through the full-process design and manufacturing service capabilities. The core of brand manufacturers is to integrate software and hardware and realize the development, production and circulation of products based on deep insights into customers (consumers). The essence of 3nod group's OPM model lies in accurately grasping and understanding the brand manufacturers' product realization intentions, and rushing out of their insight into consumers' vision, so as to find the priority definition ability in the process of new product development. This process is inseparable from the comprehensive accumulation

of 3nod group's own industry capabilities (customers, market, design, and manufacturing capabilities)，See Table 5.2 for details.

Table 5.2 Summary Table of Ecological Relations of 3nod's Innovation Design Ability Units

Ecological dimension		Content source		Ecological effect	Ecological relationship with 3nod	Method of innovation	Successful cases	Evolution direction
Insights of products		consumer		Absorption & digestion	Heterotopic complementation	User communication	Medical health	Industrial Internet platformization and open source community design sharing
		Brand owner		Absorption & digestion		User communication		
		Industry Competition	IF	Absorption & digestion		Conference exchange		
			CES	Absorption & digestion		Talent Exchange		
			German Red dot	Absorption & digestion		Creative purchase		
			AWE	Absorption & digestion				
			3nod Cup Design competition	Absorption & digestion	Peer complementation			
Design ability	Self-owned design ability (Maxypro Design Center)	ID Appearance	UE experience	Self-innovation	Peer complementation	Absorption & digestion Re-innovation	Audio and video intelligent terminals	Industrial Internet of Design Platform
			UI interaction	Self-innovation				
			PI identification	Self-innovation				
		materials		Self-innovation	Heterotopic complementation			
		structure		Self-innovation	Peer complementation			
	Cooperative or to-be-built design abilities	software	Tencent, Baidu	Internal and external cooperation	Heterotopic complementation	Technology purchase Hardware purchase Co-development	Customizing Tencent Contents	
		contents	Himalaya, Xiaomi music,	Internal and external cooperation				
		Network access	Technology	Cooperative innovation				
		Electronics hardware		External purchase				
		Startups	Creative design	Absorption & digestion	Heterotopic complementation	Creative purchase Production trial Entrusted production	Smart LED Table Lamp	
			Award-winning works					
			Cross-border works					
		Shenzhen Industrial Design Association	Creative design & Excellent works	Absorption & digestion	Heterotopic complementation	Design communication Entrusted trial production Product development		
Supply chain of R&D	Hardware customization	Q company		Internal and external cooperation	Heterotopic complementation	Small trial production Customized demand	hardware cooperation of audio&video	Industrial Internet of Supply Chain
	Hardware customization	G company		Internal and external cooperation				
	Hardware customization	J company		Internal and external cooperation				
		.....		Internal and external cooperation				
Exsiting customers	J company abroad		Scenario demand	Internal and external cooperation	External competition and cooperation	Entrusted R&D	JBL Pulse speaker	Life Scenario Scenario service Intelligence of Service
	L company		ODM				Laptop	
	B company		Scenario demand				DuSmart speaker	
	T company		Scenario demand				Tencent Doraemon	
Developing new customers	W company abroad		Scenano demand	Internal and external cooperation	External competition and cooperation	Entrusted R&D	UCC Conference System	Application scenario demand
	A company abroad		Not available				Not available	
	J company		Not available				Not available	

Remarks: In the process of absorbing design innovation abilities,3nod used to rely only on traditional off-line models (exhibition, purchasing design samples, referencing excellent design works, etc.) to absorb product design experiences. About “how to absorb design inspiration through open-source communities in the future?”, 3nod has not yet taken substantial steps. And, 3nod has not yet formed a systematic knowledge system to identify excellent design works, so this kind of ability needs to be further strengthened.

Ecological unit of product technology innovation

3nod's needs in the ecological unit of product technology innovation

3nod's ecological unit of product technology innovation best represents the characteristics of product adaptability innovation under the conditions of a new generation of information technology, and the possibility of adopting new technologies determines its direction. In terms of access to the network, integration of big data, and artificial intelligence (AI), it provides broad product possibilities for 3nod to realize smart life, smart home, smart education, audio-visual entertainment, etc. In terms of technological innovation abilities, 3nod is relatively weaker than in terms of design abilities and manufacturing abilities. In order to build technical barriers, it strengthens the market bargaining of products. The blue oval circle indicates that 3nod will focus on software and hardware technology, network technology, differentiated technology, and emerging technologies in the future. The dark red oval circle represents 3nod’s main technical partners, which are formed by university research institutes, industry Associations, technology intermediaries, technology companies, intellectual property institutions, etc. See Figure 5.5 for details.

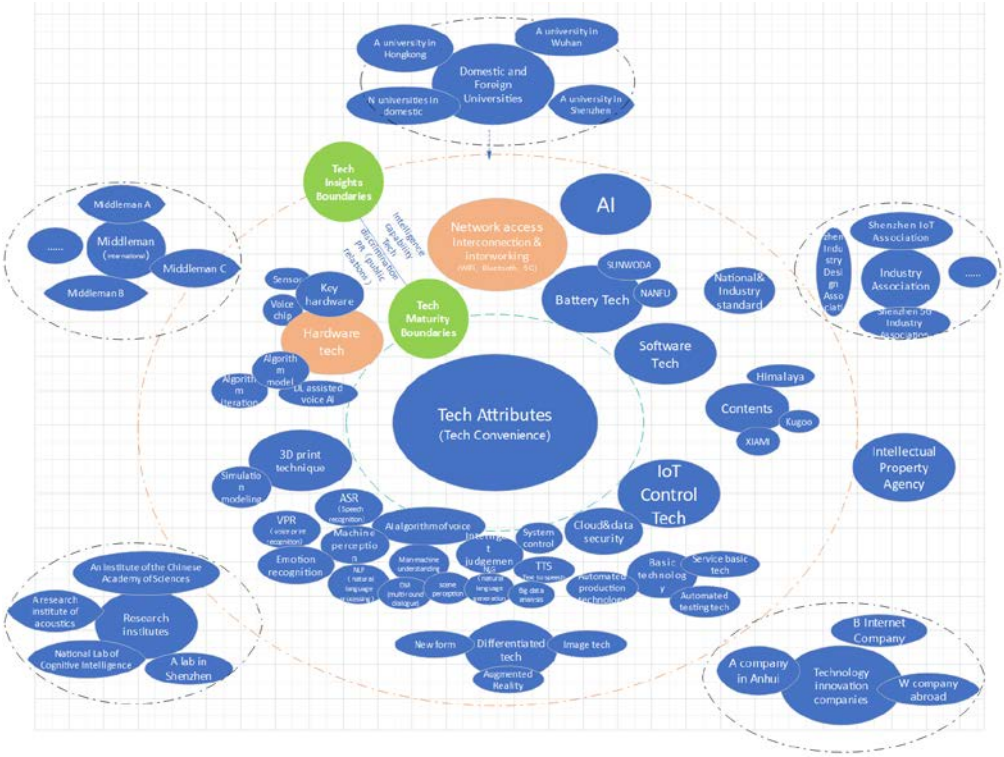


Figure 5.5 3nod Technology Innovation Ecology Unit

The expansion direction of 3nod technology ecology unit：See the table 5.3

Table 5.3 Summary Table of Ecological Relations of 3nod Technology Ecology Unit

Technology dimension	Content source	Ecological effect	Cooperative partner	Method of innovation	Successful cases	Evolution direction
Hardware technology	Critical hardware	External cooperation Heterotopic complementation	University Research institutions Industrial association Intellectual Property Agency Middleman Technological innovation enterprise	Entrusted R&D Joint R&D Technology purchase Industry-University-Research Cooperation Technology cooperation Joint research	N University in domestic, N University in Shenzhen, Internet company BT, a university in Hong Kong, the Hong Kong University of Science and Technology(HKUST), etc. have successfully developed products such as BAR and speaker-related technologies.	Keep tracing Research and Judgment Technology Maturity Introduction of technology Technology purchase
	sensor					
	Voice chip					
	……					
Software technology	Algorithm model					
	Algorithm iteration technology					
	DL voice-boost AI					
Network technology	WIFI					
	BLUETOOCH					
	5G					
Differentiated technology	Imaging technology					
	Augmented Reality					
	New Form Technology					
Emerging technology	Voice AI algorithm					
	IOT control technology					
	3D printing technology					
	……					

Remarks: 3nod is still in a disadvantageous position in the process of establishing a technology R&D supply chain with universities and research

institutes, and has no major advantages compared with its peers. The technological transformation of scientific research results in universities requires bridges in the process of cooperation with enterprises, and in the process of cooperating with 3nod in terms of similar technologies, 3nod does not have the exclusive advantage. It is a challenge for 3nod how to utilize the scientific achievements of the university earlier (stage 0-1), which requires making more effort in technology identification ability and public relations.

Key difficulties of 3nod's technological innovation ecology unit：

3nod’s technology and product development requires attention to engineering application technology. Its core difficulty lies in the scientific process and technology maturity management process between the technological insight boundary and the technological maturity application boundary. At present, the ecological expansion capability of the company mainly relies on the personal experience of responding to management positions, so the empty load rate of R&D and innovation is high, and the maturity of technology transformation is not high.

Ecological Unit of 3nod's Product Manufacturing Innovation

The demand of 3nod's product manufacturing innovation unit

From the perspective of 3nod's own development practice, in order to realize the digitization and intelligence of OPM manufacturing capabilities in the future, it is necessary to find the following ecological partners: IT servers, technology providers for industry 4.0, operation technology suppliers, physical automation and robotics suppliers and professional service organizations.

Functional positioning of product manufacturing ecology unit

3nod's positioning of ecological unit for its manufacturing innovation is: to meet the improvement of production efficiency, to meet the needs of personalized production, and to support the research and development, production, and delivery of customers in new fields.

The main business of 3nod products is concentrated on the three aspects of audio speakers, notebook computers and smart tablets. At present, 3nod has strong manufacturing and delivery capabilities. In order to continue to maintain this advantage, 3nod has carried out ecological exploration in strengthening the traditional supply chain, large-scale manufacturing, industrial Internet's intelligent upgrade of factories, and R&D technology supply chain. At present, 3nod is building an industrial Internet design platform to strengthen its OPM response ability under informatization conditions. See Figure 5.6：

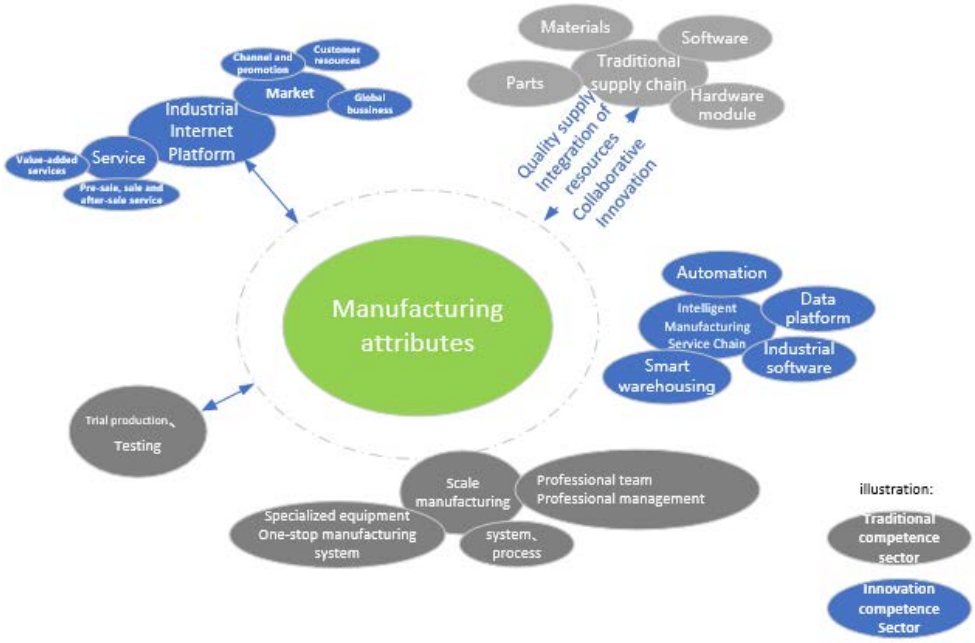


Figure 5.6 the structure diagram of the innovative ecological unit of 3nod Manufacturing

Table 5.4 Summary Table of Ecological Network Relationship of 3nod Manufacturing Capability Unit

Ecological dimension	Contents	Ecological effect	Ecological relationship with 3nod	Method of innovation	Successful cases	Evolution direction
Original supply chain	materials	Internal support	Peer cooperation	Integration of resources and collaborative innovation External cooperation	Construction of 3nod's smart factory	Industrial internet
	components					
	Hardware module					
Scale manufacturing	Specialized equipment		Peer cooperation			
	One-stop manufacturing system					
	professional team					
Intelligent Manufacturing Service Chain	Automation		Internal extension			
	Data center					
	Smart warehousing					
	Industrial software					
Industrial Internet Platform	Market		Internal extension			
	Service					
Trial production and testing	Automated production technology		Peer cooperation			
	Automated testing technology					
	Basic technology of service					

Remarks: Since there are no fully mature cases in the same industry in terms of digital transformation and digital factories, 3nod faces great difficulties in the process of digital upgrading of manufacturing units. First, there is an overall lack of mature talents in the industry. Second, there are few successful cases 3nod can learn from. In the process of absorbing case achievements, 3nod needs to disassemble and analyze the success points of digital pioneering enterprises. This kind of fragmented ability is a huge difficulty in cognition and judgment for 3nod itself. Third, for 3nod's digital transformation based on its own understanding, this requires a great deal of fault tolerance, and puts a huge investment pressure on 3nod.

