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Country Study: China

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Cambridge Industrial Innovation Policy

Contents

Introduction 3
Organisations 7
Processes 11
Content 15
Good Practices 18
References 32

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Introduction

For more than half a century, many countries in the world have been searching for different paths to industrialization and modernization from their own starting points. Some countries mainly rely on their own rich natural resources to increase national wealth, such as Middle Eastern oil producing countries; some countries mainly rely on the capital, market and technology from developed countries, such as some Latin American countries and Southeast Asian countries; and some countries take technological innovation as the most important engine, and given first priority as the basic strategy, continuously advancing their technological innovation ability and as an increasingly strong competitive advantage. While China is rising from a less developed nation, then the biggest developing country, and up to now, the biggest manufacturer and second largest economy in the changing world.

By 2022, China has successfully become a so-called “innovative country”. As an innovative country, it should have the following four characteristics:

(1) high innovation inputs, R&D (research and development) expenditure usually accounts for more than 2% of GDP. China’s has now reached 2.44% in 2021.
(2) the contribution rate of technology progress is above 70%; China is about 70% in 2022.
(3) strong independent innovation ability, the foreign technology dependence index of the country is usually below 30%. China is about 50% in 2022.
(4) high innovation output, a highly efficient national innovation system is the main distinguishing mark between innovative countries and non-innovative countries. China’s invention patent granted 798,000 items in 2022.

People often use related innovation inputs and outputs to measure the innovation level of a country. Generally, the innovative comprehensive index of an innovative country is obviously higher than other countries. In the past 50 years, some developed countries have already become innovative countries. There are about 20 countries recognized as innovative countries in the world, such as the United States, Japan, Finland, South Korea, etc. To gain the initiative in the competition, relying on technological innovation to enhance the country's comprehensive national strength and core competitiveness, setting up a national innovation system have become the common choice of many countries in the world. For developing countries, although they are in different historical backgrounds, one thing is certain: innovation is an indispensable part of developing countries in the process of industrialization and modernization. Only by grasping the "first-mover advantage" of innovation can we break out of the traditional development model, transform many development problems, and achieve the goal of rapid development. On the one hand, it is necessary to set scientific targets for improving innovation capacity, increasing R&D investment level and investment efficiency; on the other hand, it is necessary to improve the innovation system, pay attention to the coordination of national innovation policies, construct an environment of active cooperation between enterprises and scientific research institutions, carry out more developmental research projects, and establish more perfect market mechanisms.

According to research, in 2004, China's science and technology innovation capabilities ranked 24th among 49 major countries (accounting for 92% of the world's GDP). In view of specific national conditions and needs, China has proposed that science and technology progress and innovation should be the primary driving force for economic and social development, improving independent

innovation capacity should be the central link to adjust economic structure, transform growth mode and enhance national competitiveness, and constructing an innovative country should be a major strategy towards the future.

In the past ten years, R&D investment in China has increased from 103 billion yuan (USD $15.18 billion) in 2012 to 279 billion yuan (USD $41.12 billion) in 2021, and the intensity of R&D investment has increased from 1.91% to 2.44%; China's ranking in the Global Innovation Index has risen from the 34th in 2012 to the 12th in 2021. China's position and role in the global innovation landscape have changed, and it is not only an important participant in international cutting-edge innovation, but also an important contributor to the solution of global problems.

An initial point of departure for assessing China's industrial innovation policy is to have a look at China's innovation performance. Box 1 captured and summarized several innovation-related indexes.

Box 1. Innovation Related Indexes Comparison

As can be seen in the table, the Chinese economy appears to be among the innovation leaders, and also performs very well in terms of competitiveness but much less so for entrepreneurial activity.

Index	Ranking	Description	Comment on China's Position
Innovation			
EIS – European Innovation Scoreboard (International comparison)	n/a	Index of 19 indicators grouped into 10 innovation dimensions in four groups: framework conditions, investments, innovation activities and impacts	None
GII - Global Innovation Index	11 (of 132)	81 indicators grouped into 21 sub-pillars, 7 pillars (Institutions, Human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology output, and creative outputs)	China continues its ascent toward the top 10, reaching 11th position in 2022. China remains the only middle-income economy within the top 30, keeping its 3rd place within the Southeast Asia, East Asia, and Oceania (SEAO) region and staying in 1st place in the upper middle-income group.

Bloomberg Innovation Index	16 (of 60)	Less compressive and transparent (open) than EIS and GII "analyses dozens of criteria using seven equally weighted metrics, including research and development spending, manufacturing capability and concentration of high-tech public companies."	China ranked high in indicators like high-tech Intensity and R&D Intensity. In particular, China ranks 4th in patent activity.
Competitiveness			
GCI (2019)	28 (of 141)	Global Competitiveness Index 4.0 measures national competitiveness—defined as the set of institutions, policies and factors that determine the level of productivity. The overall GCI 4.0 score is the average of the scores of the 12 pillars. In total, there are 103 indicators distributed across these 12 pillars. CGI 4.0 does not seem to have been updated since 2019.	China ranks 28th overall, unchanged from the previous edition. Its score increased by 1.3 points, driven by a significant boost in ICT adoption (78.5, 18th). China is by far the best performer among the BRICS economies: 15 places ahead of the Russian Federation, 32 places ahead of South Africa and some 40 places ahead of both India (68th) and Brazil (71st). China's strengths obviously include the sheer size of its market (100, 1st, when combining the domestic and export markets) and macroeconomic stability (98.8, 39th). In several areas, China's performance is almost on par with OECD standards.
IDM World Competitiveness index	17 (of 63)	Based on statistics and survey the capacity of countries to create and maintain an environment which sustains the competitiveness of enterprises is ranked based on 255 criteria and categorized into 20 sub-factors and in four main factors: Economic Performance, Government Efficiency, Business Efficiency and Infrastructure	According to the changes of the ranks, China was confronted with a few challenges such as managing the economic and social uncertainty caused by COVID-19 pandemic, achieving socio-economic development goals by using macroeconomic policy mix, expanding domestic demand through effective investment, and boosting consumption, addressing ever growing geopolitical risks and governance crises globally and building unified national market to enhance long-term economic prosperity.

Entrepreneurship			
GET	43	The Global Entrepreneurship Index GEI is an annual index that measures the performance of entrepreneurship ecosystems in 137 countries with measurements grouped in 14 pillars	China performs better (than expected from the ranking) in the dimensions of opportunity perception and startup skills.
GEM	N/A	Survey and expert interview-based research on entrepreneurship and entrepreneurship ecosystems around the world. Among the indicators is TEA - Total early-stage Entrepreneurial Activity	

China has formed a whole process integrated governance mechanism of "policy preliminary research - formulation – Implementation-Supervision - Evaluation - feedback - modification and improvement – exit". In China, the main bodies of industrial policy evaluation are mainly the research institutions of the competent government departments and the special research teams authorized by the government. The policy research institutions set up by the people's congresses, CPPCC, Party committees, and governments at or above the county level also undertake the investigation, research, and filing of social and economic policies and regulations. The industry's participation in the evaluation of industrial policy is still relatively low.

The current governance mechanism brings the following four main contributions to society:

(1) Implement a series of policies and measures to promote the steady growth of the industrial economy, strengthen policy support and promote the implementation of various policies and measures.
(2) Give priority to the protection of basic industrial products and important living materials, and get through the supply blocking points of key products.
(3) Several industrial infrastructure reconstruction projects were launched to boost effective investment in the manufacturing industry.
(4) Implement preferential policies such as reduction and exemption, and take multiple measures to expand consumer demand.

The innovation policies of China and the United States were born in the same era background and have many common points, but the policy contents are different due to the differences in their strategic

positioning, economic stage, and social and humanistic environment. From the distribution of policy concerns and policy measures, the following conclusions are drawn.

First, the main concerns of innovation policies in China and the United States are the same. However, putting aside the similarities, China's dual innovation emphasizes service enterprises and the development of science and technology, while Entrepreneurial America emphasizes government support for research and education.

Second, the distribution of innovation policies among government departments in China and the United States differs significantly, and there are subtle differences in the focus of policy measures. Qualitative data on innovation policies show that the lead department for dual-innovation policies in China is the Development and Reform Commission, while for entrepreneurship in the United States is the Small Business Administration; both countries' policy measures are more inclined to business incubation and add-on policies, but relatively speaking, there are more business incubation policies than add-on policies; in terms of using innovation policies to stimulate innovation activities, the United States focuses more on technology transfer policies than China, and China emphasizes commercial system reform more than the United States.

