

# THE IMPACT OF INNOVATION PLATFORM, INNOVATION CULTURE, AND INFORMATION TECHNOLOGY ON THE INNOVATION ABILITY OF SME ENTERPRISE: STUDY IN HEFEI

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## ABSTRACT

Innovation is the first driving force leading development. The improvement of SMEs' innovation ability is of great significance to the high-quality development of the economy and society. The purpose of this study is to adopt a mixed research method combining quantitative and qualitative methods to take the innovation capacity of SMEs in Hefei City as the research object, collect data through interviews, field research, questionnaires, and other methods, and analyze the impact of innovation platforms, innovation culture, and information technology on the innovation capacity of SMEs. Conclusion of the study: Whether SMEs build innovation platforms, innovation culture, and the degree of application of information technology are positively related to SMEs' innovation ability. The elements of innovation platform, innovation culture, and information technology share resources and synergize with innovation objects such as universities, research institutions, and the government to promote enterprise innovation capability. Enterprise innovation capability is composed of elements such as innovation resource input capability, research and development capability, and has gone through imitation innovation, cooperative innovation, collaborative innovation, and independent innovation paths. Contribution: This paper can provide a reference for the high-quality development of the innovation capacity of small and medium-sized enterprises in Hefei City.

**Keywords:** Innovation Platform, Innovative Culture, Information Technology, SME Innovation Capacity

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## INTRODUCTION

At present, along with the new round of scientific and technological revolution and industrial change being advanced in-depth, China's economic development has entered a new normal. Global technological change and the fourth industrial revolution have brought new opportunities for enterprise innovation and development, and at the same time, affected by the COVID-19 epidemic and other factors, in the context of the world's century-old change and the reversal of economic globalization, it has posed a new challenge to the innovation capacity of enterprises, and required small and medium-sized enterprises (SMEs) to grasp the opportunities of the new generation of technological change. China is striving to gradually adopt a series of policy measures dedicated to becoming a leader in the new type of economic globalization.<sup>2021</sup> In March 2021, the Outline of the Fourteenth Five-Year Plan for the National Economic and Social Development of the People's Republic of China and the Outline of the Vision for 2035 focused on "Improving the Technological Innovation Capability of Enterprises". The National Innovation Index Report 2020 shows that "the innovation capacity of Chinese enterprises has steadily improved". The Ministry of Science and Technology and the Ministry of Finance issued the Action Program for Enhancing the Technological Innovation Capacity of Enterprises (2022-2023), which "proposes to promote the growth of small and medium-sized enterprises as an important source of innovation" and other ten action programs, guiding and supporting various types of enterprises to make scientific and technological innovation their core competitiveness.

Innovation is the first driving force to lead development, and enterprises are the driving force to promote innovation and creativity. Enhancing the technological innovation capacity of enterprises is the micro-foundation and power source for building an innovative country (Lu Xianxiang, 2021). Small and medium-sized enterprises (SMEs) are an important group of enterprises in the national economic system, and enhancing the innovation capacity of SMEs is of great strategic significance in promoting high-quality development (Zhou Lizhong, 2022). SMEs have become an important force for economic and social development, and it is imperative to enhance the innovation capacity of SMEs. However, many small and medium-sized enterprises, including Hefei City, have been hit, and there are still many differences in the construction and development of small and medium-sized enterprises in terms of innovation capacity, which makes it difficult to play the role of boosting the innovation capacity of small and medium-sized enterprises by innovation elements, and there are also difficulties and Problems

This paper takes Hefei, the capital city of central Anhui Province, as the research scope and the innovation capacity of small and medium-sized enterprises (SMEs) in Hefei as the research object. Hefei is the first pilot city of science and technology innovation in China, as well as a "double node city of the Belt and Road and Yangtze River Economic Belt strategy. Especially in recent years, it has been called the city of innovation. It is one of the fastest-growing cities in China, one of the four comprehensive national science centers in China, one of the world's top 100 regional innovation clusters, one of the world's top 20 scientific research cities, and one of China's top 10 innovative cities.