Innovation Platform Unit

3nod is positioned as a platform-based industry group and is committed to building an industrial ecosystem. 3nod mainly revolves around its three main businesses (audio business, information technology business and smart home business) to build an ecosystem with an open platform as the core. Among them, the open platforms mainly include industrial design platforms (represented by independent design companies such as Maxypro), intelligent manufacturing platforms (represented by the industrial parks in Songgang , Shenzhen and Beihai, Guangxi), and supply chain platforms (represented by the "Haohanbang" plan), market-oriented platforms (represented by the global main customer department), industrial financial platform (represented by Guangzhou &Shenzhen United Holdings).

Industrial design platform: 3nod established an independent design company (Maxypro Design Company), acquired some design companies in Korea, and cooperated with some design companies on electronic products; in

addition, it led the establishment of the Shenzhen Industrial Design Industry Association; at the same time, it has wonderful cooperation with some design agencies in Hong Kong and Northern Europe.

Intelligent manufacturing platform: 3nod has industrial parks in Songgang, Shenzhen and Beihai, Guangxi to undertake the task of product manufacturing.

Supply chain platform: 3nod implements the "Haohanbang" plan to establish strategic-level cooperation relationship with some excellent suppliers.

"Haohanbang, to put it simply, is to pass our core philosophy to them (suppliers), and tell them clearly where we will go in the future? At the same time, we tell them where we go through what, and use the vision and values to unite these high-quality suppliers. Then they will form a dedicated team to support us."

Through these platforms, 3nod links a lot of resources to form an ecosystem. For example, through the industrial design platform, on the one hand, many external design units are linked. In addition to enriching and opening up the design ideas and horizons of its own design company, and improving design abilities, it can also understand the advantages and strengths of many external design units. When encountering the design fields 3nod is not good at, it can quickly find a suitable design unit to cooperate; on the other hand, many cross-border resources are linked, such as clothing companies, Internet companies, social celebrities, etc., which allows design companies to accumulate a large amount of data and information, more accurately grasp market opportunities and respond to market changes more quickly. For another example, through the supply chain platform, 3nod implemented the Haohanbang plan, which used the industrial advantages of the Pearl River Delta to link many parts supply

companies based on the needs of the three main businesses, and achieved agile and flexible manufacturing combining with the intelligent manufacturing platform.

Architecture framework of coral group innovation ecological platform

Coral Group is a key part of the external support system of 3nod's innovation ecology. 3nod has a specific and clear ecological positioning for the coral group innovation platform. Its main function is to serve as the ability extension and absorption target of the OPM model. Practicing the B2S industry innovation model (Business Backed Startup), integrating space, service, and capital elements, practicing open innovation and enabling service concepts, and connecting large enterprises and entrepreneurial enterprises as well as ecological partners through linking, promoting, and self-organizing core capabilities, we will build a resource-rich innovation and entrepreneurship ecosystem, and strive to enhance corporate innovation, increase the success rate of entrepreneurship, and promote industrial innovation and upgrading.

In order to grasp market opportunities more accurately and provide necessary supplements for its main business, 3nod Group uses its own industrial resource advantages to jointly initiate the establishment of Coral Group Innovation Accelerator with former Huawei executives, domestic intelligent hardware experts, and business model design experts, and the purpose of Coral Group Accelerator is to link the resources of large enterprises and start-ups, improve the success rate of innovation and entrepreneurship, help traditional enterprises to transform and upgrade, and improve the innovation ability of large enterprises. Coral Group has linked resources from Internet company T's Makerspace, J and other large corporate to assist innovative and entrepreneurial

companies in an all-round way. In 2015, Internet company T Makerspace, J and Coral Group Innovation Accelerator jointly released a joint incubator plan to serve smart hardware startups in Beijing. The three parties plan to jointly incubate outstanding smart projects every year. Startups that join the incubation plan will obtain many aspects of support such as investment, incubation, design, marketing, supply chain of manufacturing, big data, office space, etc.

At present, Coral Group has provided entrepreneurship and innovation services for nearly a thousand large and small enterprises, and it has operated and managed many high-quality makerspaces such as 3nod Coral Group Makerspace (national-level Makerspace), Internet company T Makerspace (Shenzhen), Internet company T Makerspace (Guangzhou), etc. Coral Group has successively obtained a number of honors and recognitions such as National Makerspace, Shenzhen Innovation and Entrepreneurship Base, and National Excellent Operator of Internet company T Makerspace. Coral Group Innovation Accelerator provides support to startups from two aspects: helping to link related resources and improving the abilities of startup teams, as shown Figure 4.6. Coral Group Innovation Accelerator helps start-up companies link capital resources through the entrepreneurship and innovation finance platform, helps innovation companies connect intellectual resources of design through the industrial design platform, helps innovation companies connect industrial resources through the intelligent manufacturing platform and supply chain platform, helps innovation companies connect channel resources through the market platform, helps innovation companies create an entrepreneurial atmosphere and promotes mutual exchanges and cooperation between innovation entrepreneurs through the entrepreneurship and innovation space

and alliance; through the Entrepreneurship and Innovation Academy and Practice Center, it also helps innovation entrepreneurs improve their abilities, and guides entrepreneurs to avoid low-level, homogeneous entrepreneurship as much as possible. See Figure 5.7 for details.

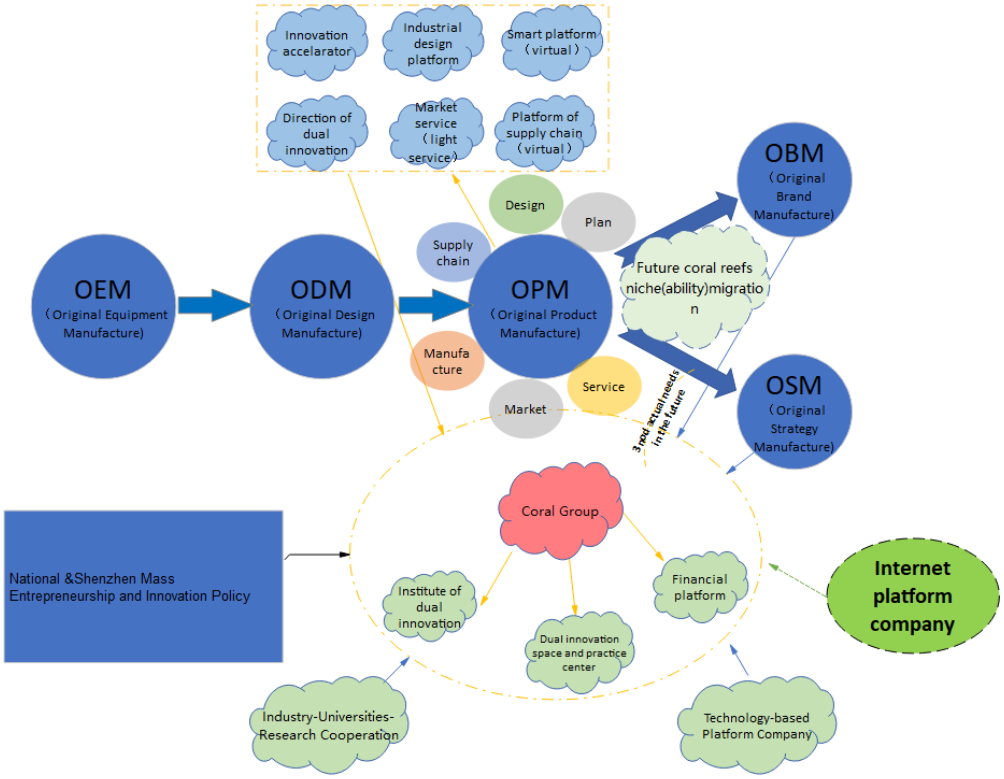


Figure 5.7 Coral group structure diagram of entrepreneurship and innovation platform

Innovation Ecology of Coral Group（External）

Coral group focuses on the field of innovation and entrepreneurship. Based on the B2S industry innovation model, Coral group provides systematic innovation and entrepreneurship services and products for large, small and medium-sized enterprises, governments and other customers, and promotes the improvement of corporate innovation and industrial innovation and upgrading, as shown in Figure 5.8.

It provides three major services: providing the government with industrial innovation services; providing open innovation services for large enterprises; and providing six enabling services for entrepreneurial enterprises.

It exports six major products: incubators, accelerators, industrial innovation bases, Hong Kong, Macao and Taiwan innovation and entrepreneurship bases, innovation and entrepreneurship activities, and innovation and entrepreneurship training.

Companies currently settled in are: Ciyun Technology, Abbots Technology, Bike, Huihuibao, Juxin Microelectronics, Flame Technology, Jiatui Technology, etc.

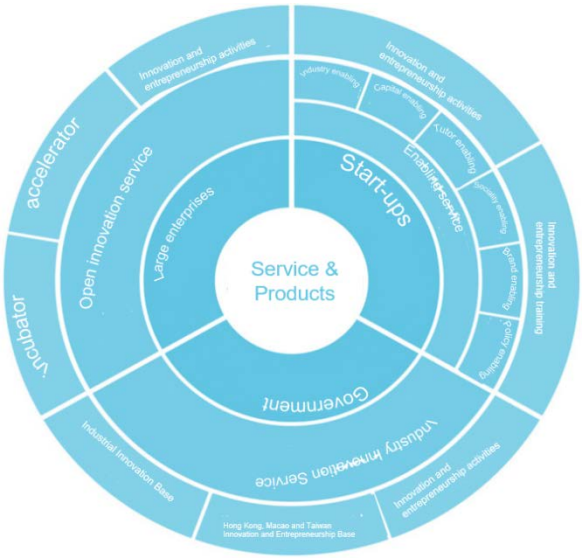


Figure 5.8 Coral group (accelerator) innovative ecological products and services output

Remarks: 3nod's current retail investor group innovation accelerator has initially taken shape, but it is still in a relatively naive stage. At present, for 3nod itself, supporting start-up companies has still financial pressure. In addition, there is still a gap between the settled enterprises and the innovation ability established by 3nod (such as how to select and identify, how to manage, and how to fully absorb the golden ideas of these companies). At present, the

corresponding operation method has not yet been formed. If the government policy has changed, and the function of the innovation accelerator is not still released, then the pause in the period will become a more embarrassing situation for 3nod.

Chapter summary

This chapter mainly focuses on Industrial Internet and intelligent manufacturing conditions, enterprises have to apply more industrial Internet technologies and advanced manufacturing technologies. Therefore, 3nod's OPM model needs new changes. This chapter explains the latest progress of 3nod innovation ecosystem in design innovation module, technology innovation module, manufacturing innovation module and application scenario innovation module. It mainly describes the actual situation of innovation of design innovation module, technology innovation module, manufacturing innovation module, and innovation platform module from the definition of 3nod product scenario, which further confirms the original intention of research and design, and compares 3nod's primary innovation ecosystem and 3nod's advanced changes in the innovation ecosystem to lead to the conclusion that the more advanced construction of 3nod's innovation ecosystem is mainly carried out in three directions: scenario definition, new technology and new manufacturing, which are the basic components of 3nod's technological innovation ecosystem. The reason why the definition of product scenarios is the starting point of innovation is mainly because the interaction between products and application scenarios will become more and more important under the new generation of information technology.

Chapter 6：Case Analysis and Discussion

The abstract of this chapter

Although the previous chapters 3 to 5 have conducted research on the innovation ecosystem of 3nod's OPM model, through the elaboration of the above issues, it is not difficult for readers to find that the essence of 3nod' OPM model is the 3nod technology innovation ecosystem. But an important aspect of the innovation system is its non-technical property. Therefore, in terms of non-technical property, it is also necessary to study non-technical support systems and innovation living environment. So, in this chapter, after attributing the internal and external factors of 3nod's innovation ecosystem (innovation living environment), we will analyze the OPM model (technological innovation system) of 3nod and the response of 3nod's technological innovation support system to the upgrade and evolution of the OPM model. The adaptive changes made are also studied while conducting the complementary research on the key factor (the choice of ecological partners) of the innovation ecosystem construction process. In this way, the innovation ecosystem of 3nod will be more complete and vivid.