Organisations

The State Council, constitutionally synonymous with the Central People's Government since 1954 (particularly in relation to local governments), is the chief administrative authority of China. It is chaired by the premier and includes the heads of each of the constituent departments (ministries). Among the ministries, the Ministry of Science and Technology (MOST) and the Ministry of Industry and Information Technology (MIIT) have the close relation with the innovation-driven development of manufacturing. MOST coordinates the development of the national innovation system and the reform of the national S&T management system, and works with relevant government departments to improve incentive mechanisms for technological innovation. MOST endeavors to improve the national R&D system, facilitate the reform and development of research institutes, enhance the innovation capabilities of enterprises, promote military-civilian integration, and develop the consulting system for major national S&T decision-making.

Figure 1 - Chinese Organization Mapping Ministerial Structure

MIIT is a newly established central ministry in the context of China's "ministerial system" reform in 2008. The Ministry of Industry and Information Technology (MIIT) was established following the government reform program of the 11th National People's Congress. The central government integrated the industrial management responsibilities of the National Development and Reform Commission (NDRC), the responsibilities of the National Defense Science and Technology Commission (NDSC) except for nuclear power management, and the responsibilities of the Ministry of Information Industry (MIIT) and the Information Technology Office of the State Council, and transferred them to the Ministry of Industry and Information Technology (MIIT). In addition, the National Defense Science and Technology Industry Bureau was formed and is managed by the Ministry of Industry and Information Technology. In addition, the State Tobacco Monopoly Administration was transferred to the management of the Ministry of Industry and Information Technology. The National Defense Science and Industry Commission, the Ministry of Information Industry, and the Information Office of the State Council are no longer retained.

The science and technology department is a key department of the Ministry of industry and information technology. It organizes the formulation and implementation of plans, policies, and standards related to bio-medicine, new materials, aerospace, and information industry in high-tech industries; Organizes the formulation of industrial technical specifications and standards and guides the quality management of the industry; Organizes and implements the basic technical work of the industry; Organize major industrialization demonstration projects; Organize the implementation of major national science and technology projects, and promote the combination of technological innovation and industry-university research.

The Science and Technology Department has achieved significant results in its work: developing a large number of advanced science and technology, completing major state science and technology projects, promoting integration of production, study and research, and making important contributions to the economic and social development of the state. At the same time, the Science and Technology Department has also carried out various technical innovations, continued to optimize the allocation of scientific and technological resources, and accelerated the promotion of technical upgrading. In the future, the Science and Technology Department will continue to increase the intensity of technology research and development, especially in space technology, intelligent technology and emerging technologies, actively explore new breakthroughs; increase input intensity, deeply implement the demonstration work of production, study and research, enhance innovation ability, and continuously optimize the allocation of science and technology resources; pay more attention to technology management, improve management level, and build a more sound technology management system; Strengthen technical services and promotion, promote the transformation of scientific and technological achievements, and improve the efficiency of science and technology; actively open up international cooperation, promote the export of science and technology to foreign countries, and enhance the international influence of science and technology. In the future, the Science and Technology Department will also implement the spirit of the 19th National Congress of the CPC, carry out the important expositions of General Secretary Xi Jinping on technological innovation, improve and perfect technological standards and norms, enhance industrial innovation capacity, adhere to the scientific development route, and provide more support for the national economic development.

In recent years, to accelerate the implementation of the national innovation-driven development strategy, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, and the National Development and Reform Commission has proposed to build manufacturing innovation centers, technology innovation centers, and industrial innovation centers respectively. The construction of three types of innovation centers will inevitably lead to a new round of agglomeration and integration of China's innovation resources and the formation of a new pattern. The Institute of Industrial Science and Technology of the SEDI think tank analyzes the similarities and differences between the three types of innovation centers from different dimensions and puts forward four thoughts on how to coordinate the construction of the three types of innovation centers and create a collaborative innovation system: improve the top-level design to avoid a new round of innovation resource elements from being repeatedly dispersed; clarify the functional positioning to create an efficient and collaborative innovation system; expand the funding channels to give full play to the leverage of government finance, and strengthen the supervision and evaluation. Explore diversified innovation center evaluation mechanisms.

With the accelerated emergence of a new round of global science and technology and industrial revolution, technological innovation is increasingly showing new characteristics of multi-point burst, interpenetration, and cross-fertilization, and the cross-field integrated collaborative innovation mode is gradually replacing the traditional single-field, single-play model. For example, the Manufacturing Innovation Institute in the United States, the Institute for Innovation in Manufacturing in the United Kingdom, and the Institute for Innovation in Manufacturing in the United States. For example, the Manufacturing Innovation Institute in the United States and the "Catapult Center" in the United Kingdom. In recent years, China has also launched the construction of several new national innovation carriers, such as manufacturing innovation centers, technology innovation centers, industrial

innovation centers, etc. Systematically analyzing the similarities and differences between these three types of new innovation carriers is of great significance to coordinating innovation resources, collaborating innovation forces, and improving the national manufacturing innovation system.

Processes

There are three main sources for determining industrial innovation policy (IIP): the decision-making advisory department within the ministry, departments, and bureaus within the ministry and the public sector. With the consent of the minister, the formulation of policy documents (this is the industrial policy-making procedure initiated by the Ministry) may be officially started, or further reported to the State Council.

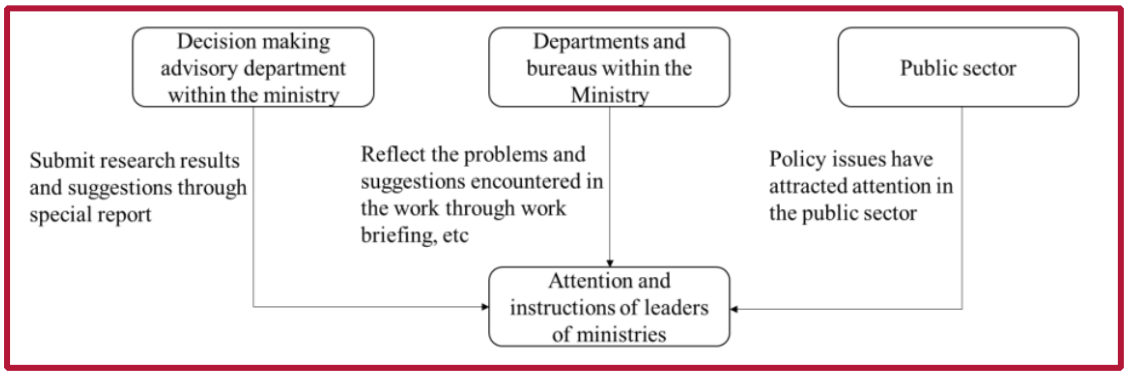

Figure 2 - Chinese industrial innovation policy making process

The rationales for national IIP:

- Innovation should be placed at the core of the overall development of the manufacturing industry
- Take quality as the lifeline of building a manufacturing power
- Take sustainable development as an important focus of building a manufacturing power
- Take structural adjustment as a key link in building a manufacturing power
- Regard talents as the foundation of building a powerful manufacturing country

Objectives: With the theme of promoting the innovative development of the manufacturing industry, the objectives of IIP are to strengthen the basic industrial capacity, improve the comprehensive integration level, and promote industrial transformation and upgrading.

The Ministry of industry and information technology (MIIT) mainly manages the planning, policies, and standards to guide the development of the industry. It plays the role of trade associations and social intermediary organizations. The figure shows different roles concerning academia, companies, and other beneficiaries.