Hefei's GDP in 2021 will be RMB 1141128 billion. According to the 2021 National Economic and Social Development Statistics Bulletin of Hefei City, Hefei has 60 institutions of higher learning, such as the University of Science and Technology of China, 70 academician workstations, and 138 academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering. There are 12 national (key) laboratories, 36 ministries (key) laboratories (including ministry-province joint construction), 128 provincial (key) laboratories; 139 engineering technology research centers above the provincial level; 120 engineering research centers above the provincial level; 67 engineering laboratories above the provincial level; 400 enterprise technology centers above the provincial level. There are 4,578 national

high-tech enterprises and 98 scientific and technological enterprise incubators above the municipal level. Generally speaking, Hefei is rich in scientific and technological resources and education, with complete major scientific and technological infrastructures, a solid industrial foundation, and complete construction of various scientific and technological innovation platforms. Therefore, the selection of Hefei to carry out the study of SMEs' innovation capacity is representative to a certain extent.

**Table 1** Statistical Table of Major Innovation Platforms in Hefei City in 2021

Style	Affiliated management departments	Quantity
Academician workstations	Office of Science and Technology of Anhui Province	70
National (key) laboratories	Ministry of Science and Technology, Ministry of Finance, etc.	12
Ministry (key) laboratories (including ministry-province joint construction)	Relevant Ministries and Provincial People's Governments	36
Provincial (key) laboratories	Office of Science and Technology of Anhui Province	128
Engineering technology research centers above the provincial level	Office of Science and Technology of Anhui Province	139
Engineering research centers above the provincial level	Anhui Development and Reform Commission	120
Engineering laboratories above the provincial level	Anhui Development and Reform Commission	67
Enterprise technology centers above the provincial level	Anhui Provincial Department of Economy and Informatization	400

Data source: Hefei City 2021 National Economic and Social Development Statistics Bulletin. Therefore, under the new situation, this study takes the innovation capacity of SMEs in Hefei as the research object and focuses on the impact of innovation platform, innovation culture, and information technology on the innovation capacity of SMEs in Hefei. Meanwhile, the following questions are raised: What are the impacts of innovation platform, innovation culture, and information technology on the enhancement of innovation ability of SMEs in Hefei respectively? How to play the role of innovation elements such as innovation platforms, innovation culture, and new generation information technology to promote the enhancement of SMEs' innovation capacity?

### Research Objectives

- 1) To analyze the influence of innovation platforms, innovation culture, and information technology on the enhancement of SMEs' innovation ability.
- 2) To explore the role positioning and interaction mechanism of government, universities, and enterprises in SMEs' innovation capacity enhancement based on the triple helix innovation theory.
- 3) To build the path and evaluation model of SMEs' innovation ability enhancement based on innovation ecosystem theory.

## LITERATURE REVIEW

### Small and Medium-sized Enterprises (SMEs) and Enterprise Innovation Capability

According to the Provisions on the Classification Standards for Small and Medium-sized Enterprises (SMEs) researched and formulated by the Ministry of Industry and Information Technology (MIIT), National Bureau of Statistics (NBS), Development and Reform Commission (DRC), and the Ministry of Finance (MOF), SMEs are classified as medium-

sized, small-sized, and micro-types, and specific standards are formulated based on the indexes of the enterprises such as the number of employees, business revenues, and the total amount of assets, as well as the enterprise holdings, etc., and the characteristics of industries. In 2017, the National Bureau of Statistics (NBS) revised and released the Measures for the Classification of Statistically Large, Small, Medium, and Micro Enterprises (2017) based on the Classification of Industries of the National Economy (GB/T4754-2017). SMEs are important creators of innovation (Saunila et al., 2014). At present, small and medium-sized enterprises (SMEs) account for more than 90% of China's enterprises, and the level of technological innovation capacity of SMEs has a direct impact on the construction of the innovation capacity of the whole country. (Zhou, lizhong, 2022).