Analysis and discussion of construction motivation in 3nod innovation ecosystem

Figure 6.1 Internal and external transmission logic of 3nod innovation ecosystem construction

Firstly, 3nod's external technology, market, and institutional contextual pressure drives are the starting point for the construction of 3nod's innovation ecosystem. In particular, for the current digital intelligent technologies represented by 5G, Internet of Things, artificial intelligence, and big data, the lagging characteristics triggered by their complexity, dynamics, and maturity,

as well as market contexts characterized by the diversity of market demand and the systemization of market competition, and institutional contexts characterized by the guidance of formal institutional opportunities and the driving of informal institutional pressures have made a single enterprise with limited resources having to rely on the resource capabilities of external organizations such as universities and research institutes, technology leaders, users, suppliers, and governments to build an enterprise-centric open innovation ecosystem through technology cooperation, technology alliances, technology introduction, collaborative innovation and other methods. Therefore, the different pressure characteristics of external technology, market and institutional context induce the construction of the 3nod innovation ecosystem in the "first order". However, the external contextual characteristics do not need to be fully manifested. The manifestation of a certain type of characteristics can prompt the construction motivations of the enterprise-centric open innovation ecosystem to be transmitted to the next stage.

Secondly, corporate behavior begins with the process of identifying the internal and external environment of the enterprise by the entrepreneurs and executives. The attention of entrepreneurs and executives is an important link connecting the internal and external environment and entrepreneurs' cognition, and it is the basis for entrepreneurs and executives to pay attention to information, translate information and act accordingly. Therefore, Liu Zhixiong, 3nod’s chairman, and his executives’ attention to 3nod’s external technology, market and institutional environment, and 3nod’s internal resource capabilities are based on the premise that the cognition of building an open innovation ecosystem is formed with 3nod as the core.

Therefore, the internal and external attention of entrepreneurs and executives is allocated in the "second order" to induce the construction of the enterprise innovation ecosystem. For example, Liu Zhixiong repeatedly emphasized that the market, technology, policy context and 3nod's own strength involved in the voice + application scenarios should be fully evaluated before choosing an appropriate innovation strategy. Only when entrepreneurs and executives realize the allocation of internal and external attention at the same time, will the motivation for the construction of the corporate innovation ecosystem be transmitted to the next stage.

Thirdly, based on the evaluation of the internal and external environment of the enterprise by entrepreneurs and executives' attention to internal and external allocations, and the entrepreneurs' economic perception of increased revenue and cost reduction, as well as the non- economic cognition of resource acquisition and industry discourse power, enterprises will form the necessary cognition of an enterprise-centric open innovation ecosystem. Therefore, entrepreneurs' economic and non-economic cognition induce the construction of an enterprise-centric open innovation ecosystem in the "third order". For example, Chairman Liu Zhixiong repeatedly emphasized that 3nod has won a large number of orders from JBL, Internet company T, and Baidu because of its insistence on innovative design, which has brought direct economic income to 3nod and has gained an extensive reputation for brand manufacturing abilities in the smart speaker industry. It also directly promotes 3nod's own delivery ability. Here, the cognitive characteristics of entrepreneurs and executives do not need to be fully manifested. The manifestation of a certain type of

characteristics can prompt the construction motivation of the enterprise-centric open innovation ecosystem to be transmitted to the next stage.

Finally, although the chairman and executives of 3nod perceive the necessity of constructing an enterprise innovation ecosystem based on the economic or non-economic cognition, if they lack the entrepreneurial spirit that includes challenge consciousness, innovation mind, and risk-taking awareness, enterprises will lose the courage and ability of building a corporate innovation ecosystem. Therefore, Liu Zhixiong ,3nod Chairman and executives' challenge consciousness, innovation mind and risk-taking awareness induce the construction of an enterprise innovation ecosystem in the "fourth order". For example, 3nod’s creation of an innovation ecosystem under the background of digital economy and digital transformation is inseparable from the personal style, vision and courage of Chairman Liu Zhixiong. Therefore, when the chairman of 3nod and executives have the challenge consciousness, innovation mind and risk-taking awareness at the same time, the construction of the innovation ecosystem of 3nod will be a matter of course.

To sum up, along the transmission path of " technology, market and institutional context level→entrepreneur attention level→entrepreneur cognition level→entrepreneurship level", the motivation for constructing an enterprise-centric open innovation ecosystem are characterized by technological complexity, technological dynamics, technological lagging, market demand diversity, market competition systematization, formal institutional opportunity guidance, informal institutional pressure drive, and internal and external attention allocation, economic and non-economic cognition, challenge consciousness, innovation mind and risk-taking awareness.

Only when different source levels show different characteristics, can it induce the construction of an enterprise-centric open innovation ecosystem. Among them, the level of external context in the "first order" and the level of the entrepreneurs' cognition in the "third order" do not require all the characteristics to be manifested. The manifestation of a certain type of characteristics can complete the transmission of construction motivation of an enterprise-centric open innovation ecosystem. And the entrepreneurial attention level in the "second order" and the entrepreneurial spirit level in the "fourth order" require all the characteristics to be manifested at the same time, so as to complete the transmission of the construction motivation of the innovation ecosystem with 3nod as the core.

3nod Innovation Ecosystem Structure

Based on the components of the natural ecosystem (producers, consumers, decomposers, non-biological substances and energy) and the theory of enterprise innovation management (strategic, cultural, market, management, system, technology and other multi-dimensional elements that affect the innovation performance of enterprises) , based on the analysis of the value realization nodes of the disruptive innovative products/technologies launched by 3nod Group in recent years, this research exploratively summarizes the components and niches of 3nod's enterprise innovation ecosystem, as shown in Figure 6.2.

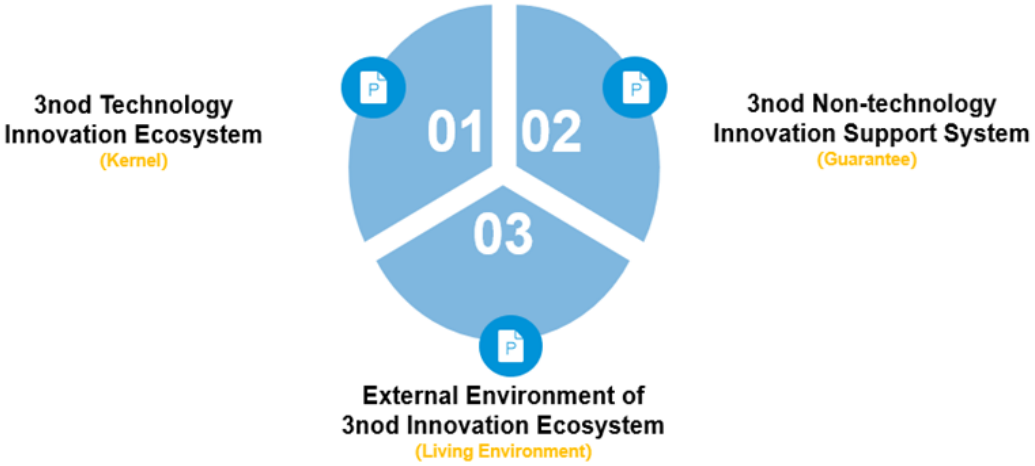


Figure 6.2 3nod Innovation Ecosystem Structure

3nod Enterprise Technology Innovation Ecosystem

The core enterprise technology innovation ecosystem is the core component of the enterprise innovation ecosystem, the main niche for the flow of resources and energy in the enterprise innovation ecosystem, and the main initiator of the operation of the enterprise innovation ecosystem. This dissertation describes the composition of the 3nod enterprise innovation ecosystem as follows: The construction still borrows the concept and terminology of the natural (releasing) ecosystem. The system 3nod innovation ecosystem constructs is a one that meets the maximization of economic, social and ecological benefits at the same time, and its core is an all-region and comprehensive innovation system with economic growth as the center, and the comprehensive and coordinated development of the economy and the external environment, people, and society as the goal. In the natural ecosystem, organisms and the natural environment are interdependent and restrict each other. Between organisms, and between organisms and the environment, material circulation, energy transferring and information exchange are continuously carried out through metabolism, which thereby promotes the

tendency evolution of the entire ecosystem from low-level to high-level, from simple to complex, and finally was kept stabilized. Companies are like living organisms, which have direct or indirect interactions with each other, and form a whole together with the surrounding environment. This whole constantly exchanges innovative materials, energy and information in the process of technological innovation with 3nod as the core enterprise. The whole is interdependent and interacts with each other, so that the whole gradually evolves into an enterprise technology innovation ecosystem, and maintains the harmony and balance of the system through competition, cooperation and symbiosis, therefore achieves a win-win situation.

This dissertation defines the 3nod innovation ecosystem as follows[65]: 3nod's technological innovation ecosystem refers to the upgrading and evolution of each capability unit of the OPM model as the core within a certain time and space range, and is reflected in design innovation, technological innovation, manufacturing innovation, application scenario innovation, and 3nod's internal and external innovation platform cooperation and innovation, with collaborative innovation as purpose, cooperation and symbiosis as the base between all units, and realizes a dynamic balance system of mutual dependence and interaction of innovation resource sharing, complementary advantages and risk sharing through innovative material, energy and information flow. It includes all kinds of resources required by suppliers, manufacturers, sellers, scientific research institutions, intermediaries, financial institutions and

[65] Referring to Shi Zhuqin. "Study on the Innovation Ecosystem of Technology-based SMEs-Taking Shanxi Province as an Example[M]". Shanghai Jiaotong University Press, 2017.7 related theories for definition.

enterprises to carry out technological innovation activities, and the rules to maintain the operation of the system. See Figure 6.3 below for details.

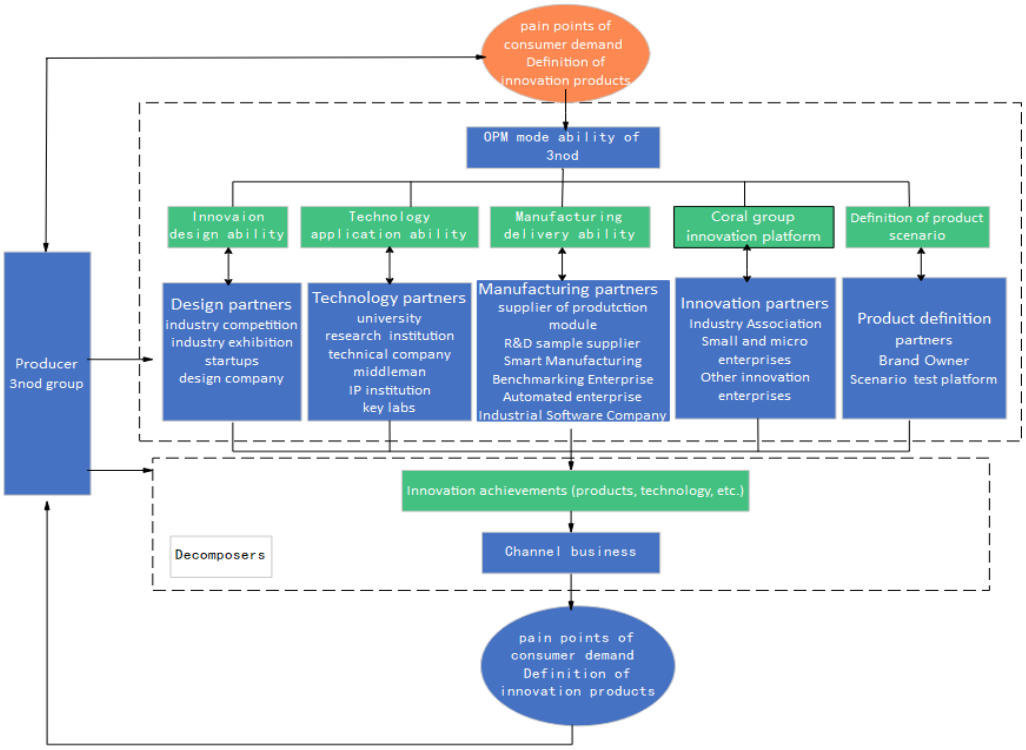


Figure 6.3 3nod Enterprise Technology Innovation Ecosystem

First, with brand owners and consumers as the core, it plays the role of "seeds", and the deep-seated needs of brand manufacturers and consumers are the main source of creativity for 3nod Group in product innovation, at the same time, 3nod also actively draws inspiration and obtains creative works in industry competitions, start-ups, and exhibitions. The above are the main driving forces of 3nod Group's innovation activities, meeting its ultimate demands, that is to say, the ultimate goal of 3nod Group's innovation activities. Brands represent market orders and are the ultimate goal and destination of commercialization of technological innovation. How to meet the increasingly diversified, complex, and personalized needs of users is the fundamental reason and goal of core enterprises to build an enterprise innovation ecosystem. User-centric enterprise innovation is not only user innovation, but also involves core enterprises'

creation or improvement of new technologies and products based on user pain points to meet user needs as the original goal and ultimate goal. The Internet solves the problem of information asymmetry between enterprises and users, such as time-delay and inadequate information transmission, and continuously interacts with users throughout the product/technology innovation process to provide users with a full-process product experience. Therefore, the construction of enterprise innovation ecosystem is germinated by core enterprises based on satisfying users' complaints and needs, allowing enterprises to create more value for users, thereby enhancing enterprise innovation performance and innovation value. Second, building an innovation platform. Innovation platforms play the role of "bees", such as 3nod's coral group innovation platform. The coral group innovation platform is an effective way and method for the various BUs of 3nod Group to find and attract various types of partners. The core enterprise uses its own innovation platform to gather the innovation elements inside and outside the system. Through the cooperation between system members at different levels, it can optimize the allocation of innovation resources, and improve the commercialization efficiency of core enterprise innovation technology when promoting multi-party win-win, and constantly create value for consumers, thereby enhancing the creativity of the entire enterprise innovation ecosystem. Core enterprises use network effects and bilateral markets to play the effective role of innovation platforms. they can achieve the purpose of pooling global resources, integrating and sharing resources, and innovate technology & products and create greater economic value around user value through multi-level and open platform construction and improvement. The establishment of enterprises innovation platforms does not