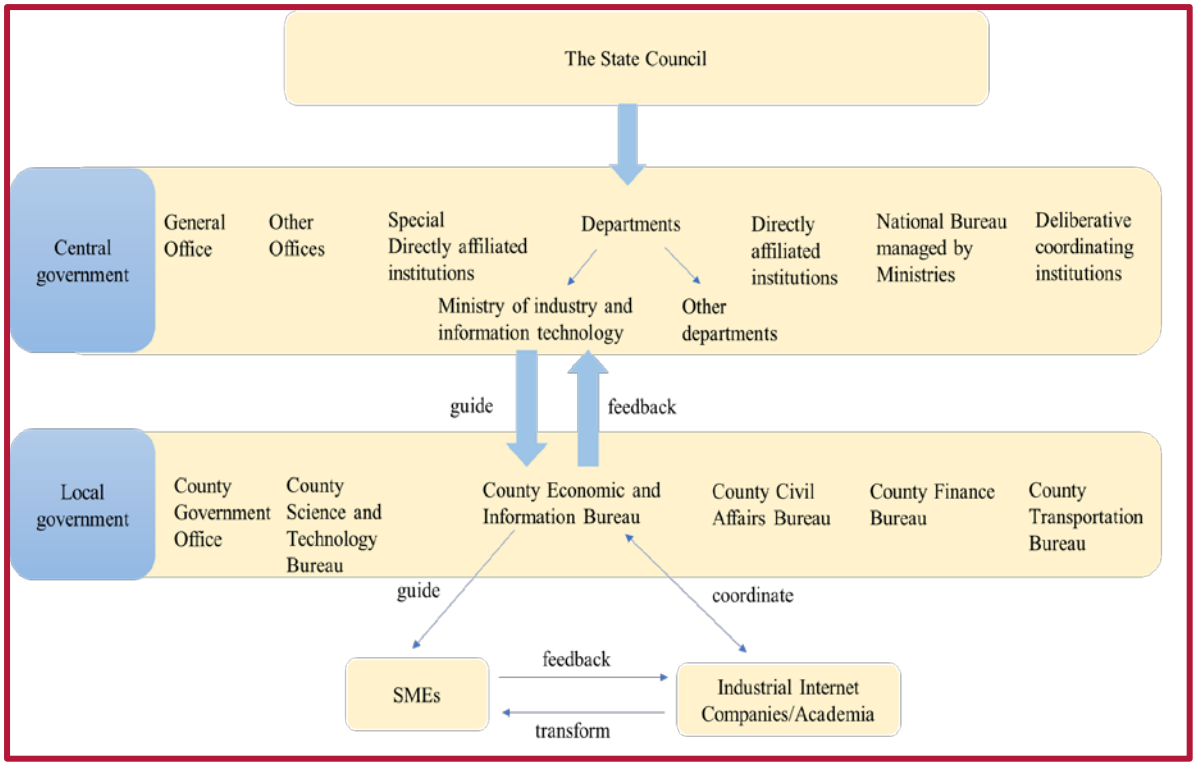

Figure 3 - Organizations supporting Chinese industrial innovation policymaking

Deepen the integration of industry-university-research and build a new model of collaborative innovation development

Developed countries in Europe and the United States as well as leading provinces in China have placed an important position on collaborative innovation between industry, university, and research, promoted the opening and sharing of innovation resources, and accelerated the transfer and transformation of scientific and technological achievements.

First, the innovative "industry-university-research-user" cooperation model. The U.S. government and the three major domestic automakers jointly formed the "Partnership for a New Generation of Vehicles (PNGA) Strategic Alliance". Japan introduced the "Industry-University Joint Research Policy", "Talent Exchange Policy", "Intellectual Property and Technology Transfer Policy", "Policy on Promoting the Development of University Ventures" and other policies to promote the cooperation of industry-university-research and encourage industry-university-research tripartite to join the construction of innovation platforms.
Secondly, it builds a platform for the effective matching of technology supply and demand. Relying on the technology information network covering 27 EU member states and more than 600 cooperative organizations in 22 non-EU countries, the EU has established a service system of "visiting enterprises - identifying technology needs and potentials - finding partners - refining support opinions - helping to sign contracts". -The service system of "helping to sign contracts" has been set up to match the technology supply and demand sides of large enterprises, SMEs, scientific research institutions, universities, and industry associations to conduct technology transactions and technical cooperation globally. Such as Chongqing Liangjiang New Area, by building the "Mingyuehu Ultra-high Precision Additive Materials Research Institute Shared Platform Service", has joined hands with 35 research institutes to collaborate on next-generation precision printing stability issues.

Third, to create an "Internet +" scientific and technological achievements transformation platform. Jiangsu Province has applied the "Internet+" model innovation to the transformation of technology achievements trading, established an online and offline integration of technology property rights trading market, through the collection and release of enterprise technology needs, provide and display patents and technology achievements, built up a huge database of technology achievements, patent information, technology needs, etc., effectively promoting The technology achievements are matched with the needs of enterprises.

Strengthen the combination of science and technology finance and increase the platform policy support

Financial investment is an important guarantee to promote the construction of an innovation platform, and high-intensity capital investment can support a high level of innovation and high return income. Firstly, the government should take the lead in setting up innovation guidance funds. The European Union has implemented the "Horizon 2020" strategy to increase the proportion of R&D expenditure to 3% of GDP to ensure the daily operation of the platform and the construction of information and communication infrastructure. The Japanese government has set up a special regulation fee to support the construction of innovation platform infrastructure.

Beijing Zhongguancun is the first in China to implement a proof-of-concept support program, in which the government and enterprises jointly fund a joint fund or project start-up pool to support the development of regional proof-of-concept projects and the formation of proof-of-concept centers at universities and institutes to precisely match basic research results, marketable achievements and technology demand subjects.

Second, market-led venture capital for science and innovation. Silicon Valley, the center of venture capital activities in the United States, has gathered more than 200 venture capital companies to provide full life-cycle financial products and services for high-tech SMEs in innovation platforms.

Third, improve the comprehensive service system of science and technology finance. Wuhan City in Hubei Province has taken the lead in exploring the reform and innovation of science and technology finance in the areas of equity incentive, pledge loans for intellectual property rights, and pilot investment and loan linkage for science and innovation enterprises, establishing "six special mechanisms" for institution establishment, operation mechanism, financial products, information platform, direct financing, and financial supervision, and building a comprehensive credit service and The platform of government, bank and enterprise communication and cooperation has formed the "East Lake model" of comprehensive financial services for the whole life cycle of science and technology enterprises.

Continuously deepen reform and innovation, optimize the platform operating system and mechanism

By improving the system guarantee system and coordinating the construction of software and hardware infrastructure of the innovation platform, we can effectively promote the healthy and

efficient operation of the innovation platform, stimulate innovation vitality and enhance innovation momentum.

First, the innovative platform operation and management mode. The Jiangsu Industrial Technology Research Institute (JITRI) has been attracting qualified R&D institutions to join it in the form of a membership system, exploring the diversified mode of "multi-party construction, diversified investment, mixed ownership and team-based" to carry out R&D of industry-related technologies or transfer of secondary development results. The central enterprise's blockchain cooperation and innovation platform adopts the way of member cooperation and is jointly initiated by NNEC and more than 20 central enterprises, relying on the resource advantages and strong influence of central enterprises, with the key construction content of carrying out collaborative research on blockchain core technology, building blockchain industry standard system and exploring blockchain application technology guidance and specification to accelerate the process of blockchain industrialization and scale up.

Second, the innovation of science and technology project organization mode. Hubei Province follows the market-oriented principles of the deployment of advantageous innovation resources, for the key core technologies that limit industrial development, to explore the implementation of the "scientific research unveiling system" to guide domestic and foreign enterprises and universities, and research institutions to participate in research and development, to promote the effective docking of the upstream and downstream links of the industrial chain. Wuhan City set up the Wuhan Institute of Industrial Innovation and Development, through the implementation of the "project management system", "unveiling the list hanging system" and "investment package system", to explore new mechanisms for the integration of talent, technology, and capital To promote the transformation of scientific and technological achievements into real productivity.

Third, innovative talent attraction and evaluation system. Qingdao City, Shandong insists on "use-oriented", introduces academicians and academician projects from all over the world flexibly by building an international academician port, and builds a high-end science and technology innovation and industrialization platform featuring academicians under the layout mode of "Science City + Industry City". Jiangsu Province through the selection of a science and technology mayoral group, industrial professors, vice president of science and technology, and other forms, to promote the two-way exchange of high-level talents in schools, universities, and enterprises, such as postings, so that talent into the main battlefield of economic and social development.

Fourth, improve the innovation platform assessment and evaluation mechanism. With the help of the "1+4+N" innovation system, Weihai City of Shandong coordinated the construction of the city's innovation platform, and took the lead in the province in implementing the innovation platform scoring and rating mechanism to assess the performance of the city's innovation platforms incorporated into "4" and "N The "4" and "N" innovation platforms are subject to performance assessment and dynamic management, and are rated and rewarded according to the assessment results, to release the vitality of innovation platforms to the maximum.

Content

Approach industrial & national competence & capability, cooperation and coordination capability.

The industrial Internet policy issued by the MIIT guides the development of Xinchang. Since 2018, the "Xinchang model" of local promotion of industrial Internet has been typical by the MIIT and Zhejiang Province and has been popularized and copied in many places.

