THE IMPACT OF ORGANIZATIONAL CULTURE, INNOVATION INPUTS, AND DIGITAL TECHNOLOGY ON SMES' INTELLECTUAL PROPERTY INNOVATION CAPABILITY

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ABSTRACT
The purpose of this study is to identify the impact of organizational culture, innovation input, and digital technology on the intellectual property innovation capability of SMEs in Hefei. A simple random sampling analysis of 343 samples from Hefei was conducted. The purpose of this study is to explore the causal relationship among organizational culture, Innovation Inputs, digital technology, and intellectual property innovation in SMEs. A structural equation model is established and verified in this study. The results support the hypothesis of H1 to H6. The qualitative results show that the innovative organizational culture has a positive impact on the intellectual property innovation ability of small and medium-sized enterprises. The degree of innovation inputs and the degree of digital technology application are positively correlated with the intellectual property innovation ability of small and medium-sized enterprises. There are also mediating effects between organizational culture and innovation input and between innovation input and innovation ability.
Keywords: Organizational Culture, Innovation Inputs, Digital Technology, Intellectual Property Innovation Capability

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INTRODUCTION

According to China Statistical Yearbook 2022, in 2021, the number of SMEs accounted for 90.23% of the total number of enterprises, SMEs have become an important force in the economic and social development of SMEs. The 2021 Evaluation Report of Chinese Enterprises' Innovation Capability evaluates Chinese Enterprises' innovation capability from four dimensions: innovation input capability, collaborative innovation capability, intellectual property capability, and innovation drive capability. The report points out that in recent years, Chinese enterprises have invested heavily in innovation, improved their ability to innovate, and improved the protection of intellectual property rights. The innovation ability of enterprise intellectual property has become a key factor in measuring the innovation ability and economic competitive power of an enterprise and a country.

The World Intellectual Property Organization (WIPO) also states, "Intellectual property is a key driver of innovation and an important incentive for innovation and creativity, and any enterprise can benefit from the successful use of intellectual property". Intellectual Property and sustainable innovation implementing sustainable development goals in national intellectual property systems (source: https://www.wipo.int/about-ip/zh/index.html). In China, the idea that "Innovation is the primary driving force for development, and protecting intellectual property is protecting innovation" reveals the close relationship between intellectual property and scientific and technological innovation, it points out the direction for pushing forward the protection of intellectual property rights and scientific and technological innovation under the new situation.

Intellectual property innovation capability of small and medium-sized enterprises is an important component of innovation capability of small and medium-sized enterprises. In the second aspect, many scholars have done some research from different angles. Edmonds Michael Phelps, a prominent economist and Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel argues that innovation is thinking and developing a better way of doing things in our minds, or a process that can be done better. Innovation is the lifeblood of SME development and survival (Zahra & Cowen, 1994). Small and medium-sized enterprises are the main body of national economic and social development and play an important role in promoting growth, ensuring employment, and improving people's livelihood. Improving the technological innovation capability of enterprises is the micro-foundation and power source of building an innovation-oriented country (Lu Xianxiang, 2021). Small and medium-sized enterprises (SMEs) are an important group of enterprises in the national economic system. It is of great strategic significance to promote the high-quality development of SMEs (Zhou Lizhong, 2022). Intellectual property capacity positively influences the degree of regional independent innovation (Xie Qijun, Song Wei, et al., 2019). Intellectual property rights play an increasingly active role in stimulating local innovation and promoting local economic development (Liu Yumeng, 2020). The effective use of intellectual property assets of small and medium-sized enterprises is the key factor of sustainable economic development. (Sati-salmah Sukarmijana et al., 2014). Intellectual Property (IP) is an important intangible asset to enhance the innovation capability of SMEs. (Liu Zhenyuan et al., 2018). In developed countries and developing market economies, knowledge creation is the largest driver and strongest predictor of innovation performance. (Robertson et al., 2023).