only refer to tangible network platforms. For example, the "coral group" innovation platform is a one that combines physical and network innovation communities. The network platform analyzed in this dissertation also includes intangible innovation platforms, that is, enterprises determine the next R&D plan based on users' pain points and complaints. Based on the background of the company's implementation of open innovation, the enterprise conducts innovation activities such as technology R&D and parts supply with different partners around the world, and then provides an innovation platform for multiple partners. The enterprise will converge and integrate the required innovation resources based on a specific technical solution, optimize resource allocation while reducing innovation risks and innovation costs, and shortening the innovation management cycle, and realize the sharing of innovation resources, complementation of advantages among the internal members of the system, cooperation win-win and jointly maintain the healthy operation of the entire system. Third, partners of different types. The partners play the role of "species". The relationship between the partners and the core enterprises is a one of competition and cooperation with mutual promotion and co-evolution, and they belong to different types of partners such as technology partners and distributors. Firstly, 3nod Group cooperates with scientific research institutions, universities, enterprises, technology transfer centers and other partners at different levels, and they can provide users with better innovative products and service while to achieving cooperation win-win through the complementation of resources and advantages; Second, the handover and delivery of innovation results between 3nod Group and brand owners can make innovation results commercialized, and at the same time, based on brand owners' feedback on

users’ opinions of innovative products, it is conducive to core companies for the next round of product/technological innovation on the basis of users’ pain points and market feedback. Therefore, the innovation function of brand owners is mainly embodied in discovering new user needs and market demands for core enterprises, and providing guidance for core enterprises' innovation decision-making. The second section of this chapter focuses on analyzing the issues related to the relationship management between core firms and technical resource parties.

Support System of 3nod Non-Technical Innovation Ecology

The non-technical innovation system of core firms is an important part of the enterprise innovation ecosystem, a favorable guarantee for the healthy operation of the enterprise innovation ecosystem, and a coordinator of the operation of the enterprise innovation ecosystem. The enterprise non-technical innovation system of 3nod mainly includes strategic innovation, management innovation, system innovation, cultural innovation, and market innovation. They are like rainwater and fertilizer in the natural ecosystem, and are perfectly matched with the flow of material and energy in the technological innovation ecosystem, supporting the construction and development of the technological innovation system and continuing to provide essential nutrients for the technological innovation ecosystem. Combined with existing research results, this dissertation summarizes the niche of 3nod’s non-technological innovation system from the following points:

Strategic innovation is the compass

The key to non-technological innovation support system is to be led by strategic innovation. The strategic innovation of the core enterprise indicates

the direction for the overall development of the enterprise, that is, what value should be created for users; the strategic innovation also plans the path for the sustainable development of the enterprise, that is, how to create value for users. Strategic innovation is the direction of enterprise innovation and development and the blueprint for the future development of the enterprise. It can provide overall guidance and planning for the innovation activities of the enterprise, and point out the direction for the development of enterprise technological and non-technical innovation.

3nod's innovation is manifested in three aspects: business model innovation, technology and design innovation, and innovation ecology construction. First of all, in terms of business model, at the beginning of the establishment of the company, the founder Mr. Liu Zhixiong hoped that 3nod could get rid of the old way of traditional Chinese copycat manufacturing. He believed that the quality of an enterprise is not only reflected in product quality, but also requires strong innovation ability to create distinctive products that exceed customer expectations. Therefore, 3nod boldly carried out subversive innovations after passing through its survival period, and created the original OPM business model (Original Planning Manufacturer, provider of original product planning and design) at the beginning of this century. Second, 3nod Group implements an innovation-driven strategy with "design innovation and technological innovation" as the dual engines to promote 3nod group from “Made in China” to “Created in China”. 3nod's industrial design center has been rated as a national industrial design center, ranked 13th among global design agencies. 3nod's technology and design innovations ensure the differentiation, high quality and creativity of its products. Third, in terms of constructing an

innovative ecosystem, 3nod focuses on cross-border cooperation and provides overall solutions for many countries and regions around the world. 3nod successively initiated the establishment of the Shenzhen Industrial Design Industry Association, the Smart Life Industry Association and the Shenzhen Smart Home Association to actively promote the transformation and upgrading of Shenzhen's manufacturing and the cluster development of the smart home industry chain. In recent years, 3nod has actively launched the "3+" plan of "Creative+, Maker+, Creator+" to build a one-stop service platform, support innovation and entrepreneurs, and expand the boundaries of enterprise innovation to the outside world, as well as focused on building a borderless and open innovation ecology, and strived to create a three-in-one innovation model of B2B, B2C, B2S, and (Business-Backed-Startup). At the same time, under the two-wheel drive of "smart industry + innovation investment", 3nod will build a new strategic capital-driven sector, which will have the ability of the whole investment industry chain from incubations to mergers and acquisitions, and construct the industrial ecosystem, which links the Internet upward and the Internet of Things downward, centering on 3nod's ecological chain of “voice +”, smart information industry chain, and ecological chain of innovation and entrepreneurship to link more global original technologies, and realize the linkage from global innovation power to China's industrial power.

Case story 1: "If the boss does not stick to his beliefs, but goes the short-cut and holds the mentality that he is almost done, then anything cannot be implemented, and it must be carried out from top to bottom. Therefore, when the conflict is very fierce, we finally invite the boss out. you have to show what kind of attitude you have. The boss has asked for customer orientation in the company roundtable several times, all practices of

organizational behavior must be customer-oriented, and if the existing organizational behavior cannot meet customer needs, reforms should be made."

Case story 2: In the process of promoting digital factories and intelligent projects, there are some inevitable interest conflicts among BUs within 3nod Group, which are mainly reflected in two aspects: first, the balance of interests between cash business (profit) and seed business (investment); second, The chairman of 3nod and the senior management had different opinions in the middle of the implementation steps and a problem of inconsistent cognitive focus in the process of promoting the strategy implementation. The chairman considers more from the financial support of 3nod itself, while the executive Dept. believe that it is more important to promote a certain project as soon as possible. For example, In the process of promoting the construction of a project in Songgang Town, Shenzhen City, 3nod has to take into account not only government policy subsidies, but also the difficulty of project implementation, and some executives have resigned in the project period (Outside hired executives face the pressure of new project promotion performance appraisal, and enterprises have to be afraid that the project progress is not in line with expectations), which is a big challenge for 3nod to promote digital innovation and carry out in-depth changes in the innovation system.

(2) Management innovation is the cornerstone.

The enterprise innovation performance is directly related to business management. Business management needs to review the current situation. It needs to innovate along with changes in the external innovation environment and internal innovation activities of the enterprise， so as to ensure

Interdependence and mutual evolution between corporate strategy, culture, organization, systems and technological innovation.

3nod Group embodies the idea of game and cooperation in product design, R&D, implementation and sales. As the core department of 3nod Group, the product department staff must shuttle and communicate between different teams, such as R&D, design, manufacturing, and sales departments, so as to ensure the effective implementation of products which have been designed and planned. If the R&D team cannot design it, the product department needs to find a team that can complete the design to prove that its plan can be realized. 3nod Group adopts a competitive incentive system in product development. If Team A cannot complete a project, then Team B is responsible for it. Thus, team B's successful completion is a kind of stimulus and spur to Team A, which urges Team A to change its original thinking, so as to achieve the purpose of continuous innovation. If the manufactured products cannot be sold out, the staff in the product department need to conduct the sales themselves to set an example for the staff in the sales department. Therefore, all departments in 3nod exist in a large game body, and there are both cross-competition and cooperation relations among departments.

Since 2011, 3nod's strategic planning has undergone many changes, but the three keywords of "innovation, speed, cost" have always guided the direction of changes. They are not only the standard for testing operation and management of an enterprise, but also the ultimate goal to be achieved in the implementation of operation management and process optimization. In the past few years, 3nod has maintained a momentum of rapid development. In 2015, in the face of a severe global economic downturn, it increased by 50% against the

trend, and its various performances of operation have developed steadily and rapidly, reaching a new level and height in the enterprise's development history. It was expected that in 2016, 3nod would also continue to maintain a rapid growth rate of more than 50%, and its operating income exceeded tens of billions. With the continuous expansion of the enterprise scale and the diversified business development, 3nod is still able to achieve such high-speed growth. This also reflects from the side that 3nod has achieved excellent score of operational management while firmly grasping the "innovation, speed and cost".

In terms of promoting innovation, 3nod uses the IPD knowledge management system to manage its own R&D team, control the R&D cycle and process of products, and promote the high-efficiency of R&D and innovation activities. As the team gradually expanded, 3nod's executives also realize that 3nod must adopt a process-based model to manage R&D and promote innovation:

Case story: "When I led a team of 20 people, I just "said" like this and everyone heard it. When I led a team of 50 people, I "roared" like this and everyone could hear it. When I led a team of 300 people, the methods of the above are useless, and I needed a system for management. Then, we introduced IPD, including some system tools like PLM and so on." The newly established subsidiary of information technology draws on the R&D experience of the audio department, and has obtained Industry-leading R&D level:

"For example, in the case of notebooks, its standard cycle of R&D is usually eight months, but different models may take eight months to 12 months, in fact, we followed this relatively new model for R&D, our first case only took

four and a half months last year, and it was shipped within four and a half months."

（3）Cultural innovation is the forerunner.

From the generation of innovative ideas, the process of innovative activities to the commercialization of innovative results, all aspects are permeated with innovative culture. The innovative culture of the enterprise creates a good atmosphere and environment for the innovative behavior and characteristics of enterprise employees. Studies have shown that innovation culture has a positive supporting effect on organizational performance. Corporate culture is the soul of corporate development and an inexhaustible driving force to promote corporate development. Therefore, cultural innovation plays a leading role in the construction and operation of corporate innovation ecosystems. Based on the concept of open innovation, 3nod Group does not exclude all foreign technologies. In order to achieve a win-win, 3nod Group generally does not adopt the cooperation modes such as mergers and acquisitions in the process of cooperation with technology partners, but chooses joint research and development, and provides partners with innovative resources and platforms for research and development.

The core keywords of 3nod's corporate culture include: quality, innovation, openness, aggressiveness, and responsibility. The above-mentioned core cultural characteristics have penetrated into all aspects such as 3nod's product business, organization and management, and talent concept. The culture of "three philosophies" always runs through the main axis, that is to say, pursuing excellent quality, which includes product quality, human quality and corporate quality: “One generates Two, two generates Three, three times three is Nine,

nine and nine in One”; “first-class Products create first-class Brand, and first-class Talent create first-class Enterprise”, namely a hard work can get a harvest (no pains, no gains). Only by creating and realizing value, can the enterprise develop, the product can have its market, the team can obtain the achievements, and the individual can gain what he wants.

Story case: "When I joined 3nod, Chairman Liu talked to me about a situation. He said that we have no factions in 3nod, and where there are factions, we will destroy them. The issue of political struggle basically does not exist within 3nod. "

"In recent years, we have basically been grabbing business from Hong Kong-funded and Taiwan-funded enterprises. Looking back now, compared with these companies, 3nod is not smart enough, but its efficiency is an advantage, and there is no such phenomenon as internal friction in 3nod.

3nod has a culture called partner culture - 'Mutual Achievement', when a person joins the company, we will support him for success and help him, and you help me, I help you, which is called 'Mutual Achievement'. "

（4）Institutional innovation is the driving force.

When the culture innovation operates, there must be a certain institutional system as a guarantee. The enterprise's institutional innovation behavior can guide, support and protect the enterprise's technological innovation behavior. Institutional innovation and technological innovation are embedded in each other in different dimensions to directly generate the bonding effect, and become the key link in the formation of the sustainable development power of the enterprise. The system innovation of 3nod's advanced consciousness has laid the foundation for its innovative culture, and further guided the changes in the organizational structure of corporate, continuously injecting fresh vitality into 3nod group, and promoting the overall development of 3nod. The

repressive mechanism internally implemented, which starts from the needs of users, forms repressive resources within the enterprise from top to bottom, formulates a full-process collaborative commitment from the repressive enterprise's internal business entities to external suppliers, and formulates budgets to ensure the completion of goals. The related "reversing mechanisms" such as "two-dimensional dot matrix", "user likes" ensure that enterprises carry out a series of innovative processes such as product R&D, manufacturing, sales, and service according to users' needs, allowing all employees to face their own users directly. This can not only sensitively feel the dynamic changes of the market, and catch the needs of customers in time, but also promote the flatness, dynamics and networking of internal organizational structure of the enterprise while driving technological innovation.