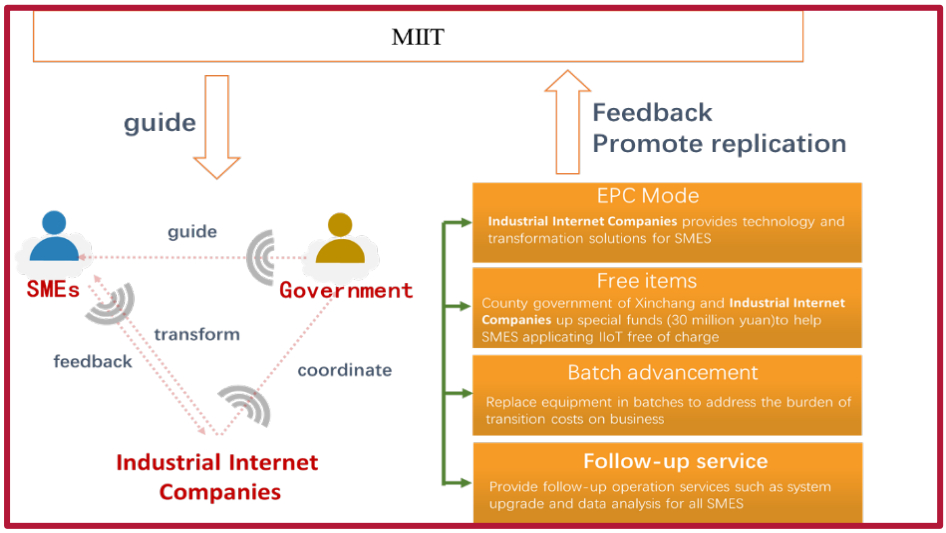

Figure 4 - Xinchang Model of local industrial internet promotion

Required policymaker capabilities & competencies, Fostering and guiding capability.

Manufacturing innovation centers are the hubs of manufacturing innovation networks. By providing technology research and development, incubation, and other public services to fill the "valley of death" between technology research and development and commercialization, innovation centers foster the innovation ecosystem of their industries and promote the sustainable operation of their government, industry, academia, research, and financial innovation systems. The Industry Innovation Center operates on a market-based basis, either as a board of directors or as a corporate entity. It provides innovation center members with club products, including public services such as R&D of manufacturing processes, common technologies and advanced materials, talent training and vocational training, technical infrastructure, and industry-standard making and revision, reducing the risks and costs of members from R&D to first commercialization. The Manufacturing Innovation Center integrates government, enterprises, industry associations, research institutes, and colleges, and also receives financial support from financial institutions. Therefore, the government can assist with the integration of innovation resources involved in the construction of innovation centers, undertake the construction of industry innovation centers and manufacturing innovation networks, and commission independent third parties to evaluate the performance of innovation centers, while financial institutions provide funds for the construction and operation of the centers: organizations such as enterprises, industry associations, research institutes, and colleges act mainly to provide R&D, talent training and other public services mentioned above. The composition and behavior of subdivided industry innovation center subjects can be represented by the following diagram.

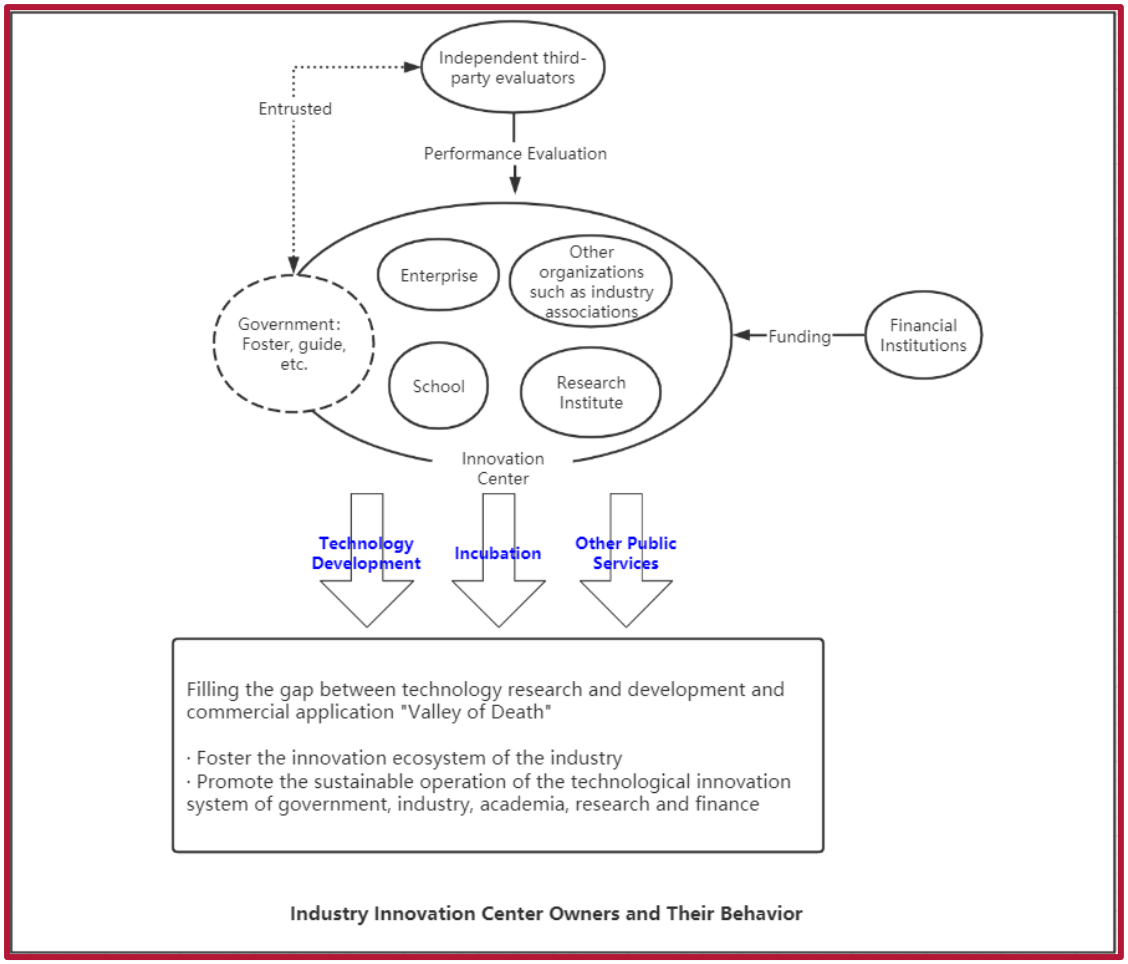

Figure 5 - Industry innovation center owners and their behavior[1]

Accommodating unidentified future trends & trajectories

On May 23, 2016, the outline of the national innovation-driven development strategy was officially released, defining the objectives, directions, and key tasks of innovation-driven development in the next 30 years. One of the highlights is the systematic deployment of the industrial technology system, which specifically defines the technical development direction of 9 key areas, including information, intelligent manufacturing, modern agriculture, modern energy, ecological environmental protection, etc.

In terms of "strategic objectives", the outline has been deployed following the three stages of 2020, 2030, and 2050. The objectives of each stage echo and support the "three-step" objectives of China's modernization drive.

The first step is to enter the ranks of innovative countries by 2020, to effectively support the realization of the goal of building a moderately prosperous society in all respects; **The second step** is to become one of the most innovative countries by 2030, to lay a solid foundation for building an economic power and a society of common prosperity; **The third step** is to build China into a world power of scientific and technological innovation by 2050, providing strong support for China to build itself into a prosperous, strong, democratic, civilized and harmonious modern socialist country and realize the Chinese Dream of the great rejuvenation of the Chinese nation.

[1] Source: Research on the construction of a manufacturing innovation center based on a multiplayer game, 2017

As the industry management department, the Ministry of industry and information technology mainly manages the planning, policies, and standards to guide the development of the industry. Some policy documents of unidentified future trends issued this year are as follows:

- Guiding opinions of five departments on promoting high-quality development of the light industry
- Circular of the Ministry of industry and information technology on printing and distributing the Interim Measures for the administration of gradient cultivation of high-quality small and medium-sized enterprises
- Notice of the general office of the Ministry of industry and information technology on publishing the list of cross-industry and cross-domain industrial Internet platforms in 2022
- Notice of the eleventh Department on "joint action" to promote financing innovation of large, medium, and small enterprises (2022-2025)
- Circular of the general office of the Ministry of industry and information technology on organizing and recommending national technological innovation demonstration enterprises in 2022
- Notice of the general office of the Ministry of industry and information technology on the selection, evaluation, and evaluation of service-oriented manufacturing demonstration in 2022
- Guidance of five departments on Further Strengthening the construction of safety systems of new energy vehicle enterprises

Common pitfalls/failings of foresight & content activities, failings in policy effect evaluation.