In the past, several experts and scholars have generally focused on the concept of innovation capability (Calantone, Cavusgil, & Zhao, 2002; Lawson & Samson, 2001; Lin, 2007; Romijn & Albaladejo, 2002). Both internal sources (e.g., prior work experience, education) and external sources (e.g., suppliers, customers) contribute to the ability to innovate (Romijn & Albaladejo, 2002) for the potential to create valuable new products or knowledge (Zheng, Liu, & George, 2010). Lawson and Samson (2001) defined innovativeness as "the ability to continuously transform knowledge and ideas into new products, processes, and systems for the benefit of the firm and its stakeholders". Kittilaksanawong and Ren (2013) argued that collaboration with research institutions helps to improve exploratory and developmental innovation capabilities. Saunila (2017) states that there are three dimensions of innovation capability, namely, participatory leadership culture, proprietary technology development, and conceptualization and organizational structure are closely related to firm performance.

For SMEs, the core competitiveness of an enterprise is its ability to innovate. And there have been new explorations by scholars in recent years. Enterprise innovation capacity refers to a series of social organization practice activities in which an enterprise benefits and eventually obtains advantages through systematic change or adaptation (Zhong Jinyi, 2022). According to Lv Xin, enterprise innovation capability should have the ability to improve production technology or produce new products or services, should have the ability to integrate resources to carry out innovative activities, and the ability to achieve economic benefits and other scientific and technological achievements (Lv Xin, 2021).

SMEs, as the main participants in economic innovation activities and the most active component of national economic development, play a very important role in the national innovation-driven development strategy. The science and technology innovation capacity of SMEs is related to the vitality and level of science and technology innovation of the whole country, as well as the leader of technological progress and productivity growth (Li Xuan et al., 2022).

Therefore, this study proposes the following 2 hypotheses:

Hypothesis 1: The size of SMEs is positively related to the degree of innovation capacity enhancement.

Hypothesis 2: The amount of innovation investment of SMEs is positively related to the degree of innovation capacity enhancement.

### **Innovation Platforms**

The innovation platform studied in this paper mainly refers to the science and technology innovation platform established by enterprises. A science and technology innovation platform is a basic support system relying on physical facilities and social organizations, organically composed of a series of scientific and technological elements such as knowledge, information, technology, talents, policies, funds, etc., and providing public and shared services for scientific and technological innovation in a certain region (Lu Xiaoyao, 2021). Innovation platform refers to an integrated system led by the government or organization to support independent innovation and scientific and technological progress of a certain industry and region by

gathering innovation elements, integrating scientific and technological resources, and carrying out scientific research and technological development activities (Chen Jianhong et al., 2022). The innovation platform is an important part of the national strategic scientific and technological force and is the main carrier of high-quality innovation resources. The innovation platform is an important part of the national strategic scientific and technological force and is the main carrier of high-quality innovation resources, which can maximize the key technologies, disseminate innovation results most efficiently, and maximize the support for industrial development. (Graciela Corral de Zubielqui et al., 2013). Institutional integration has proved to be an important aspect of the empowerment of the various participants, contributing to the achievement of a common understanding. (Brouwers, J., Sanogo, D., Fayama, T. et al., 2023). In an effective Platform participants view innovation as "a systematic and dynamic process of institutional and social learning" (Klerkx et al., 2013; Sanyang et al.). Open innovation platforms help to facilitate interaction between participants (Parjanen & Rantala, 2021; Tukiainen et al.). Open innovation platforms may have different impacts on firms depending on their stage of maturity. Serve as an innovation platform that mobilizes resources and improves the innovation capacity of enterprises. (Irene Vivas Lalinde et al., 2018). It can be argued that platforms essentially refer to some kind of resource organization: bilateral and multilateral stakeholders use platforms as intermediaries to connect and match with each other, thus forming a network. (Peng Lu et al., 2023). Currently, more and more enterprises are focusing on tapping and realizing the potential of innovation platforms. Innovation platforms can enable organizations to create a broad and dynamic portfolio of applications that can lead to new market opportunities and business growth.

Therefore, this study proposes the following 2 hypotheses:

Hypothesis 3: Innovation platforms can positively influence SMEs' innovation capabilities.