3nod will provide employees with opportunities to participate in external courses, suppliers' training courses or online courses. For participating in external courses, the enterprise will give certain economic subsidies to encourage employees to continuously improve their professional skills. When young employees put forward some adopted viewpoints or new product designs, the organization will give them praise, awards and bonuses. In addition to motivating employees to learn and innovate through material and spiritual incentives, the enterprise conducts various selections of projects every quarter, and rewards the projects that have obtained best practice.

（5）Organizational innovation is the guarantee

Enterprise organization innovation is a relatively complex management system, which involves various elements and combinations of elements within the enterprise. Its essence is the application of a new way or method at the

enterprise organizational level. The state after the change of this change or revolution, compared with the previous state, is obviously novel or significantly improved. In the information age, knowledge capital has become more and more prominent. How to optimally allocate the human, material, and financial resources within an enterprise is an important factor influencing the development of today's enterprises. 3nod is decomposing a "big enterprise" into multiple small teams or groups, and small and micro platform-based enterprises, and then forming a closed-loop network organization, constantly interacting with users, sensitively feeling the external market environment, and creating more disruptive products. Organizational innovation guarantees that 3nod can achieve the best state in which everyone can participate in innovation. Through the unique structure of "online" and "on-the-record" employees of the small and micro enterprise, the enterprise fully achieves continuous interaction with users and allows frontline employees to implement self-management according to the needs of the market and users, allowing employees to thoroughly control the rights of benefit distribution, resource allocation, and business decision-making, so as to realize the two-way coupled development of technological and organizational innovation of enterprise, and the mutual promotion and dependence between the two.

Organizational innovation in 3nod group is mainly reflected in the human resources department, and human resources is one of 3nod's operational support. The continuous talent guarantee has helped 3nod to achieve previous strategic transformations and embark on the fast lane of development. 3nod's human resource management has its own distinctive features. The first is that the main leaders in the enterprise attach great importance to and support the work of

talents. The chairman of the enterprise has higher requirements and clear instructions for human work, which also puts the 3nod's human resources team under unusual pressure. The second is to have a clearer strategic positioning of talents. Its talent strategy is guided and indicated by corporate strategy to achieve seamless connection between strategies. The key element lies on "getting the right people get on at the right time." The third is a flexible talent management mechanism. As an enterprise spanning manufacturing, technology research and development, industrial design, marketing and other fields, 3nod has very diverse employee jigsaws. 3nod Human Resources adopts Matrix Decentralization Management, and the human resources team at the headquarters is quite streamlined, and carries out overall control of human strategy and personnel policies, and explores the activeness of each BU and business platform. In general, 3nod's human resource management is committed to creating value for the enterprise, and its value chain of human resource is relatively clear, and the internal effective integration of the human resource management mechanism has been initially realized. Organizational structure adopts a partnership system, loose coupling between departments. 3nod Group, from an internal perspective, mainly implements a partnership system. Everyone is the owner of the business and everyone is an entrepreneur, at the same time, is fully authorized financially.

Case story: "In the future, traditional standardized industrial product brands have no value. For a traditional industrial enterprise, if it wants to have its own brand, it needs to develop, manufacture, and sell its products. This burden is very heavy; it will fall into vicious competition with its competitors in the same channels. The industry will rebuild its value. In the future, industrial boundaries will become blurred. The era of differentiation and personalization will inevitably bring profound market changes. Cross-border and cross-

industry will become the new normal of social and economic development. Users will become the people who lead the product brand. 3nod should be guided by individual needs, through cross-border integration, to carry out differentiated, cross-border and personalized brand cooperation in the fields of entertainment, fashion, education, technology, etc., to form the synergy and influence of cross-border Integration and development, as well as new industries and industry alliances."

（6）Market innovation is a pathway.

The ultimate goal of an enterprise's innovation in different dimensions is to realize the commercialization of innovative products. It can be seen that market innovation is a pathway of construction and operation of an enterprise's technological innovation ecosystem, and it has a direct relationship with the overall development performance of an enterprise. The advent of the Internet Economy presents both an opportunity and a challenge to the market development of enterprises. How to break the market shackles of the traditional economy and break through the market black box brought about by the Internet Economy has become an important factor influencing the development of enterprises.

Case story: "For example, all the executives we interviewed today basically have the same idea, that is, the chairman is constantly instilling. Because he thinks more than everyone thinks and sees farther, he needs to timely promote the transmission of information, and cannot let the following information be interrupted. He believes that the most important thing is that the executive must understand his ideas, and which is what he wants, and then you know how to do it. He must communicate with the most core team members, and needs to know some real thoughts in your heart." "Now, for the boss, his role has changed, that is, he just talks to us about ideas, ideas exchanges, and

exchanges ideas every month, no matter whether it is a guide or confrontation, refining and bumping something out.

"How can I sell products abroad? Most of the Chinese products are very crude. My first product was an audio system, that is to say, speaker, and I thought I should make something that makes people feel good. The starting point at that time was that the products that were launched must be different from others, and the problem of product homogeneity in China was very serious at that time. I made new products. Innovation is life. This is a very important point. At the beginning of the business, I wrote down your expectations and my promise, exceeding the expectations of customers, and this concept has not changed until now, and “3nod” is also named by myself. 3nod - Quality, Service, Value."

"When 3nod was founded, firstly, we had to survive. In the early days, we thought about how to make computer speakers better than others. Chairman Liu said that a product is nothing more than three points: 1) Cost-effectiveness; 2) Helping customers expand market share; 3) Innovation. "

"We all know where the roots of 3nod are, that is, “Design drives Innovation”."

Research on the living environment of 3nod innovation ecosystem

Non-biological environment mainly refers to light, heat, water, soil, atmosphere, rocks and non-living organic matter, as well as climate or other physical conditions (such as temperature, air pressure), etc. It is composed of two parts: matter and energy. The non-biological environment is the basis for the existence of various organisms in the ecosystem. The "non-biological

environment" of 3nod innovation ecosystem includes two parts: an innovation habitat and an innovation platform.

The meaning of the innovation habitat has been explained above, and it mainly covers the market environment, technological environment, policy and legal environment, cultural environment, innovative resource environment, financial environment, and infrastructure environment. Among them, the market environment includes the size of the market demand for the products of the enterprise technology innovation ecosystem, the strength of competitors, and the size of the competitive pressure; will it encourage more companies to join the system? Is the competition mode malicious or healthy? the size of the market's driving force for enterprise technological innovation, whether the market behavior is standardized, etc.; the technological environment includes the number of various technical information, knowledge, patents, whether the source is extensive and reliable, and whether the level of technological development is consistent with the innovation intention of the enterprise technology innovation ecosystem, industrial technology concentration, the driving force of technology for enterprise technology innovation, the speed of technology diffusion, etc.; the policy and legal environment includes whether the government creates a good market atmosphere, whether the policy (taxation) encourages and supports technological innovation in a certain industry, Whether the law can effectively protect the intellectual property rights of enterprises, whether the country has special investment in technological innovation, whether intermediary agencies can play a service role, etc.; cultural environment includes whether the innovation culture between enterprises within the system is consistent or contradictory, and whether the enterprise's

own culture is conducive to the development of technological innovation, whether the overall culture of the enterprise technology innovation ecosystem is the same as the social culture and values outside the system, how to deal with the problems caused by cultural differences between cross-regional and cross-international partners, etc.; the innovation resource environment includes, in the process of enterprise technology innovation, whether the supply of natural resources (such as land, energy, water, etc.) is sufficient, the quality of natural resources is good or bad, whether the supply of human resources is sufficient, whether the training and use of talents can meet the requirements, the amount of innovation resource such as the available scientific research institutions and universities, etc.; the financial environment includes whether the financing channels of the enterprise technology innovation are smooth, whether financial derivatives of financial institutions can be used, the size of interest rate fluctuations, the level of participation in the financial investment market, and the level of corporate creditworthiness, etc. The infrastructure environment includes the new and old equipment for technological innovation of the enterprise, the transportation situation of the area where the major innovative enterprise in the technological innovation ecosystem of the enterprise is located, the construction of roads and railways, the situation of electric and hydraulic supply facilities, and the living facilities of the employees of the enterprise. These environments directly or indirectly affect every technological innovation activity in the technological innovation ecosystem of enterprises, and there are also mutual influences and interactions between them. Therefore, the choice, adaptation and transformation of innovation habitats are all crucial to enterprises and even the entire technology innovation ecosystems.

Overview of 3nod Enterprise Innovation Ecosystem

As mentioned above, based on the macro-innovation environment of the enterprise's external market, resources, culture, and policies, 3nod Group takes users as the center and implements open innovation by building a coral group innovation platform, and conducts creative cooperation with different types of partners to build a core enterprise technology innovation ecosystem. At the same time, the non-technical innovation system of the enterprise is built by integrating the multi-dimensional innovation management elements of enterprise strategy, culture, management, system, market, organization, etc., thereby constructing a core firm innovation ecosystem. At the same time, it is compatible with external policies, markets, resources, and cultural environments. The internal components of the system depend on each other, support each other, and evolve together, thus forming the ecological network of 3nod Group's innovation ecosystem as shown in Figure 6.4 below.:

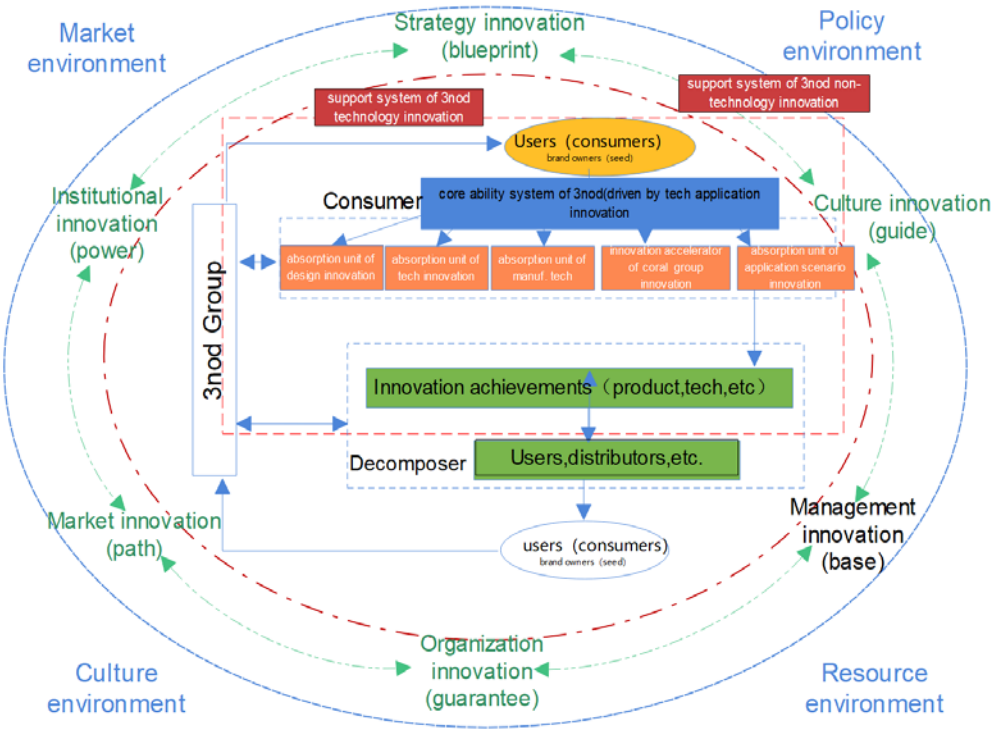


Figure6.4 Ecological overview of 3nod innovation ecosystem

This figure is composed of the technological innovation ecosystem of 3nod, the non-technical innovation support system, and the innovation ecological environment, which constitutes the overview of 3nod's innovation ecosystem. The red dotted circle in the innermost layer represents the innovation ecological layer of 3nod's core technical abilities. The green dashed circle on the second layer represents the non-technical innovation support system of 3nod, and the blue dashed line in the outermost circle represents the external living environment of 3nod's innovation ecosystem. At the same time, each circle is interpenetrated with each other.

Selection of 3nod Innovation Ecosystem Partner

Cooperation motivation

The motivations for cooperation between 3nod Group and different organizations are different: the motivation for cooperation with universities, R&D centers and other R&D institutions is mainly technological leadership. The cooperation between the two parties is at the conceptual level of creative products/technology, and the partners focus on patents and the evaluation of professional titles of technical engineers and university professors; the motivation for cooperation with large-scale well-known enterprises is the feasibility of technology, that is, the commercialization of technology can be achieved within a certain period of time, focusing on the application of creative technology, which means it can provide users with solutions to meet users' needs, and then create profits and value for the enterprise; the motivation for cooperation with other small or start-up companies is the commercialization of

technology, and at the same time, the partners hope to create profits in the short term to maintain the organization's cash flow and reduce the risk of business operations. The motivation for cooperation between the core enterprise and the technical resource party is technological complementation, and this case study verifies the conclusion. The motivation for cooperation between 3nod Group and its technical partners is complementation of resources and advantages. Among them, technical feasibility is the first, followed by the commercialization of the technology, the acceptability of the cost, and finally the execution of the partner.