- It is easy to determine the qualitative standard and difficult to determine the quantitative standard, public managers often pay too much attention to the qualitative standard and ignore the quantitative standard, resulting in the fuzzy evaluation standard.
- Policies include both short-term and long-term impacts; There are both positive and negative effects. Some factors are difficult to measure, or even impossible to measure at all. Various influencing factors are often difficult to measure by a single measurement standard.
- The implementation of the policy has both positive and negative impacts, which are difficult to measure by a measurement standard.
- The overlapping of policy resources and policy behaviors makes the effects of different policies mixing, affecting each other, or even interfering with each other. It is difficult to distinguish the actual effect and influence of a policy, and it is difficult to carry out efficient policy evaluation.
- The relevant personnel of the policy operation obstruct or oppose the policy evaluation based on their own interests. The size of this hindrance is often the key to the success or failure of the policy evaluation.
- Data and information are the basis for policy evaluation. Without sufficient and available data related to policy operation and other policy information, policy evaluation is difficult to carry out, let alone objective and fair.

Good Practices

The national manufacturing innovation center: a new mode for innovation-driven development

Made in China 2025 and the guidelines require that several manufacturing innovation centers, including national manufacturing innovation centers and provincial manufacturing innovation centers, be built around the major common needs of the transformation and upgrading of key industries and the innovation and development of new-generation information technology, intelligent manufacturing, additive manufacturing, new materials, biomedicine, and other fields. By 2025, about 40 national manufacturing innovation centers will be formed.

To comprehensively enhance the innovation capability of the manufacturing industry, national manufacturing innovation centers composed of enterprises, research institutes, and universities have been established nationwide since 2016, covering industries such as power batteries and robotics. The details about the number of new national manufacturing innovation centers are shown in Fig.1 and Table 1.

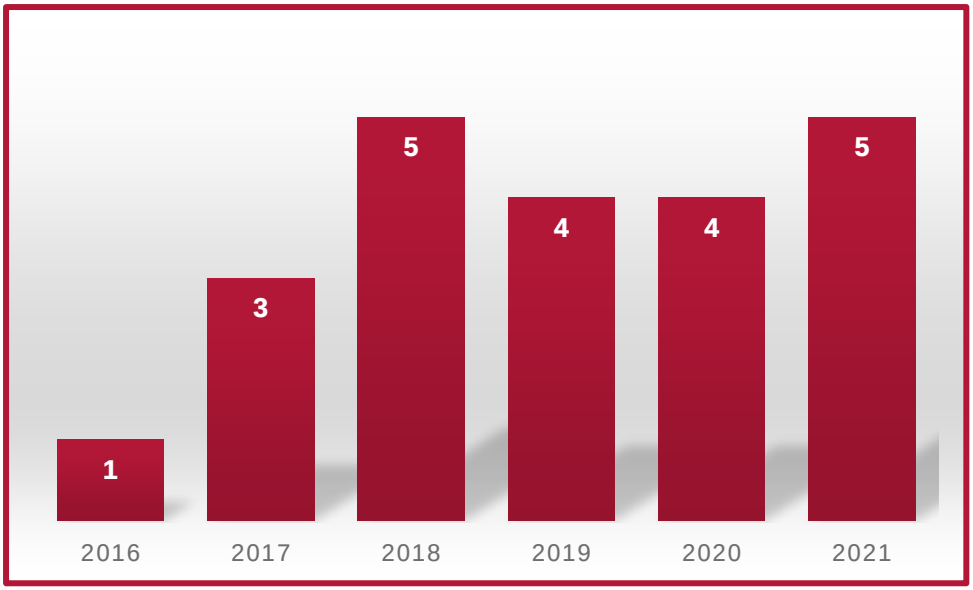

Figure 6 - The number of new national manufacturing innovation centers[2]

Box 2. The Number of New National Manufacturing Innovation Centers

Year	No. of new national manufacturing innovation centers	Name of National Manufacturing Innovation Center	Location
2016	**1**	National Power Battery Innovation Center	Beijing

[2] Source: Yangtze River economic belt development report 2019; List of national manufacturing innovation centers, 2022

2017	**3**	National Additive Manufacturing Innovation Center	Xi'an
		National Printing and Flexible Display Innovation Center	Guangdong
		National Information Optoelectronics Innovation Center	Wuhan
2018	**5**	National Robotics Innovation Center	Shenyang
		National IC Innovation Center	Shanghai
		National Smart Sensor Innovation Center	Shanghai
		National Digital Design and Manufacturing Innovation Center	Wuhan
		National Lightweight Material Forming Technology and Equipment Innovation Center	Beijing
2019	**4**	National Innovation Center for Advanced Rail Transit Equipment	Zhuzhou
		National Innovation Center for Agricultural Machinery and Equipment	Luoyang
		National Smart IOT Innovation Center	Beijing
		National Innovation Center for Advanced Functional Fibers	Jiangsu
2020	**4**	National Rare Earth Functional Materials Innovation Center	Jiangxi/Neimeng
		National Innovation Center for High-Performance Medical Devices	Shenzhen
		National IC Specialty Process and Packaging Test Innovation Center	Jiangsu
2021	**5**	National and local co-construction of silicon-based hybrid integration innovation center	Chongqing
		5G Medium and High-Frequency Device Innovation Center	Shenzhen

		National Innovation Center for New Glass Materials	Anhui
		National Innovation Center for High-end Intelligent Household Appliances	Qingdao
		National Intelligent Voice Innovation Center	Anhui

Manufacturing innovation centers are the hubs of manufacturing innovation networks. By providing technology research and development, incubation, and other public services to fill the "valley of death" between technology research and development and commercialization. Innovation centers foster the innovation ecosystem of their industries and promote the sustainable operation of their government, industry, academia, research, and financial innovation systems. The Industry Innovation Center operates on a market-based basis, either as a board of directors or as a corporate entity. It provides innovation center members with club products, including public services such as R&D of manufacturing processes, common technologies and advanced materials, talent training and vocational training, technical infrastructure, and industry-standard making and revision, reducing the risks and costs of members from R&D to first commercialization. The Manufacturing Innovation Center integrates government, enterprises, industry associations, research institutes, and colleges, and also receives financial support from financial institutions. Therefore, the government can assist with the integration of innovation resources involved in the construction of innovation centers, undertake the construction of industry innovation centers and manufacturing innovation networks, and commission independent third parties to evaluate the performance of innovation centers, while financial institutions provide funds for the construction and operation of the centers: organizations such as enterprises, industry associations, research institutes, and colleges act mainly to provide R&D, talent training and other public services mentioned above. The composition and behavior of subdivided industry innovation center subjects can be represented by the following diagram.

Company-led

A significant number of innovation centers are established by a company, and their subsequent development remains company-driven. Here is an example of the National Innovation Center for Intelligent Sensors.

In 2018, the National Smart Sensor Innovation Center was established. The National Smart Sensor Innovation Center is operated by Shanghai Xinwu Technology Co., Ltd. with the China Sensor and Internet of Things Industry Alliance as its extension. Ltd. is invested by 12 leading companies and institutions in various segments of the industrial supply chain, which are distributed in all major segments of the smart sensor industrial supply chain from R&D, design, manufacturing, packaging, and testing to application. The China Sensor and IoT Industry Alliance covers nearly 1,000 alliance members, providing the Innovation Center with rich industrial supply chain resources and an industry exchange platform.

On the afternoon of May 31, 2019, the Joint Laboratory of the National Smart Sensor Innovation Center was opened in Jiading District, Shanghai. The Joint Lab is an important part of the construction of the National Smart Sensor Innovation Center, which will rely on the key common sensor technologies independently developed by the Innovation Center and advanced device solutions of enterprises to develop multi-sensor data fusion systems and provide an experimental environment for technological innovation and standardization.

The joint laboratory is planned to cover an area of 2,000 square meters, and the first phase has been opened with more than 50 cooperative units. In the field of sensor devices, the Joint Lab focuses on six major areas of motion sensors, optical sensors, acoustic sensors, environmental sensors, bio-sensors, and RF sensors as well as IoT communication modules, and has built a large database of sensors, which currently contains more than 10,000 sensors.