With the new demand of development, the development of small and medium-sized enterprises, the protection of intellectual property rights, and the innovation of science and technology are facing not only the challenge of rapid change of internal and external environment but also the historical opportunity of transformation and upgrading, innovation and development. Many small and medium-sized enterprises do not effectively exert the direct influence of organizational culture and the positive intermediary role of innovation investment and digital technology in the innovation process. Therefore, it is of great theoretical and

practical significance to study the impact of organizational culture, innovation input and digital technology on the innovation capability of enterprise intellectual property and its impact on enterprise value.

In this study, the intellectual property innovation capability of SMEs in Hefei is taken as the research object to determine the path of the impact of organizational culture, innovation input and digital technology on the intellectual property innovation capability of SMEs in Hefei, testing the intellectual property innovation capability model structure of Hefei small and medium-sized enterprises based on organizational culture, innovation input and digital technology, the objective of this study is to analyze the interaction mechanism of intellectual property innovation capability of SMEs in Hefei based on organizational culture, innovation input and digital technology. There are 6 hypotheses about the positive impact of organizational culture of innovation on intellectual property innovation ability of SMEs.

LITERATURE REVIEWS

Literature Review of Organizational Culture

The concept of organizational culture was only formalized in the 1980s Schneider et al. (Schein, 1985). In Jennifer Chatman believes that the OCP scale distinguishes seven cultural dimensions (innovativeness, stability, respect for employees, result orientation, attention to detail, aggressiveness, and team orientation), and that the innovation values, innovation incentive system, and innovation behavioral patterns in the organizational cultures of high-end equipment manufacturing enterprises have different degrees of positive impact on organizational innovation activities. (Wang Chenggang & Shi Chunsheng, 2018) Generally speaking, organizational culture has three levels: the surface material level, the middle institutional level and the core spiritual level, in this sense, organizational culture refers to a dynamic process based on the operation of the four-helix innovation ecosystem. (Yang Xueding, 2020)

Denison's model of organizational culture focuses on four key characteristics of an ideal corporate culture: external adaptability, internal integration, flexibility, and stability; and Fiennes-Trampinas's model of organizational culture latitudinally classifies organizational culture into four types: the family-oriented organizational culture, the conservation-oriented organizational culture, the missile-oriented organizational culture, and the Eiffel Tower-oriented organizational culture. According to Hofstede, organizational culture is a characteristic possessed by the organization rather than the individual. Michael Harris Bond (Hofstede & Bond, 1988) proposed power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity, femininity versus masculinity, and long-term versus short-term orientation (Hofstede, 1991, 2001). In the process of carrying out organizational innovation and transformation, managers should fully recognize the important role of organizational culture, attach great importance to the cultivation of employees' innovative values, pay attention to the innovative behavioral patterns of enterprises is the second, and the innovative incentive system is the last. (Wang Chenggang & Shi Chunsheng, 2018). Studies have shown that subcultures emerge in scale-up companies, and these subcultures may deviate from the primary organizational culture pursued by the management team. (Julia Strangers et al., 2022) Theoretical studies have shown a strong link between organizational culture and performance (Hartnell et al., 2019; Kim & Chang, 2019).

Jo Kotter and James Heskett state that company culture is critical to the continued growth and success of a company. O'Reilly et al. categorize organizational culture into seven dimensions: innovation orientation, results orientation, respect for others, team orientation, stability, aggressiveness, and attention to detail. Hofstede et al. categorize organizational culture into six dimensions: process orientation/results orientation, employee orientation/work orientation, narrowness/professionalism, openness/closure, loose control/strict control, and

standardization/efficiency into six dimensions: process orientation/results orientation, employee orientation/work orientation, narrowness/professionalism, openness/closure, loose control/strict control, and standardization/efficiency. Tsui et al. categorized organizational culture into results-oriented and innovation-oriented. Suli Zhu and Lirong classified organizational culture orientation into three types: financial result orientation, market result orientation and innovation result orientation.