Cooperation principles

The principle of cooperation between 3nod Group and different technical parties is mainly the complementation of technologies and resources, and the scale, brand, and qualifications of the partners are not important factors. When 3nod has cooperation intentions with different types of resource parties(partners), it can consider other different cooperation principles according to different projects, such as team execution and cultural compatibility. After the cooperation principle between 3nod Group and its partners has met the complementation of resources, the following qualifications (non-mandatory conditions) should be considered: 1)Brand: large international companies, domestic well-known companies, etc.; 2)Qualifications: performing successful project cooperation with the top three brand enterprises of internet in recent years ; 3)Team: the team leader has relevant industry experience; 4)Execution: The team has strong execution and reasonable arrangements of project cycle. As mentioned above, the principles for core companies to choose partners for cooperation are: information symmetry, complementation of

resource and technology, and compatibility. The process of economic globalization is accelerating, and the relationship between more and more enterprises has evolved into a competition mode of "ecological concept" based on mutual independence, equal status and coexistence.

Cooperation model

The cooperation model between 3nod Group and the technical resource parties mainly includes: first, Entrusted Development, through negotiation between the two parties, the two parties draft deliverables at different stages, and partners provide products or service at different stages, and 3nod pays for it; second, Joint Development, both parties jointly research and develop innovative technologies and share innovative results through certain agreements; third, Supply Commissions, according to the modular demand for innovative products, 3nod Group allows technical parties to directly supply products or service and become the first-level or second-level suppliers of 3nod Group.; fourth, Strategic Cooperation. The two parties will carry out a long-term strategy based on the needs of users, highlight the advantages of both parties and achieve 1+ 1>2 win-win cooperation through different cooperation mechanisms such as joint laboratory building, brand cooperation, channel sharing, etc.; fifth, Patent Cooperation. 3nod Group establishes cooperative relations through different cooperation mechanisms such as patent pools, patent buyouts, patent authorizations, etc., to ensure that it can create disruptive products /technology in the shortest time; sixth, Project Consulting. R&D institutions, universities and other technical resource parties participate in and guide the R&D process of 3nod Group, and provide professional advice. 3nod Group and technical partners should choose different cooperation modes

according to different innovation projects and resource requirements. For 3nod Group, each cooperation mode has its advantages and disadvantages, therefore, 3nod Group, as the core enterprise of the corporate innovation ecosystem, needs to cooperate with different partners at different levels based on the overall operation of the system and the principles of complementary advantages and resources between system members.

Cooperation conflicts

The main factors influencing the establishment and maintenance of partnerships between enterprises are cultural compatibility, complementation of resources, and good and effective communication mechanisms. 3nod Group seeks resources globally with an open and innovative mentality, and realizes creative cooperation with different types of partners. This kind of innovation culture lays a cultural foundation for 3nod to accommodate other international leading technologies and experts, and accelerates the cooperation between the two parties. The complementation of resources is the basic prerequisite for the construction and operation of the enterprise innovation ecosystem, which won't be repeated in this section. Enterprises adopt different cooperation modes to establish cooperation relationship at different levels. The most important thing in the establishment and maintenance of cooperation relationship is effective communication. When 3nod Group cooperates with foreign companies, cultural and geographical differences will cause certain obstacles to the communication between the two parties; there are some disagreements between 3nod Group and different types of technical partners due to patent ownership, stage deliverables, and project progress, etc., which will affect the entire project cycle of innovation products. Therefore, in the process of cooperation between the two parties, it is

necessary to solve such problems through efficient communication and management mechanisms. 3nod Group advocates an entrepreneurial culture of "everyone is a CEO", every employee facing the market, directly connecting with his own users, and making technical engineers become all-round talents, and improving their communication and interpersonal skills, so as to promote the smooth progress of each innovation project, further shorten the technological innovation cycle, and improve the creativity of the entire enterprise innovation ecosystem. In the process of managing the conflict between the core enterprise and the internal members of the system, the core enterprise must effectively integrate the various elements of enterprise innovation management so as to form a dynamic interactive relationship between each other and realize the continuous interaction between the enterprise and the users. At the same time, based on the implementation of non-technical innovations such as strategy, management, culture, systems, and markets, the core enterprise must build a solution mechanism that can quickly and agilely manage the cooperation conflicts between the core enterprise and technology providers, so as to ensure the innovation management cycle of innovation products/technologies and achieve mutual promotion and co-evolution between system members.

Chapter summary

This chapter mainly expresses that 3nod focuses on building its own technological innovation ecosystem (the core of the innovation ecosystem) on the basis of accurate assessment of its own internal and external environment. But the enterprise innovation ecosystem itself lies in not only technical field, but also has non-technical features. Therefore, it is necessary to study the non-

technical innovation support system and the innovation ecological environment. The innovation system formed in this way requires the adaptive change of 3nod's technological innovation support system and better contact with external parties. This is in line with the inherent requirements of the 3nod’s current innovation ecological environment. Based on the latest progress of 3nod's OPM model innovation ecosystem under new technology conditions, the general path of SMEs' innovation ecosystem construction can be summarized. It has reference value for the construction of innovation ecosystem for the majority of SMEs

Chapter 7：Conclusion and Outlook

Through the research in the previous chapters, 3nod is evolving and developing in the OPM model to build its own innovation ecosystem. In the process of sorting out this process, the development needs to start from the new changes in internal and external reasons faced by its own innovation, so it pays more attention to the common problems faced by the manufacturing industry, as well as the new impact of industrial Internet and intelligent manufacturing conditions on enterprise transformation, and this transformation is accompanied by the conflict between the old and new knowledge systems of the enterprise, which is where the majority of SMEs need to strengthen their attribution cognition. At the same time, the structure of the innovation ecosystem formed by the evolution of the OPM model as the core also has practical reference significance for the majority of SMEs. Therefore, the conclusions of this dissertation are mainly reflected in the following two aspects.

Conclusion of research

（1）Based on the analysis of internal and external factors of 3nod’s construction of innovation ecosystem, this dissertation supplements the model of Professor Han Shaojie and Professor Lv Yibo of Dalian University of Technology. In its external impact factors, the common problems faced by the manufacturing are added, and in the internal impact factors, two factors are added: the evaluation of the enterprise's own manufacturing capacity and the cooperation between entrepreneurs and senior management. It is proved by the internal and external factor analysis and various OPM capability sections of 3nod innovation ecosystem, aiming at learning from for the majority of

manufacturing enterprises. For supplemental evaluation form, see Table 7.1 for details:

Table 7.1 Internal and external factors evaluation model for enterprises to build innovation ecosystem

Type	Category	Concept	Keywords
Motivation of external ecology context	Level of technical context	C_1 Technical complexity	Interdisciplinary |Subject complexity | Multidisciplinary |Technology Convergence | High technical complexity | Structural complexity |Many parts| Technical complexity | Complex manufacturing process
		C_2 Technical dynamics	Fast technology updates |Fast technology changes | Short product cycle | Short technology cycle | Rapid emergence of new technologies | Rapid emergence of new disciplines | Unpredictable technological changes |Fluctuating technology
		C_3 Technology lagging	Backward technology| Backward enterprise |Technology introduction| Technology purchase | Imitation learning | Newbie in the industry | New entrant | Weak foundation | Reverse engineering
	Common external problems manufacturing industry is facing	C_4 Complexity of manufacturing	Environmental protection and green manufacturing| Demographic Dividend |Intelligent manufacturing| Digital transformation| Industrial software| Automation | Integration of Informatization and Industrialization | Technical talent | Labor cost |
	Level of market context	C_5 Market demand diversity	Product customization | More product series |Customer commissioning | More customer requests | Demand specialization | Demand personalization |Special device
		C_6 Systematization of market competition	Industry chain competition | Technology System | Group competition | Full industry chain | Full technology chain | Competition system | Network competition
	Level of institutional context	C_7 Formal Institutional opportunity guidance	National policy | Tax preferences | Financial support | Key projects | Special planning| Government subsidy | Fund support| National procurement| Government certification
		C_8 Informal institutional pressure drive	Leader inspection | Leader care | Leader matchmaking| Government model projects | Government-enterprise relationship | Potential rule | Political capital | NPC member
Motivation of internal ecology context	Attention level of entrepreneurs and executives	C_9 Internal entrepreneurial attention	Internal resources of enterprises| Enterprise talent | Level of enterprise technology | Financial strength | Production efficiency | Quality of staff | Profit margin | Internal management
		C_{10} External entrepreneurial attention	Latest development of new technology | Market share of enterprises | National policy trends | Technology talent | Industry position of enterprises | Customer demands | Competitive environment| Change of government leaders
	Cognition level of entrepreneur and executives	C_{11} Economic cognition	Reduction of operational cost | Increasement of corporate profitability | Reduction of R&D expenditure | Increasement of new products | Increasement of turnover
		C_{12} Non-economic cognition	Technology standard | Discourse power of industry | Sustained competitive advantage | Complementation of resources | Mutual benefit
	Spirit level of entrepreneurs and executives	C_{13} Challenge consciousness	Advance against hardship| Challenge industry overlords | Face the competition | Ambitious goal | National industry | Becoming an industry leader | Not afraid of hardships
		C_{14} Innovative mind	New technology | New methods | Development of new products | Pay great attention to R&D | Exploring new models | Adaptive adjustment | Flexibility | Product innovation | Organization innovation
		C_{15} Risk-taking awareness	Seeking wealth in risks | coexisting of risk and benefit | Risk means opportunity | Taking risks
	Change level in internal manufacturing capabilities of enterprises	C_{16} Evaluation of Enterprise Manufacturing Capability	Quick response of mold| Injection molding| Modularization of production unit| Assembly link| Process link| Automation| Lean production| Informatization | Industrial platform |Design ability |OPM| Application scenarios of products|
	Relationship level of entrepreneurs and executives	C_{17} cooperation situation of entrepreneurs and executives	Entrepreneur's Personal Charm | Enterprise Platform Attraction | Enterprise Institutional Pressure | Enterprise Development Potential | Enterprise Development Dividend Sharing |

(2) This dissertation analyzes some experiences 3nod has ever experienced ,namely based on the external macro innovation environment, with brand owners and consumers as the source of innovation, based on the powerful internal design innovation center, 3nod group and Internet company T jointly established the open innovation platform of Coral Group to gather technology and creative resources, Coupled with creative cooperation with different types and scales of partners to establish a technological innovation ecosystem; at the same time, under the non-technical innovation support system, which takes strategic innovation as the blueprint, cultural innovation as the guide, management innovation as the foundation, organizational innovation as the guarantee, and institutional innovation as the driving force, 3nod group, together with Internet company T, have jointly constructed the whole process of the innovation ecosystem of 3nod. On this basis, the main conclusions of this study are as follows:

According to the structure of 3nod's innovation ecosystem, we conclude that the manufacturing innovation system is generally composed of three parts: the enterprise's core technical ability support system, the non-technical support system, and the external living environment. The core of which is the induction and summary of the core technical ability system in the red dashed circle. Of course, the number of core competency modules within each manufacturing industry and manufacturing enterprise varies. For example, 3nod has five innovation modules, and other companies may have three or more. To establish the innovation logic of the core technical ability sector, the non-technical support abilities such as enterprise strategy need to be adjusted and adapted. The focus of attention at different stages is different, so that the enterprise's own

innovation ecosystem can be better integrated into the external living environment. In this way, enterprises have the possibility of sustainable development. See Figure 7.1 for details.

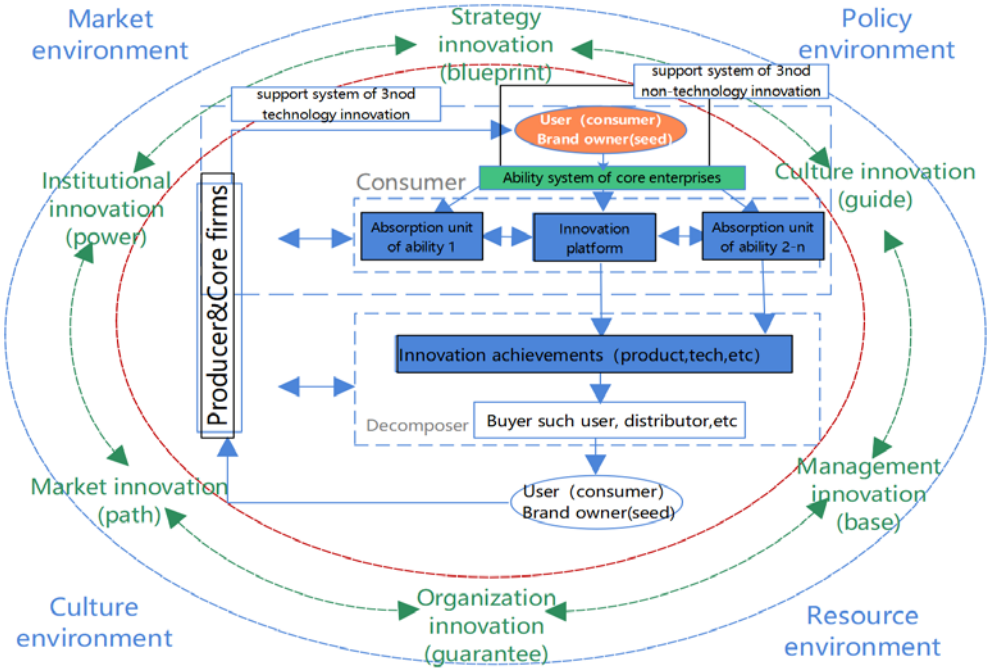


Figure 7.1 Framework Model of Enterprise Innovation Ecosystem from the Perspective of Core firm

Limitations and Outlook of the research：

The limitations and outlook of this research are mainly reflected in the following three points:

(1) Based on an exploratory single case research, this dissertation only takes 3nod Group as a case to discuss the mechanism of consumer electronics companies constructing an enterprise innovation ecosystem, and it is based on the micro perspective of the internal innovation management elements of the enterprise. Therefore, there are certain limitations in the perspective and methods of the research, and there is also no complete and in-depth analysis of the structure of the enterprise innovation ecosystem, the role of members in

system, and the operating mechanism of the enterprise innovation ecosystem based on the overall perspective of the enterprise.