In the field of sensor application, it provides a verification and demonstration platform for seven major application areas of smart sensors, namely, smart cars, industrial IoT, smart buildings and homes, smart agriculture, biomedical, environmental monitoring, and robotics.

The joint lab provides a highly effective R&D experiment environment and industrial cooperation environment for sensor technology innovation and standardization. And the joint lab has completed the research and development of smart driving, industrial Internet of Things, environmental safety monitoring, and smart sensor fusion system solutions. The joint lab has completed system-level solution exhibitions and validation labs in the fields of smart driving, industrial Internet, environmental safety monitoring, smart home, smart agriculture, smart medical, etc.

In 2021, the National Smart Sensor Innovation Center and smart device solution provider - RuiSheng Technology (AAC) signed a strategic cooperation agreement, the two sides will face the field of smart sensors, in technology product innovation, domestic supply chain improvement, industrial ecological construction and other aspects of all-round cooperation.

Company + Alliance

In 2021, the Ministry of Industry and Information Technology approved the establishment of four national manufacturing innovation centers, including the National Innovation Center for 5G Medium and High-Frequency Devices, the National Innovation Center for New Glass Materials, the National Innovation Center for High-end Intelligent Household Appliances, and the National Innovation Center for Intelligent Voice.

From the characteristics of the four newly approved national manufacturing innovation centers, based on the previous enterprise + alliance creation model, the new trends such as cross-collaboration of leading enterprises and alliance-led innovation development deserve attention.

According to the Ministry of Industry and Information Technology "Manufacturing Innovation Center Construction Project Implementation Guide (2016-2020)", "the main body of enterprises, relying on existing industrial technology alliances, or guide and encourage enterprises, research institutes,

universities, especially conversion institutes, voluntarily choose to combine independently, build various industrial technology alliances, play their respective advantages, integrate relevant resources, explore mechanism and model innovation, and create innovation centers" requirements for the creation of the way, the four newly approved national manufacturing innovation centers are based on enterprises as the carrier.

From the perspective of the shareholding structure, there are 10 shareholders in the National Intelligent Voice Innovation Center. Among them, KDDI Co. holds up to 40.6% of the shares. The next two are Qingdao Haier Intelligent Technology R&D Co. and Anhui Province Information Industry Investment Holding Co., both companies having a 10% shareholding.[3]

As can be seen, the top shareholders of these two innovation centers, as industry leaders, both hold more than 35% of the shares, and the combined shareholding of the top two shareholders exceeds 50%, reflecting the significant influence of the leading companies on the innovation centers.

At the same time, it is worth noting that the first major shareholders of the two innovation centers are KDDI and Haier respectively, while at the same time, they are one of the major shareholders of the other innovation center. This mode of extensive penetration and collaboration of enterprises in different industrial fields may become another important trend in the development of enterprise technology innovation in the future.

Unlike the National Intelligent Voice Innovation Center and the National High-end Intelligent Household Appliance Innovation Center, the National Glass New Material Innovation Center, which was established based on the Glass New Material Innovation Center (Anhui) Co. has a relatively dispersed shareholding.

The alliance features are even more significant in the National 5G Medium and High-Frequency Device Innovation Center, which was formed based on Shenzhen Huixin Communication Technology Co. According to the official website (https://www.hatchip.com/), the company has 32 shareholders, among which Shenzhen Huixin Investment Partnership (limited partnership) has the highest shareholding of 24.6%, followed by Shenzhen Futian Investment Holding Co., Ltd. with 15.7%, 6 companies with shareholding between 2%-10%, 10 companies with shareholding between 1%-2% and 14 companies with shareholding less than 1%.

Alliance-led

The National 5G Medium and High-Frequency Device Innovation Center is a manufacturing innovation center established to further implement China's "strong network country" and "strong manufacturing country" strategies. It is a new manufacturing innovation carrier focusing on the R&D supply, transfer and diffusion, and commercialization of frontier technologies and common key technologies in the field of 5G communications, which was jointly initiated by Shenzhen Futian District Government, Southern University of Science and Technology, and Lihe Science and Technology Group, together with

[3] (Source: https://baijiahao.baidu.com/s?id=1717112848942321259&wfr=spider&for=pc)

several leading enterprises and listed companies in the upstream and downstream of the 5G industrial supply chain.

To better promote the overall synergy of the industrial supply chain, the Innovation Center adopts the operation mechanism of "company + alliance", with Shenzhen Huixin Communication Technology Co., Ltd. as the backbone and the "5G Industry Technology Alliance" as the link, effectively integrating the innovation elements of the whole 5G industrial supply chain, creating a 5G industry innovation ecosystem covering technology, talent, platform, policy, capital, and international cooperation and other elements of interactive integration.

The "5G Industry Technology Alliance" works under the guidance of the Ministry of Industry and Information Technology. The highest authority of the Alliance is the Council, which exercises power on behalf of all members. The Council has 1-2 chairmen, several vice chairmen, and 1 executive chairman (individual); 5-8 chairman units (institutions), several executive director units (institutions), and several director units (institutions). The chairman, chairman of the unit, and part of the executive director of the unit to the election (the first chairman, chairman of the unit, executive director of the unit, director of the unit to the election + the recommended way to produce), the executive director and part of the executive director of the unit to appoint the way to produce. When the number of director units reaches 50 and above, the appointment will be combined with the election of the way to produce the executive director units. The structure of the council is shown in the following figure.

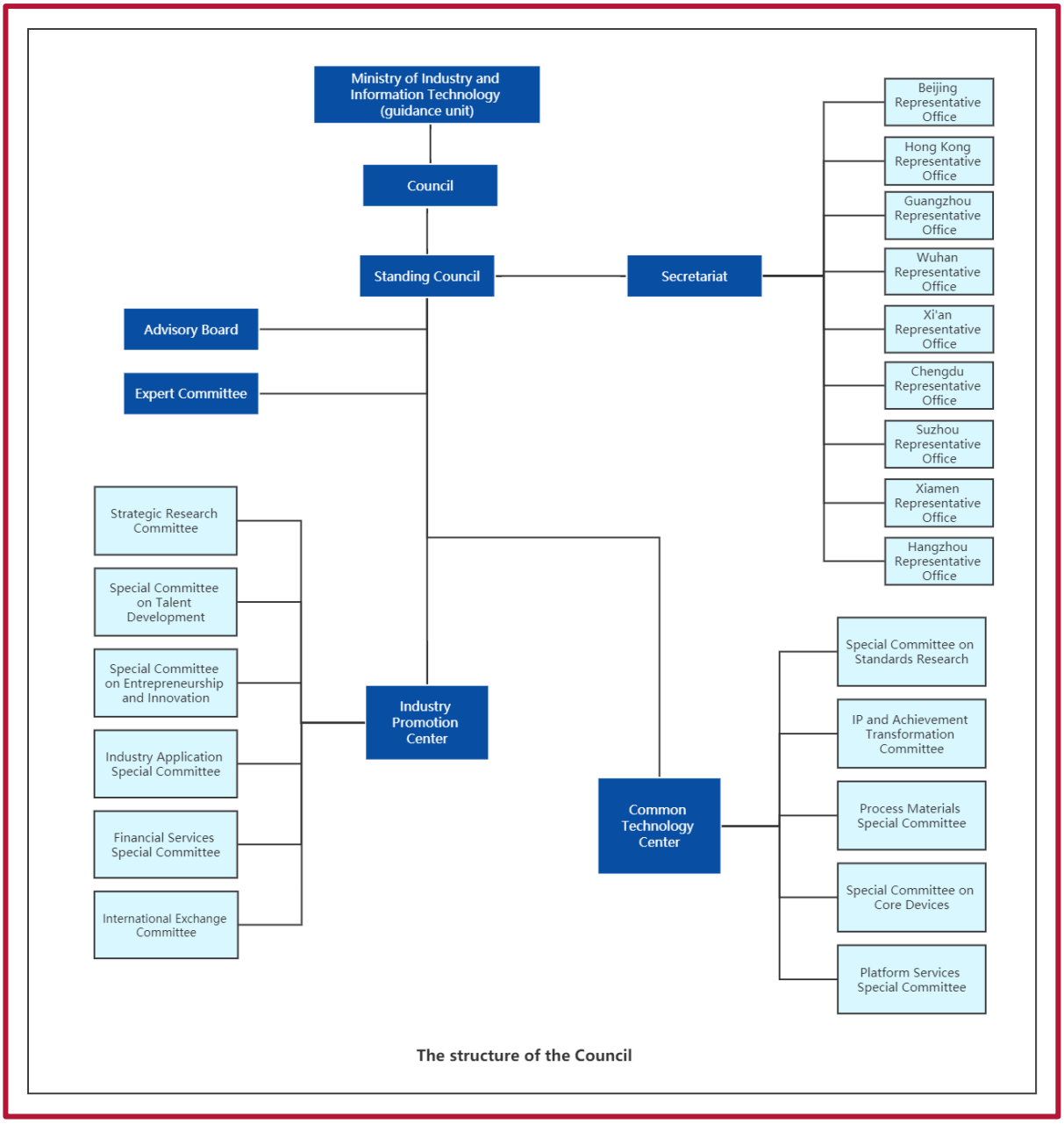

Figure 7 - The structure of the council "5G Industry Technology Alliance"[4]