Hypothesis 4: There is a positive correlation between the establishment and level of innovation platforms and the degree of improvement of SMEs' innovation capacity.

### **Innovation Culture**

Innovation culture is an important part of the enterprise innovation system. Des - Champs Sonsino attributes innovation culture to the external cultural environment on which scientific and technological innovation must depend and interprets the formation of innovation culture through multi-dimensional analysis. Yang Gang et al. analyzed the characteristics and trends of China's innovation culture research in the past 30 years through bibliometrics and sorted out several topics that have been concerned in this field through the research (Yang Gang et al., 2021). Innovation culture is an important part of the enterprise innovation system. As an intrinsic mechanism, it influences the operation of enterprises and promotes the generalization of innovative behaviors (Wu Hui, 2021)." As an internal mechanism, it influences the operation of enterprises and promotes the generalization of innovative behavior (Wu Hui, 2021)." Innovation culture is a rational choice for enterprises to meet the challenges of the knowledge economy, and innovation culture is a booster for enterprises to keep up with the pulse of the times" (Shen Renrui, 2022).

Innovation culture can be defined as a cultural system with "innovation" as the core. It is characterized by inclusiveness, openness, mutual trust and cooperation, subject consultation, pioneering creativity, and tolerance of failure. SMEs are more likely to rely on organizations other than universities and relevant R&D firms for knowledge acquisition. Companies need to apply a culture of innovation in their practices to be successful in innovating products and services. Success in innovative products and services. A culture of innovation is where creativity, empowerment, and organizational culture change drive innovation. (Binnewies, Ohly et al., 2023). Firms need to value, build, maintain, and promote a culture of innovation if they are to remain successful and create new products. According to the theories of Hofstede, Schwartz, Hampden-Turner, and Trompenaars, as well as Inglehart, the culture of innovation

is often considered to be a derivative of the generic concept of national culture. Social values are widely recognized in some literature as characterizing a culture of innovation. Social values and norms are often seen as key to the success of innovation.

Therefore, this study proposes the following 1 hypothesis:

Hypothesis 5: Whether differences in innovation culture have an impact on regional innovation capacity enhancement.

### **Information Technology**

Information technology is a generic term for a variety of technologies used primarily to manage and process information. It mainly applies computer science and communication technology to design, develop, and install information systems and software. There are mainly sensing technology, computer and intelligent technology, communication and control technology. The new generation of information technology can improve the innovation efficiency of enterprises, and the increase in its level helps to positively regulate the innovation efficiency of enterprises (Yang Fan, 2021). At present, the application of new-generation information technology with artificial intelligence, cloud computing, big data, and the Internet of Things as the main forms, and with digitalization, networking, and intelligence as the important characteristics, is becoming more and more widespread. Since 2021, "new technologies and applications such as quantum technology, meta-universe, chatGPT, Wenshin big model, Xunfei Starfire cognitive big model are proposed precisely to refresh our understanding of the new generation of information technology.

Therefore, this study proposes the following 1 hypothesis:

Hypothesis 6: There is a positive correlation between the level of IT adoption in SMEs and the level of improvement in the firm's innovation capability.

### **Triple Helix Theory of Innovation**

The triple helix innovation theory was first proposed by Etzkowitz and Leydesdorff in 1995. It refers to the sharing and exchange of resources and information among universities, industries, and governments through organizational structure and institutional design to achieve efficiency and effectiveness in the utilization of technological resources (Wang Chengjun, 2006). The theory suggests that in the process of collaborative innovation, the government, enterprises, and universities form a spiral organizational structure, and the three spirals cross-influence each other.

In the era of the knowledge economy, the boundaries between the three spirals have become blurred, and only by promoting horizontal and vertical cooperation and communication can we optimize and integrate innovative resources and create more and more value based on common interests. Although the boundaries between the three spirals of the main body are blurred, there are still certain boundaries between each other, They have certain independent statuses and identities, and they have their special functions, and also play certain roles within the scope of the other institutions, overlapping each other, mutually beneficial and harmonious. scope to play a certain role, overlap each other, mutual benefit, and harmonious coexistence. In the innovation practice of SMEs, the government, enterprises, and universities are closely linked together.