Chen Weiqi et al. found that there is a positive correlation between organizational innovation culture and employee innovation behavior, while there is a negative correlation between organizational culture intensity and employee innovation behavior, but organizational culture intensity can strengthen the positive correlation between innovation culture and employee innovation behavior. Some researchers also believe that a strong organizational culture can coordinate the actions of organizational members, reduce communication costs, and improve organizational efficiency (Yilmaz & Ergon, 2008): group culture, democratic culture, hierarchical culture, and market culture.

Organizational culture is a topic that has long been discussed and researched in the field of organizational studies and has important practical and managerial implications. According to the authors, organizational culture is a composite reflection of the values that guide the sustainable development of a firm over a long period of time as it grows and develops. Overall, organizational culture theory is an important concept in understanding how organizations function and how they can be managed effectively. By recognizing and shaping their culture, organizations can create a positive work environment that supports employee engagement and drives success.

Literature Review of Innovation Inputs

R&D is the process of research and development, whereby existing knowledge is explored and integrated to create new applications. Therefore, R & D input is to research the new rules of things to be capital investment, applied to the real production of manufacturing, processing, and ultimately the formation of new applications laws from research are invested and applied to the manufacturing and processing of the real product and finally form a new final form of the new thing. (Wei Guowang, 2020)

Innovation inputs, as a factor of production, can have a positive impact on innovation performance. Innovation input can be divided into an organization’s innovation input and an employee's innovation input. The innovation input of the organization is mainly divided into the introduction of talents, the investment of funds, the introduction of technology, etc. The innovation input of individual employees can be divided into the enhancement of knowledge reserves, the payment of funds, time spent, and the use of energy, etc. From the perspective of employees, innovation input refers to the sum of time, energy and other types of resources paid by employees for innovation activities. (Wang Qiuying, 2023) Innovation investment promotes firm performance, but there is a certain lag effect. (Chen Yiping et al., 2023)

In the new economy and society characterized by knowledge and information, R&D is the basic guarantee for enterprises to obtain long-term advantages in market competition, and the R&D investment of enterprises can bring future market value to enterprises. (Zhou Yan & Zeng Jing, 2011) There is a non-linear influence effect between R&D input and economic high-quality development under the influence of different levels of financial development, i.e., when financial development reaches a certain level, R&D investment can significantly promote economic high-quality development. (Ni Ying & Wei Jingrong, 2022)

Innovation inputs play a positive Total factor productivity role in promoting the development of the digital economy. (Jin Yu et al., 2023) Using panel data from 30 province-level divisions in our country from 2000 to 2020, we studied the impact of inputs to science and technology innovation on high-quality economic development, the higher the level of intellectual property protection, the stronger the role of science and technology innovation inputs in promoting high-

quality economic development. (Cheng Hui-fang et al., 2023) The intensity of corporate R&D inputs has a significant positive effect on corporate profitability, and the effect increases over time. (Liu Yun et al., 2020) Increased government subsidies for R&D are found to promote real innovation and economic growth, and the promotion effect is non-linear. (Hu Shan-cheng & Jin Laiqun, 2021)

Chen Jin and others believe that tapping and allocating internal and external resources and providing advanced research and development equipment for innovation activities, to establish a scientific incentive system, creating a tolerant and efficient culture of innovation enables the efficient use of innovation inputs and the transformation of innovation inputs into innovation outputs (Chen Jin, Guo-Rong Yu & Liu Chang, 2020)

Based on reviewing the research of previous scholars on innovation inputs, this paper focuses on the three dimensions of R&D expenditure, Intellectual capital, and Infrastructure inputs.