M&A to boost the transformation and upgrading of China's manufacturing industry

China's M&A market (including inbound and outbound M&A of Chinese enterprises and inbound M&A of Chinese enterprises by foreign investors) announced 6603 M&As in the first three quarters of 2022, with a scale of about 1468.9 billion yuan, remaining a historical high. The reform of state-owned enterprises and industrial upgrading continued to advance. From the perspective of

[4] Source: Four national manufacturing innovation centers were approved, and the enterprise + alliance mode was further enriched, 2021

industry distribution of M&A targets, the field of science and innovation and new energy has become the focus of M&A under the promotion of “dual carbon” goals and policies. In terms of cross-border trade, the trade scale of science and technology, energy and mineral industries is growing rapidly. Chinese enterprises are changing from scale expansion to quality improvement and innovation breakthrough.

Figure 8 - Industry distribution of M&A targets in China in the first three quarters of 2022[5]

Manufacturing has always been a key industry for China's foreign direct investment and overseas mergers and acquisitions. The motivation of M&A in the manufacturing industry mainly includes resource seeking, technology seeking, efficiency seeking and strategic asset seeking. The M&A in manufacturing industry driven by each motivation will bring strategic opportunities to enhance the core competitiveness of enterprises. By the end of 2021, China's foreign direct investment flow had reached US $178.82 billion, an increase of 16.3% over the previous year, ranking among the top three in the world for 10 consecutive years. The position as a major country in foreign investment was stable.

China's manufacturing investment and M&A have experienced rapid growth and rational decline in the past eight years. Before 2018, with the in-depth promotion of the "going global" strategy and the "the Belt and Road" initiative, Chinese enterprises have fully grasped the strategic opportunities and window periods at home and abroad. The number and amount of overseas investment and M&A projects in the manufacturing industry are growing rapidly. After 2018, the project scale began to decrease. Affected by the COVID-19 and changes in the global trade

[5] Data source: Wind

environment, the amount of outbound direct investment and M&A in China's manufacturing industry fell back to the level of 2013 in 2020.

Box 3. The Number of New National Manufacturing Innovation Centers

Year	Number	Amount（USD 100 million）	Proportion in the total amount of outbound investment and M&A in the year (%)
2013	129	73.2	13.8
2014	167	118.8	20.9
2015	131	137.2	25.2
2016	200	301.1	22.3
2017	163	607.2	50.8
2018	162	329.1	44.3
2019	179	142.7	41.6
2020	152	69.7	24.7
2021	128	63	19.8

Typical cases of improving the core competitiveness of enterprises through M&A as below:

Box 4. Typical Cases of Chinese Manufacturing M&A

Company	Details
Outbound	
Geely & Volvo	On August 2, 2010, Geely completed the acquisition of all equities of Volvo at a price lower than expected of 1.8 billion US dollars and announced the members of the Board of Directors. Since 2011, Geely has set up joint ventures and factories overseas to export technical standards and management talents. At present, Geely has established modeling design and engineering R&D centers in Gothenburg, Sweden, Coventry, California, Frankfurt, Germany, Kuala Lumpur, Malaysia, etc. The world-class modern vehicle and powertrain manufacturing plants have been built in the United States, Britain, Sweden, Belgium, Belarus and Malaysia as well.
Tsingshan & Dholera	On January 18, 2019, the chairman of the board of directors of Tsingshan holding group announced at the Vibrant Gujarat Global Summit 2019 that the company

	would invest 3 billion dollars in Dholera to build a stainless steel and electric vehicle battery factory.
Ganfeng Lithium & Bacanora'	On August 9, 2022, Ganfeng Lithium acquired 71.12% of Bacanora's equity, with a transaction amount of 230 million dollars. The acquisition will help the listed company's business expansion and enhance its core competitiveness.
Inbound	
Zaozhuang Mining & Shandong Hi-speed	On July 29, 2022, Zaozhuang Mining (Group) Co., Ltd. and Shandong Hi-speed Investment Holding Co., Ltd. acquired 31.37% equity of Zhongtai Securities Co., Ltd., with a transaction amount of 3.501 billion dollars. The new provincial state-owned shareholders have strong strength, rich resources, and standardized operation, which will actively enable Zhongtai Securities to deeply cultivate the regional market, deeply serve the real economy, improve the governance level, enhance the compliance risk control ability, and help to enhance the company's comprehensive strength.

Lighthouse factories Leading the Digital Transformation of China's Manufacturing Industry

China has not only the largest number of "lighthouse factories", but also the largest number of end-to-end "lighthouse factories", which confirms the strong strength of China's advanced manufacturing industry.

Up to now, the number of "lighthouse factories" in the world has reached 114, and the number in China has increased to 42, accounting for 37% of that in the world. China has become a country with the largest number of "lighthouse factories" in the world, in which the end-to-end use cases account for more than 50%, mainly distributing in 3C electronics, household appliances, automobiles, steel, and new energy industries.

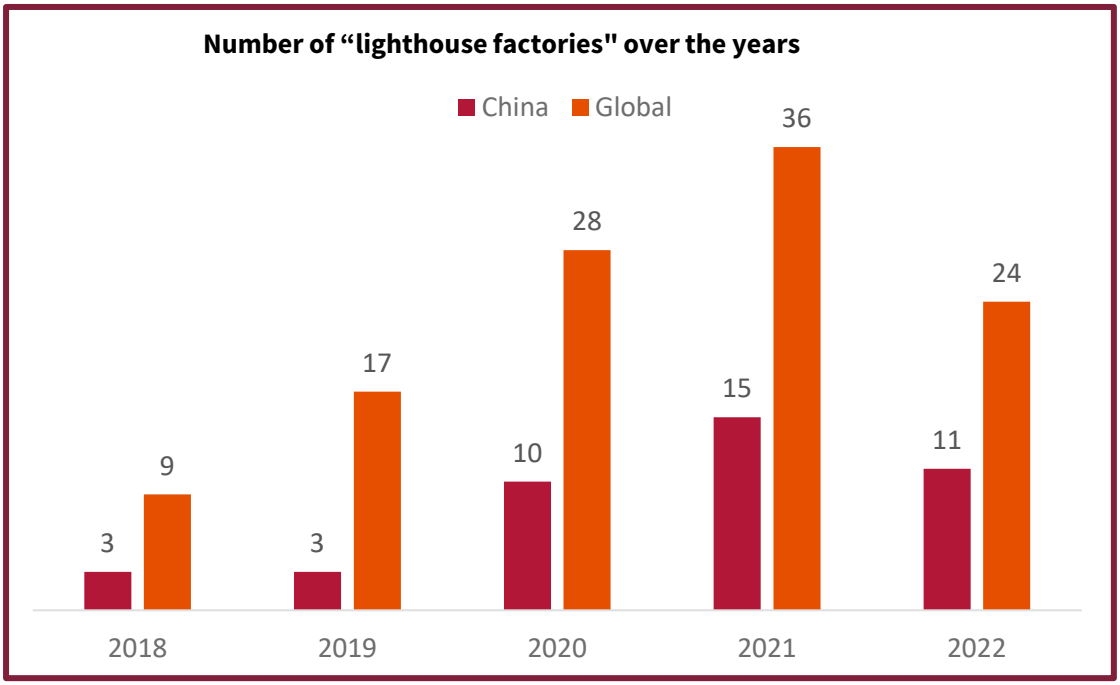

Figure 9 - Number of “lighthouse factories” (2018-2022)[6]

Through the study of 'lighthouse factories' in China, we may see that:

1. Compared with other countries, Chinese manufacturers are more willing to embrace end-to-end full value chain digital transformation. At the same time, the growing personalized needs of Chinese users, the increasingly fierce brand competition, and the booming e-commerce business are also forcing Chinese enterprises to carry out end-to-end digital transformation.
2. China's end-to-end 'lighthouse factories' makes the most appropriate digital business blueprint based on the user, product, benefit and other dimensions in the selection of digital use cases.