## **RESEARCH METHODOLOGY**

### **Research Design**

This study adopts a mixed research method combining quantitative and qualitative, takes Hefei SMEs' innovation capacity as the research object, uses the triple helix innovation theory and the innovation ecology theory to explore the influence of innovation platform, innovation culture, and information technology on the innovation capacity of SMEs, and analyzes the relationships, roles, and functions of colleges and universities, the government, and the enterprises in the SMEs' innovation capacity, to provide references and reference values for the

enhancement of the innovation capacity of SMEs, regional innovation, and high-quality development.

**Table 2** Research Variables and Dimensions of Variables

<b>Variables</b>		<b>Dimensions of Variables</b>
Independent variable	Innovation platform	Government-supported organization-led
		Led by Universities and Research Institutions
		Enterprise-led
	Innovation culture	Content
		Method
		Practical
Adjustment variables	Information technology	Next-Generation Communication Networks
		Internet of Things
		Cloud Computing
		Artificial intelligence (AI)
Dependent variable	Innovation ability of SEM	Medium-sized enterprises
		Small Enterprises
		Microenterprise
Dependent variable	Innovation ability of SEM	Learning and absorptive capacity
		Management and decision-making capacity
		Research and development capacity
		Resource input capacity
		Translation and application capacity

### Population and Sample

Hefei is the capital city of Anhui Province, known as the city of science and technology innovation, 2022. The city formulated the Hefei Science and Technology Innovation Regulations to accelerate science and technology innovation with special legislative guarantees, so the selection of Hefei as the scope of the study is representative. Hefei serves as an ideal location to study the impact of innovation platforms, innovation culture, and information technology on SMEs' innovation capacity enhancement research.

A total of 60 enterprises were selected to participate in this study. These enterprises were selected based on the stratified random sampling method. First, firms were categorized based on two main criteria: industry type and size. This stratification method ensured that the sample reflected the multifaceted nature of innovation among SMEs in Hefei. A certain percentage of firms were randomly selected from each stratum.

In the quantitative part of the study, 200 respondents were surveyed from these firms. These respondents were randomly selected from the employee database of the participating firms to ensure a broad representation of perspectives.

Qualitative research is aimed at more specific groups. Here, 20 study participants were selected through purposive sampling. This approach ensured that the study participants (mainly key decision makers, research management, R&D department professionals, etc.) had a deep understanding of their company's innovation platforms, innovation culture information technology applications, and innovation strategies.

### Research Tools

The tools used in this study are a questionnaire survey, group interviews, and expert interviews.

### **Quality Testing of Research Tools**

The researcher submitted the relevant questionnaires with suggested changes to experts for review and revision to confirm whether the questions were consistent with the research objectives.

To assess the reliability of the questionnaires, the researcher selected 20-30 homogeneous samples from the expert-validated questionnaires for the pilot study.

### **Data Collection**

The study was planned to be conducted from November 2023 to March 2024 and the researcher posted the questionnaire in an online format on social networks.

### **Data Analysis**

This study used SPSS statistical software to analyze the quantitative data obtained from the questionnaire.

Part 1: Characteristics of the respondents. Descriptive data was used to characterize the data of the respondents through frequencies and percentages.

Part 2: Factors influencing innovation platforms, innovation culture, and information technology on the innovation capacity of SMEs by analyzing means and standard deviations.

## **RESULTS AND FINDINGS**

Against the backdrop of unprecedented changes in the world and the reversal of economic globalization, the innovation capacity of SMEs has gradually become a key factor in their survival, competition, and development advantages. It is increasingly difficult for SMEs to realize technological breakthroughs by relying on their capabilities, and collaborative innovation in the innovation ecosystem centered on innovation platforms, innovation culture construction, and information technology application will gradually take the dominant position. Based on the triple helix innovation theory, this paper analyzes and discusses the impact of innovation platforms, innovation culture, and information technology on the innovation ability of SMEs with SMEs in Hefei as the research object. To solve the problem of how SMEs can improve their innovation ability through innovation platforms, innovation culture construction, and information technology application.