Literature Review of Digital Technology

Digital technology refers to the use of digital devices, software, and systems to store, process, and transmit information. Digital technology refers to the use of digital devices, software, and systems to store, process, and transmit information. Brynjolfsson, E., & McAfee, A. (2014). The second Machine Age: Work, progress, and prosperity in a time of brilliant technologies. WW Norton & Company. Digital technology encompasses a wide range of tools and techniques that enable the creation, manipulation, and transmission of information through electronic means. Castells, M. (2010). The rise of the network society: The information age: Economy, society, and culture (Vol. 1). John Wiley & Sons. Digital technology is the use of digital devices and systems to store, process, and transmit information. Collins, J. C. (2019).

The rapid development of digital technology has triggered a fundamental change in the competitive environment of firms, which has led to a closer linkage between the different innovation elements surrounding firms (Liu Shilin & Wang Qian, 2021). 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 in the form of artificial intelligence, cloud computing, big data, and the Internet of Things, with digitalization, networking, and intelligence as important features, is becoming more and more widespread.

With the rapid development of digital technologies such as artificial intelligence, big data and cloud computing, the introduction of digital elements and digital empowerment brings a series of opportunities and challenges to the innovation ecosystem and its participants, the change of participation environment and mode also put forward the need to reshape the competition, cooperation, and interaction among the participants in the innovation ecosystem. (Jiao Hao et al., 2022)

Literature Review of Intellectual Property Innovation Capabilities of SMEs

Innovation is the soul of an enterprise. soul of the industry and scholars have invested in innovation mainly by using enterprise R&D investment of the industry to measure (Hu Guoliu et al., 2019) Enterprises in technological innovation in addition to the level of scientific and technological achievements and maturity and other technological factors should also pay attention to the research and development of non-technological factors to create a good external environment for enterprise technological innovation.(Mao Yong & Liu Yazi, 2000)

Theoretical Framework for Research

This study takes SMEs' intellectual property innovation capacity as the dependent variable (i.e. the research object), organizational culture as the independent variable, and innovation inputs and digital technology as the moderating variables. The theoretical structural equation model is constructed based on an overview of previous opinions, research objectives, and the actual situation of SMEs' intellectual property innovation capacity.

The schematic diagram of the model is shown in Figure 1: The framework of this study.

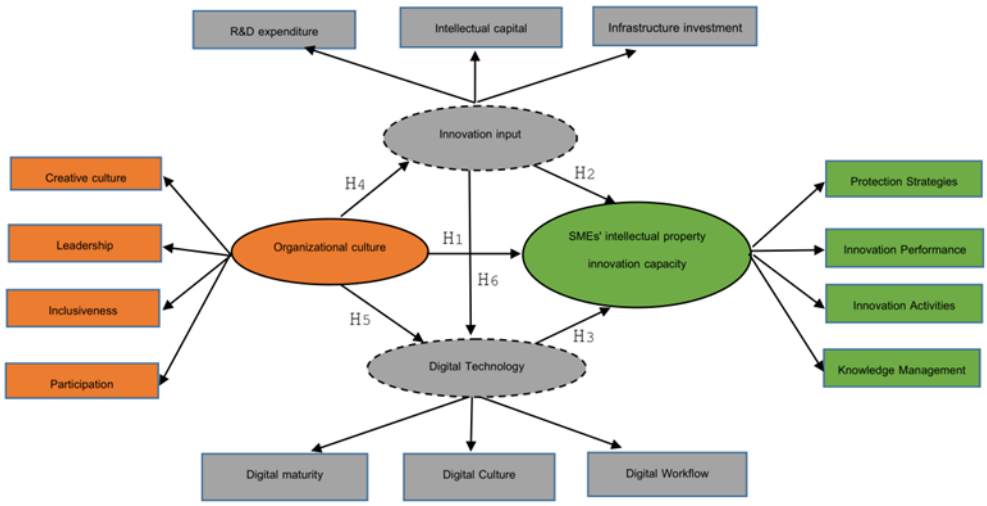


Figure 1 The Research Framework Diagram

RESEARCH METHODOLOGY

This study adopts a hybrid design, combining quantitative and qualitative research methods, to fully understand the impact of organizational culture, innovation inputs, and digital technology on the intellectual property innovation capability of SMEs. First, quantitative data were collected through questionnaires, and then qualitative interviews were conducted to gain insight into the interviewees' views and experiences in Hefei City selected as the research object in this study.