[6] Data Source: WEF, McKinsey & Company

Lighthouse factories in China can be divided into four categories as below:

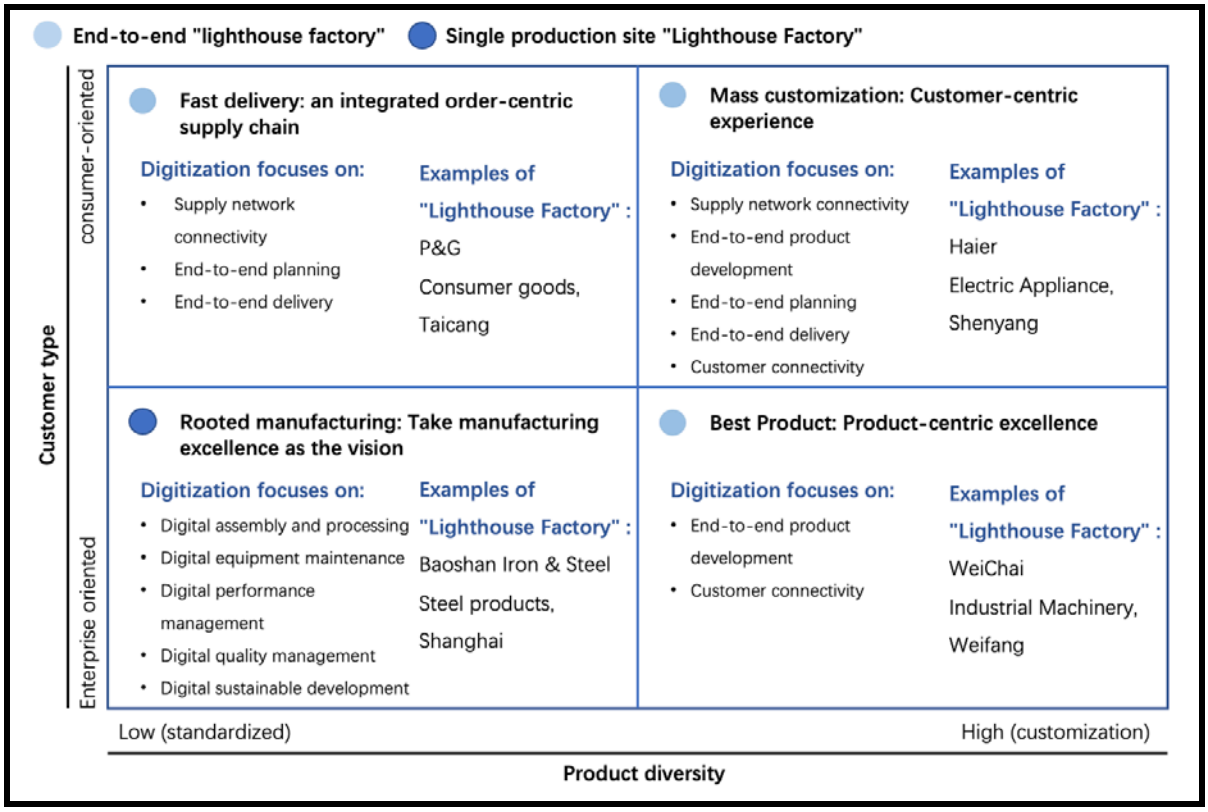

Figure 10 - Typology of China's lighthouse factory[7]

In the four categories, end-to-end use cases and manufacturing use cases account for 53% and 47% of the total use cases respectively. Details are as follows:

[7] Source: McKinsey & Company

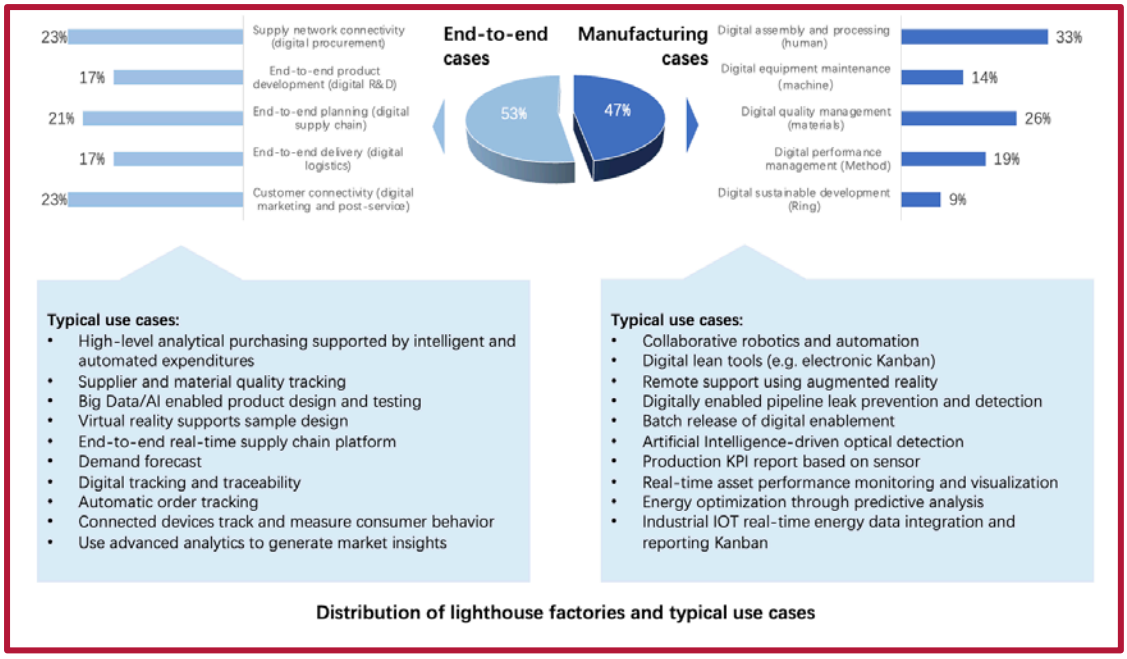

Figure 11 - Distribution of lighthouse factories and typical use cases[8]

Box 5: Lighthouse Factories Specific Cases

Company	Industry	Details
Contemporary Amperex Technology Co., Limited	New energy	CATL has achieved a defect rate of only one over a billion in three years at the speed of 1.7 seconds for each group of batteries, while increasing labor productivity by 75% and reducing annual energy consumption by 10% by using artificial intelligence, advanced analysis, edge/cloud computing and other technologies.
SANY HEAVY INDUSTRY CO., LTD.	Equipment manufacturing	In the face of the ever-changing and increasingly complex demands of the construction machinery market with multiple varieties and small batches, advanced human-computer collaboration, automation, artificial intelligence, and Internet of Things technologies have been used to increase labor productivity by 85%, shorten the production cycle from 30 days to 7 days, and reduce the production cycle by 77%.

[8] Source: White Paper on Lighthouse Factory Leading Digital Transformation

Midea Group	Home appliance manufacturing	In order to develop e-commerce business and expand overseas market share, Midea Shunde Factory implemented a series of measures such as digital procurement, flexible automation, digital quality management, intelligent logistics and digital sales, reducing product costs by 6%, order delivery cycle by 56%, and carbon dioxide emissions by 9.6%.
Haier	IoT Ecology	Haier's three "lighthouse factories" have achieved industry leadership in the three major industries of air conditioning, refrigeration and washing. This achievement cannot be separated from the help of its industrial Internet platform, COSMOPlat. The application of 5G, AI, big data and other industrial 4.0 new technologies and advanced manufacturing technology of the factory are deeply integrated. Users' use experience is connected through the network device to drive rapid iteration of products, so as to support users' multi scene experience.
SAIC MAXUS	Automobile	In the face of fierce competition in the market environment, SAIC MAXUS Nanjing Factory has launched new mode applications for large-scale customization. The factory makes use of the integrated digital main line to digitally transform and upgrade the end-to-end value chain from customers to suppliers, effectively reducing production costs while increasing sales.

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