(2) The multiple nested sub-research objects selected in this dissertation are the five ecological units under the OPM model, which is launched by 3nod and 3nod has been proud of in recent years. When we regard the five ecological units as the main starting points, they has certain limitations in the number of research objects, which have a certain impact on the scientificity and rigor of the research conclusions; at the same time, there are some common attributes of manufacturing companies in the five ecological units and there are some personalized attributes of 3nod in them, which causes a certain deviation in the integrity of data collection and has a certain impact on the reliability and generality of research conclusions.

(3) In the future, we will carry out research on core firm operation functions and system governance as evaluating the healthy operation of enterprise innovation ecosystem, further summarize the influencing factors and key points of healthy operation of core firms in enterprise innovation ecosystem, and provide reference suggestions for innovation enterprises to build and run enterprise innovation ecosystems from the perspective of theory and practice. Specific evaluation indicators include: evaluating system components based on indicators such as diversity and difference; evaluating the system’s operational functions based on driving the growth rate of new ventures and systematic creativity; evaluating systems governance based on technology dependence and technology integration of core firms and other issues.

Appendix

Number of Questionnaire：

Appendix A Special Questionnaire of 3nod Group Enterprise

Innovation

Signature of interviewee: _____
Position：
Tel.：
Date of Interview：
How long have you worked in 3nod ？
（1）1-3years （2）3-5years （3）5-10years（4）more than 10years
Your current position in 3nod?
（1） Chairman （2）Vice president （3）General Manager （3）Head of department （4）Head of Finance （5）Head of HR

一、The basic situation of enterprise innovation

1、What do you think of 3nod's current emphasis on innovation ecology?
(Please mark "√" on the option you think is appropriate, the same below)
（1）Very important（2）Relatively important（3）Normal （4）Not important （5）Very little

2、What do you think is the starting point of 3nod to build an innovation ecosystem? (Multiple choice**)**
(1) Design ability (2) Manufacturing capability (3) Technical ability (4) Definition Scenario ecological product (5) Industrial Internet

3、At present, what is the main ways of 3nod market competition? (Select up to 5 items**)**
（1）Scale up
（2）Low price
（3）High quality
（4）Innovation products/new technology
（5）Unique design
（6）Adapt to customer needs
（7）Fast delivery
（8）High-quality customer service
（9）Brand
（10）Others（Please specify）：

4、In the next few years, what are the main ways for 3nod to improve its competitiveness? (Select up to 5 items**)**

（1）	Reduce costs		factories/equipment
（2）	Brand development	（8）	Improve relationship with suppliers/customers
（3）	Improve the original products	（9）	Create brand-new products and services and bring them to the market
（4）	Strategic merger/acquisition		
（5）	Looking for investors/Financing/Issuing new shares	（10）	Attract and train talents
		（11）	Use of external services/consulting, etc.
（6）	Establish and promote an innovation culture	（12）	Others (please specify):
（7）	Invest in the construction of new		

5、What is the distribution of 3nod's income sources among the following businesses in the past three years (comparison between current and two years

later)?

	2018	2019	2020
The enterprise's existing traditional products/services	%	%	%
Extension or improvement of existing products/services	%	%	%
Breakthrough products/services (products or services with significant changes in performance or newly-emerging products or services)	%	%	%
"Disruptive" products/services (changing the business model of the industry or creating a completely new market)	%	%	%
	100 %		100 %

6、3nod's allocation of R&D fund sources, please list the proportions of each item.

Sources of funds	Proportion
(1) Internal raising	%
(2) Government funds	%
(3) Loan	%
(4) Capital market	%
(5) Domestic partners	%
(6) Foreign partners	%
(7) Others (please specify):	%
	100 %

7、Which areas of the following is 3nod's investment in scientific research is mainly concentrated in ?

(1) Basic research (R&D projects that will not be commercialized within at least three years)	%
(2) completely new products/R&D of processes (estimated to be commercialized within three years)	%
(3) R & D for the purpose of expanding product use, improving existing technology/process.	%
(4) Improving the process to increase efficiency and reduce costs	%
(5) Others (please specify):	%
	100 %

8、What are the main methods of 3nod's innovation activities? (Select up to 5 items)

（1） Centralized R&D in the enterprise R&D center

（2） Decentralized R&D in various production departments within the enterprise

（3） R&D in branch companies of the same enterprise group

（4） Cooperation with research institutes/universities

（5） Cooperation with research institutions of government

（6） Cooperation with international research institutions

（7） Cooperation with commercialized laboratories/ R&D institutions

（8） Cooperation with related companies such as equipment suppliers

（9） Cooperate with customers or clients

（10） Cooperation with competitors

（11） Cooperation with joint venture partners

（12） Hiring consulting experts

（13） Purchase of patents

（14） Mergers and acquisitions

（15） Others (please specify):

9、How are 3nod's innovation achievements (here mainly refers to completely new products) promoted in the market? (Only choose 1 item)

（1） Existing business departments

（2） Department responsible for new business

（3） Establishing a new business department or marketing agency

（4） Existing marketing channels

（5） Adopting different methods according to different innovation products

（6） The company does not have such innovative products

（7） Others(please specify)：

10、Compared with the following competitors, what are the competitive advantages of 3nod's products and services? (Only choose 1 item per row**)**

	Have a more competitive advantage	Equal competitiveness	Very difficult to compete with it	Very difficult to compare
Large state-owned enterprise				
Private enterprise				
Foreign enterprises				
The world's leading enterprises				

11、Which of the following options do you think can be used as an evaluation criterion for innovation? (Up to 5 items can be selected**)**

（1） Proportion of sales of new products or services

（2） Number of technological process improvements

（3） The degree of improvement in price competitiveness brought about by innovation

（4） The ratio of innovation returns to innovation input

（5） Number of patents or other intellectual property applications

（6） Market share changes caused by innovation

（7） improvement of production or service capacity brought about by innovation

（8） Success rate of new products

（9） The degree of social reward or recognition on enterprise innovation

（10） The degree of improvement in profitability brought about by innovation

（11） the improvement of brand awareness brought about by Innovation

（12） Number of employees' opinions on participation in innovation were adopted

（13） Others (please specify):

12、What are the main innovation effects of the innovation activities carried out in the past three years for 3nod? (Up to 5 items can be selected**)**

（1）Improve the company's "innovation" image
（2）Easier to obtain financial support
（3）Innovation has a positive impact on stock prices
（4）The scope of goods or services is expanded
（5）Open up new markets or increase market share
（6）Improve the quality of goods or services
（7）Improve the flexibility of production
（8）Reduce labor cost per unit
（9）Improve production capacity
（10）Reduced raw material/energy consumption per unit
（11）Get improved in environment, safety, etc.
（12）Get Improved in terms of norms and standards

13、In your opinion, what are the main obstacles that 3nod has in innovation? (Only choose 1 item per row**)**

	Not obstacle	Minor obstacle	Major obstacle
(1) Short-term actions of investors/stock market/superior departments			
(2) Difficulties in financing			
(3) Higher economic risk			
(4) Too many /too strong competitors			
(5) Government's restriction/control on price			
(6) Government's restrictions on business scope			
(7) Government's approval procedures are too complicated			

(8) Government procurement policy			
(9) Local protection, ownership discrimination, etc.			
(10) Unreasonable industry rules or standards			
(11) The local government is not efficient			
(12) The enterprise's location lacks a good innovation environment			
(13) Lack of intellectual property protection			
(14) Worried about leaking industry secrets by the approval department			
(15) The industry and market are dominated by large companies			
(16) Corporate culture resists innovation ideas			
(17) It is difficult to obtain technical and market information			
(18) Shortage of management talents			
(19) Shortage of technical talents			
(20) Lack of contact with research institutions			
(21) Lack of recognition and incentives for innovation			
(22) Difficult to enter new markets			
(23) Difficult to find a suitable partner			
(24) Others (please specify):			

14、3nod's experience and plans in innovation management. (Please mark "√" on the options that you think are in line with the actual situation of your company, where 5 represents completely compliant and 1 represents completely non-compliant. The larger the number of choices, the more you agree with this statement.**)**

		completely compliant……completely non-compliant
1	Incorporating innovation concepts in corporate purpose or philosophy	1 2 3 4 5
2	The company's annual report has special reports and plans on innovation	1 2 3 4 5
3	The company's innovation behavior is often seen in corporate internal communications, websites or newspapers	1 2 3 4 5
4	The company regularly holds innovation conferences to select the best innovative employees (teams)	1 2 3 4 5
5	The company has formulated an innovative vision plan and is constantly improving	1 2 3 4 5
6	The top management of the company has set up a dedicated person to be responsible for the formulation and implementation of the technical strategy	1 2 3 4 5
7	Technology strategy has a great effect on improving the core competitiveness of enterprises	1 2 3 4 5
8	The short-term technology strategy matches the long-term technology strategy to a high degree	1 2 3 4 5
9	Reform the company's organization and market-oriented promotion of innovative results	1 2 3 4 5
10	Regular coordination and contact between the R&D department and the marketing department	1 2 3 4 5
11	The matching degree between R&D projects and specific production capacity is very high	1 2 3 4 5
12	Establishing technology research and development centers in important cities at home and abroad	1 2 3 4 5
13	Establishing a good information technology communication platform with external innovation institutions	1 2 3 4 5
14	The department responsible for innovation is satisfied with the personnel treatment and reward system	1 2 3 4 5
15	The company encourages new ideas, new thoughts, and encourages the creation of new businesses	1 2 3 4 5
16	All employees of the company understand the value of innovation and actively participate in various innovations	1 2 3 4 5
17	In order to encourage innovation, allow employees to study and research off-duty	1 2 3 4 5
18	Company culture can tolerate failure	1 2 3 4 5
19	Innovators can freely put forward and elaborate their opinions	1 2 3 4 5
20	Recommendations for high rewards for success, and institutionalized	1 2 3 4 5
21	Technical file management has a high update speed and high degree of network	1 2 3 4 5
22	R&D personnel use the company's technical files to a high degree	1 2 3 4 5
23	The company regularly reviews its intellectual property rights	1 2 3 4 5
24	The level and utilization of product development equipment is very high	1 2 3 4 5

25	Talent training is very strong	1 2 3 4 5
26	The level of informatization of the innovation process is very high	1 2 3 4 5
27	The marketing department has strong market forecasting ability	1 2 3 4 5
28	Distributors and end users are highly satisfied	1 2 3 4 5
29	The technical level of the customer service staff is very high	1 2 3 4 5
30	Attaches great importance to the construction of sales channels	1 2 3 4 5
31	Very focused on key customers	1 2 3 4 5
32	Attaches great importance to the company's brand building	1 2 3 4 5

15、How about the achievement of 3nod's innovation goals in the past three years?(Only choose 1 item**)**

（1）	Exceeding expectations	（3）	Basically achieved the goal	（5）	The goal was not achieved
（2）	Achieved the expected goal	（4）	Partially achieved goals		at all

16、How do you evaluate the innovation environment in the city where 3nod is located? (Each row is limited to 1 item chosen, among which, 5 means very high evaluation, 1 means very low evaluation**)**

	The innovation environment of the city where the company is located	Your evaluation Very low evaluation……very high
1	The support of relevant policies to enterprise innovation	1 2 3 4 5
2	Urban 11th Five-Year Development Plan and Contents Related to Independent Innovation	1 2 3 4 5
3	Establishment of Productivity Promotion Center	1 2 3 4 5
4	Incubation conditions of Technology business	1 2 3 4 5
5	Science and Technology Consulting and Evaluation Agency	1 2 3 4 5
6	Development level of Technology market	1 2 3 4 5
7	Service Agency of Science and Technology Information	1 2 3 4 5
8	Service Agency of Entrepreneurship	1 2 3 4 5
9	Technological talent agency	1 2 3 4 5
10	Quantity and quality of local scientific and technological talents	1 2 3 4 5
11	Conditions for cities to attract and retain talent	1 2 3 4 5
12	The degree of development of the online talent market	1 2 3 4 5
13	The degree of development of the online technology market	1 2 3 4 5
14	Venture Capital Institution of Technology	1 2 3 4 5
15	Technology Investment and Guarantee Agency	1 2 3 4 5
16	Computer network penetration	1 2 3 4 5
17	Popularity of e-government system	1 2 3 4 5