According to the adopted data, SPSS Amos data will be used for analysis, and it is proposed to analyze in depth the interaction mechanism and characteristics between organizational culture, innovation inputs, and digital technology from the perspective of innovation ecosystem theory; this paper will explore the relationship and influence between organizational culture construction, the degree of innovation inputs, the level of digital technology and the enhancement of SMEs' intellectual property rights innovation capacity.

SMEs in Hefei were selected as the research object, and stratified sampling was carried out according to factors such as enterprise size, industry, and establishment period to ensure that the sample was representative. According to the research framework o, the dimensions of this study are as follows: the dependent variables of intellectual property innovation capability of SMEs include four dimensions: protection strategies, innovation performance, innovation activities, and knowledge management; The independent variables of organizational culture were creative culture, leadership, inclusiveness and participation, and the moderator variables of innovation input were R&D expenditure, intellectual capital and infrastructure investment, Digital technology of moderating variables selects 3 dimensions of digital maturity, digital culture and digital workflow, and there are 14 dimensions in total. The sample size of this study is set as follows: the research dimension is magnified 20 times, and the common 14% error is taken into account, so the sample size is 319.

RESEARCH RESULTS

This study first constructs a structural equation model, with organizational culture (Cul) as the independent variable, innovation inputs (Input), digital technology (Tec) as the mediating variables, and intellectual property rights (IPR) innovation in SMEs (SME) as the dependent variable. A mediated chain model is constructed to investigate how Cul influences Input, Tec,

and SME; how Input influences Tec and SME; how Tec influences SME; and whether Input and Tec act as mediators between Cul and SME.

We further conduct computations using AMOS 26.0. First, we perform a test of model fit. Based on the fit indices of the structural equation model, the requirements are as follows: X^2/df should be less than 5.000, with a value of 1.219 in this study, meeting the requirement. RMR should be less than 0.080, with a value of 0.044 in this study, meeting the requirement. RMSEA should be less than 0.080, with a value of 0.026 in this study, meeting the requirement. GFI should be greater than 0.800, with a value of 0.965 in this study, meeting the requirement. AGFI should be greater than 0.800, with a value of 0.948 in this study, meeting the requirement. IFI should be greater than 0.900, with a value of 0.990 in this study, meeting the requirement. TLI should be greater than 0.900, with a value of 0.987 in this study, meeting the requirement. CFI should be greater than 0.900, with a value of 0.990 in this study, meeting the requirement. The above values all indicate that the model fits well, rendering the subsequent analysis results reliable.