From the perspective of dynamic process, this paper analyzes how SMEs carry out technological innovation activities at different stages of development, and also what the driving factors for enterprises to shift from one stage to another, and how to enhance their innovation capability through an innovation ecosystem, and provides typical cases to explore the growth path of innovation capability of KeLi Information Company and explore the development code of the company to realize the innovation drive, to provide a good solution for SMEs to Provide a good solution for the improvement of innovation ability. This paper discusses the growth path of the innovation ability of KeLi Information Company through a typical case study and explores the password of the company to realize innovation-driven development, to provide theoretical guidance for the enhancement of innovation ability and high-quality development of small and medium-sized enterprises (SMEs).

The main research results of this paper are as follows:

- 1) The innovation ability of SMEs in Hefei City varies with the development stage of the main body of the enterprise. Whether SMEs build an innovation platform, whether they form an enterprise innovation culture, whether they use information technology promptly, and the degree of advancement are positively related to SMEs' innovation capability.
- 2) In the enterprise innovation ecosystem jointly composed of innovation platforms, innovation culture, and information technology, SMEs enhance their innovation capability through resource sharing and cooperation with innovation factors such as universities, research institutions, and government.



3) Enterprise innovation capability includes innovation resource input capability, R&D capability, production and manufacturing capability, technological innovation environment construction capability, innovation management capability, results transformation and application capability, and learning integration and absorption capability.

4) Through typical case interviews and analyses, the general paths of SMEs' innovation capacity enhancement are summarized, i.e. imitation innovation, cooperative innovation, collaborative innovation, and independent innovation. Each method has its applicable conditions, advantages, and disadvantages, and SMEs can choose appropriate technological innovation methods and capacity enhancement paths according to their development stages and conditions.

5) Setting medium-sized, small, and micro 2 regulatory variables for segmentation research on the impact of innovation platform, innovation culture, and information technology on enterprise innovation ability, proposed that SMEs need to play the positive impact of innovation platform, innovation culture, information technology on enterprise innovation ability, "Specialized, Refined, Specialized, and New" under the empowerment of the digital economy "(SRDI: Specialized, Refinement, Differential, Innovation (SRDI) development model empowered by the digital economy will be the optimal option for SMEs to improve their innovation capacity.

## DISCUSSION AND FORESIGHT

This paper constructs a theoretical analysis framework based on the triple helix innovation theory, takes the influence of the enhancement of the innovation ability of SMEs in Hefei City as the research object, and takes the innovation platform of Keli Information Company, the construction of innovation culture and the application of cutting-edge information technology as the cases to explore how to enhance the innovation ability of SMEs based on the innovation ecology. Finally, this paper has achieved certain research results and practical value, but due to the limitations of personal academic ability and time as well as the complexity of the research problem, there are still shortcomings in this paper's research from the perspective of the process of synthesized argumentation, which is to be improved and deepened in the subsequent research.

1) The enhancement of the innovation capacity of SMEs is a relatively complex systematic project, and there are still many influencing factors that have not been taken into account, the technology of SMEs covers a wide range of knowledge-intensive, for different innovation subjects, innovation elements, different geographic regions, and different subsectors and technological fields, their innovation activities and the process of innovation capacity enhancement may be different, and tapping into the more targeted characteristics is the future of this thesis The direction and entry point of the research.

2) In making the argument, this paper adopts a mixed research method combining quantitative and qualitative, conducts a typical case study, and selects Hefei SMEs as the research object, but the acquisition of relevant data is not comprehensive enough, and the interview subjects involving SMEs' competent departments and executives' groups are relatively weak, so it will be more persuasive if we conduct empirical studies with large samples in the subsequent research to increase the data analysis.

3) In the selection of research objects, this paper only takes some enterprises as typical objects, makes theoretical arguments through longitudinal research, and lacks horizontal comparisons. The follow-up research can expand the number of research samples, and form horizontal comparative analyses through multi-case longitudinal research, which will make the conclusions more comprehensive.

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