17、Assuming that 3nod chooses a city to build a new innovation center, which of the following factors do you value most? (Up to 5 items can be selected)

（1）	Developed telecommunications industry	（9）	Loose regulatory environment
（2）	Abundant suppliers	（10）	High quality of life
（3）	Sufficient corporate managers	（11）	Have a professional technical service company
（4）	Sufficient technology and engineering talents	（12）	Convenient financial services
（5）	Professional business service company	（13）	Numerous universities and other research institutions
（6）	Developed logistics		
（7）	Sufficient customers	（14）	Others (please specify)
（8）	The government has high efficiency		

二、**Related data of 3nod technology innovation (**it can be filled in by relevant personnel of the enterprise**)**

No.	The meaning of the indicator	The year of 2018	The year of 2019	The year of 2020
1	Total product sales (ten thousand yuan)			
2	Total profit (ten thousand yuan)			
3	Investment in scientific and technological activities (ten thousand yuan)			
4	Investment in technology development (ten thousand yuan)			
5	Investment in industry-university-research cooperation (ten thousand yuan)			
6	Total number of employees			
7	Number of personnel in R&D department			
8	Number of senior technical experts (including doctors)			
9	The total value of scientific research fixed assets owned by R&D institutions (ten thousand yuan)			
10	Number of R&D institutions with complete functions and standardized management			
11	Number of technical centers with provincial level and above			
12	Total salary of all employees (ten thousand yuan)			
13	Total salary of R&D staff (ten thousand yuan)			
14	Number of domestic and overseas experts who come to the company to engage in development work (person/year)			
15	Number of development projects completed by development institutions co-organized with universities and research institutes			
16	Total sales of newly developed products (ten thousand yuan)			
17	Total profit of newly developed products (ten thousand yuan)			
18	Total number of newly developed products			
19	The total number of newly developed products obtaining national green qualification & certification			
20	Number of invention patent applications			
21	Number of invention patents approved			
22	Number of utility model patents approved			
23	Number of appearance design patents approved			
24	The total number of well-known trademarks in China and well-known trademarks and products and famous-brand products at or above the provincial level			
25	Number of national awards			
26	Number of provincial (ministerial) level awards			
27	The total number of R&D and participation in the formulation of international technical standards			
28	The total number of research and development and participation in the formulation of national technical standards			
29	The total number of research and development and participation in the formulation of industrial technical standards			
30	Number of scientific papers published			

Appendix B Interview Survey Outline Of 3nod Innovation Ecosystem Construction

Strategic Issues of Innovative Ecology：

1.How is it defined for the internal & external conditions and the evolution 3nod's current ecological innovation system? What are the shortcomings of the

current stage of ecological innovation? What is the relative certainty of future evolution?

2.Where does 3nod's core capabilities accumulated over the years come from in dealing with the challenges of market changes? Does 3nod's innovation ecosystem revolve around the basic capabilities of the company? (Design, manufacture)

3. Which stages are mainly involved in 3nod's industrial design? (ID, UI, PI, UE, are there other distributions), what is the underlying logic of the selection?

4. In the intelligent era, how does 3nod understand hardware development? In addition to focusing on the field of voice artificial intelligence and voice + products, are there any new directions of attention?

5. For 3nod, how to balance the contradictions between building brand for large customers and building its own brands? What are the upgrade thrusts between product brands, consumer brands, value brands and lifestyle brands?

6. 3nod innovation ecosystem, in which ecological-level capabilities, ecological-level products (which can carry ecological value and have a product form that amplifies the overall ecological value), ecological-level alliances (breaking the symbiosis & cooperation alliance of funds, talents, labor and other elements formed by the boundaries of 3nod , this is the fundamentals of the development of ecological communities), ecological-level members (creating eco-level links with value increments, and forming new internal and external corporate communities with user operations as the core), ecological-level mergers and

acquisitions (centering on ecological construction, implementing strategic integration and incubation of ecological demand elements), ecological-level services (forming the unique product competitiveness through special provision of services which run throughout the ecology), ecological-level entrance (building the business model that is from the internal and external communities of the enterprise to the entrance of 3nod’s business core)How is it currently defined?

7. 3nod carries out a two-wheel drive innovation of technology and design. What are the management processes and risk control methods for determining and identifying the technical units that will match 3nod's development in the future, and the maturity of technology conversion products? What specific difficulties and challenges will this process encounter in actual operation?

8. How does the product strategy(meeting large customers to obtain development dividends, product line expansion, and consolidating core competitiveness), digital strategy(forming a digital management system, establishing connection with consumers through a digital platform , tracking and analyzing data, and supporting strategic decision-making, increasing investment in big data and other fields), and ecological strategy(expanding the fundamentals through mergers & acquisitions and integration, integration and expansion of the supply chain ecology, and the shaping of ecological win-win values)of 3nod's innovation ecosystem link up?

9. How is the process (from expenditure to value acquisition of the nutrients provided by the 3nod innovation ecosystem) managed and controlled scientifically? What are the current difficulties in actual operation?

10. How does 3nod assess the future spillover effects of its own innovation ecosystem? What are the main aspects involved in this spillover chain? (This process of absorption & throughput), how to calculate the fault tolerance rate? How is the cost boundary of 3nod affordable to build an innovation ecosystem defined in the process of finance and investment?

11. Facing the future of the digital economy, in which areas does 3nod have room for expansion? In the field of digital economy (except for the upgrading and development of original business), industrial Internet and data value, does 3nod have clear and detailed ideas?

12. What are the basic capability units of 3nod's current innovation ecosystem? Which capability unit is relatively weak? How is it strengthened? How are the ecological links between major business directions defined?

13. What is the investment logic built in 3nod around the innovation ecosystem? (What is the balance method between the ability of the investment company to develop and match in the future and obtaining commercial value) What is the current investment effect? What are the corresponding management process and judgment basis?

14. As the initiator or convener of the ecosystem, what are the high-premium products and services provided by 3nod (resource swap)? How is it realized that

ecosystem members are integrated together to create value increment? What is the attractiveness of symbiosis with ecological partners?

15. What is the direction and path of the evolution of 3nod's innovation ecosystem in the next three to five years? What are the internal and external conditions that it depends on?

16. Are there any conflicts between the corresponding responsible departments and actual work content in the 3nod innovation ecosystem? Which department plays the internal coordination mechanism and promoter in the process of building an ecosystem?

17. For establishing the Shenzhen Industrial Design Association, and cooperating with Hong Kong, South Korea, and Nordic design companies, what core problems will these activities mainly solve? and what are the core values obtained?

Interview Questions of Coral Group Accelerator

1. What are the main parts of 3nod Innovation System? In addition to industrial design, coral group and OPM, what other parts are involved?
2. What is the definition of innovation accelerator niche of the coral group? What is its core function? What is the focus?
3. What is the relationship between the coral group and the industrial design sector? (Competition, complementarity, symbiosis) please specify.
4. What are the specific effects of 3nod's layout in entrepreneurship and innovation (alliance, finance, college, space and practice center) on the company's own innovation? What direction does 3nod's investment focus point to? In the B2S model, which aspects are 3nod’s focus on the value of the start-up team mainly

reflected, whether it focuses on making up or extending the core capabilities of the company, or focusing on obtaining investment value?

5. 3nod Supply Chain Platform (Haohanbang) is called design supply chain. What are the functional architectures? Which specific industries are involved in the resources obtained owing to cross- border? What specific support is provided? How is it different from the traditional supply chain?

6. What are the challenges 3nod Intelligent Manufacturing Platform is facing? What is the internal process flow of 3nod Manufacturing? What is the specific path to realize smart manufacturing by using the Industrial Internet in the future?

7. At what stage is the manufacturing level of the 3nod's Songgang and Beihai factories at present, and what are the specific improvements by using the Industrial Internet in the future?

8. What are the strengths and weaknesses of 3nod in terms of talents? Which links of the ecological innovation system does the talent ratio focus on?

Public issues:

1. How are the internal and external conditions defined for the evolution of 3nod's current ecological innovation system? What are the shortcomings of the current stage of ecological innovation? What is the relative certainty of future evolution?

2. Where does 3nod's core competence accumulated over the years come from in dealing with the challenges of market changes? Does 3nod's innovation ecosystem revolve around the basic abilities of the company? (Design, manufacturing)

3. What are the main parts of the 3nod innovation ecosystem? At present, besides industrial design, coral group and OPM, other parts are involved? What is the relationship between them?

4. What are the basic abilities of 3nod's innovative ecological construction? What is the relationship between them?

Industrial Design Section:

1. What are the main sections involved in 3nod's industrial design? (besides ID, UI, PI, UE, are there other distributions), what is the underlying logic of the selection? What are the specific technologies involved in industrial design?

2. What is the entire ecological construction process of 3nod Industrial Design from the beginning to the present? Is there a clear construction path, or is it adjusted according to random reactions to market changes?

3. What is the current status of industrial Internet design platforms? What is the relationship between the establishment of the Industrial Design Association and 3nod itself (mainly referring to what 3nod can absorb from the Industrial Design Association, or what resources the Industrial Design Association can export to 3nod?), and what is the cooperation model between the Industrial Design Association and 3nod? Are there any particularly typical cases (1-3 cases).

4. Who are the external partners of 3nod Industrial Design? (Design companies, universities, industrial associations), how are these partners chosen? What are the relevant standards for choosing them?

5. What is the original intention for 3nod to hold the industrial design competition, and what is the core gain after years of insisting on it? Are there any new trends in industrial design under new technological conditions? (For example, whether there are new technologies (3D), new materials, new design software, etc.)

6. What is the position and role of industrial design in 3nod's innovation ecology? What is the transmission relationship with OPM, how to grasp the

consumer-oriented design in the industrial design process, and what are the main methods? What role does the industrial Internet design platform play in it?

7. What are the advantages and limitations of industrial design hardware development under the conditions of the Internet of Things? Which elements of the upstream and downstream of industrial design need to be paid attention to?

8. 3nod does not build its own brand, and its core abilities of industrial design are mainly invested in brand manufacturers and entrepreneurial teams. Therefore, how 3nod will show its abilities in application scenarios such as smart life, voice+, and smart home in the future? Is 3nod willing to stay behind the scenes or go to the foreground in these scenes? Can it be understood that 3nod's industrial design ability is to horizontally expand 3nod's market scope in the hardware field, without going beyond the limits of its own OPM model?

9. In the era of intelligence, how does 3nod understand hardware development? In addition to focusing on the field of voice AI and voice + products, are there any new directions for attention?

10. What is the relationship between Maxypro Design and Coral group & the industrial design sector? Which are the design companies acquired externally? For what purpose?

11. After establishing the Shenzhen Industrial Design Association and cooperating with Hong Kong, South Korea, and Nordic design companies, What core problems are mainly solved, and what are the core values obtained?

Coral Group：

1. What is the definition of the niche of the coral colony innovation accelerator? What is its core function? What is the focus?

2. What is the relationship between the coral group and the industrial design sector? (Competition, complementarity, symbiosis) please specify.

3. What are the specific effects of 3nod's layout (alliance, finance, academy, space and practice center) in entrepreneurship and innovation

on its own innovation? Which fields are 3nod's investment focus? In the B2S model, what are the main aspects of 3nod's value focuses on start-up teams, whether it focuses on making up or extending the core abilities of the enterprise, or focusing on obtaining investment value?

Supply chain and manufacturing sector:

1. 3nod supply chain platform (Haohanbang) relates to the supply chain, and what are its functional architectures? Which specific industries are involved in the cross-border resources obtained? What specific support can it provide? What differences does it have from the traditional supply chains?

2. What are the challenges the 3nod Intelligent Manufacturing Platform is facing? What is the internal technical process of 3nod Manufacturing? Taking the specific implementation and development cases as examples, what is the specific path for using the Industrial Internet to realize smart manufacturing in the future?

3. At what stage is the manufacturing level of the 3nod's Songgang and Beihai factories currently, and what are the specific improvements in its factories after using the industrial Internet in the future?

4. What are the current pain points in manufacturing? How is the status quo of warehousing and supply chain?

5. What is the current level of informatization in the manufacturing sector? What type of equipment is mainly used?

Talent sector:

1. What are the advantages and shortcomings of 3nod in terms of talents? What is the distribution of talents in the ecological innovation system?

Appendix C Question List of Focus Issues Discussion

1. What is the motivation of 3nod's innovation ecosystem?

2. How to establish the ecological axis of the 3nod innovation ecosystem? How to define and describe the core ability that 3nod has formed over the years?

3. How to define the role and function of Coral Group innovation platform in the construction process of the 3nod innovation system?

4. How to define and evaluate the role of 3nod's innovation ecology units and the elements of absorption innovation?

5. How to evaluate the maturity of 3nod's technology and innovation ecosystem?

6. What is the evolution trend of 3nod's existing innovation ecosystem, and what are the basic conditions and resources based on it?

7. Does the OPM model conform to future technology and market changes? Can the industrial Internet of OPM model be realized?

8. How to define the strategy and implementation steps of 3nod's digital transformation? What preparations should be made at the current stage, and from which aspects should we focus on the layout?

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