Table 1 The model fit indicators of the Structural Equation Model

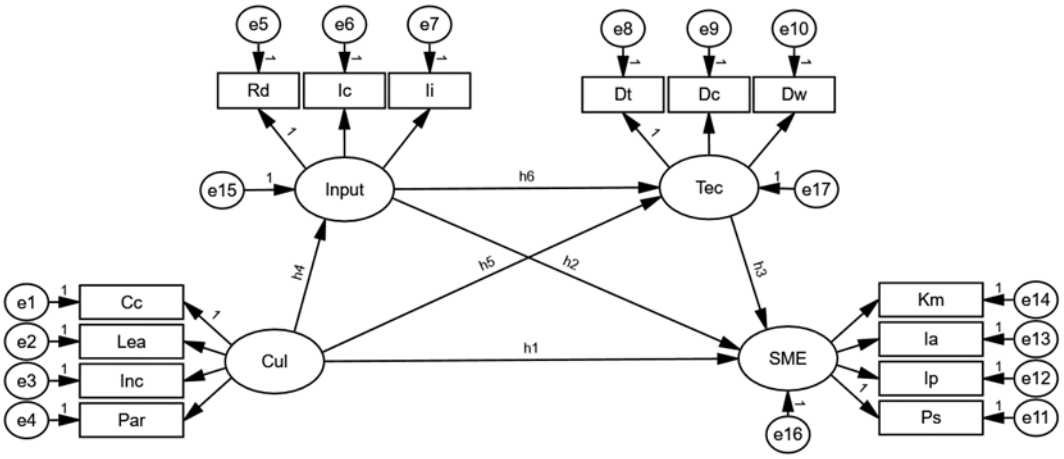
	X^2/df	**RMR**	**RMSEA**	**GFI**	**AGFI**	**IFI**	**TLI**	**CFI**
Threshold Value	<5.000	<0.080	<0.080	>0.800	>0.800	>0.900	>0.900	>0.900
Result	1.219	0.044	0.026	0.965	0.948	0.990	0.987	0.990
	√	√	√	√	√	√	√	√

Next, path coefficient tests were conducted, and parameter estimation was performed using the maximum likelihood method (Rockwood, 2020). The results are shown in the table below and the following figure: The effect of Cul on Input is positive (B=0.403, p<0.05), indicating a significant effect; the effect of Cul on Tec is positive (B=0.335, p<0.05), indicating a significant effect; the effect of Input on Tec is positive (B=0.268, p<0.05), indicating a significant effect; the effect of Cul on SME is positive (B=0.256, p<0.05), indicating a significant effect; the effect of Input on SME is positive (B=0.269, p<0.05), indicating a significant effect; the effect of Tec on SME is positive (B=0.335, p<0.05), indicating a significant effect. Therefore, hypotheses H1-H6 were all validated in this study.

Table 2 Path coefficient test of Structural Equation Model

Pathway	**Unstandardized coefficient**		**Standardized coefficient**	***C.R.***	***p***
	B	***S.E.***	***β***		
Cul→Input	0.403	0.073	0.409	5.560	***
Cul→Tec	0.335	0.076	0.344	4.410	***
Input→Tec	0.268	0.078	0.271	3.419	***
Cul→SME	0.256	0.078	0.241	3.270	0.001
Input→SME	0.269	0.081	0.250	3.334	***
Tec→SME	0.335	0.086	0.308	3.905	***

Note: *** $p < 0.001$, indicating extremely significant effects.



Figue 2 Structural model

Figure Structural equation model (Unstandardized Coefficients)
Results from the analysis indicate significant findings across multiple dimensions. Direct effects (Cul→SME), Mediating effects 1 (Cul→Input→SME), Mediating effects 2 (Cul→Tec→SME), and Mediating effects 3 (Cul→Tec→Input→SME) all exhibited significant effects, with their corresponding 95% confidence intervals excluding 0 and p-values less than 0.05. Furthermore, the total effect also displayed significance, with its effect value being 0.512 and the 95% confidence interval not encompassing 0, indicating a noteworthy impact. These findings underscore the complex interplay between organizational culture, innovation inputs, digital technology, and SMEs' intellectual property innovation capabilities within the examined model. Therefore, hypotheses H4-H5 were all validated in this study.

Table 3 Effect testing of Structural Equation Model

	Effect	***SE***	**95%CI from Bootsrap**		***P***
			lower	**upper**	
Direct effects (Cul→SME)	0.256	0.083	0.089	0.414	0.003
Mediating effects1 (Cul→Input→SME)	0.109	0.038	0.044	0.194	0.001
Mediating effects2 (Cul→Ted→SME)	0.112	0.039	0.052	0.211	***
Mediating effects3 (Cul→Ted→Tec→SME)	0.036	0.015	0.015	0.079	***
Total effect	**0.512**	**0.078**	**0.367**	**0.673**	**0.001**

Note: *** $p < 0.001$, indicating extremely significant effects.

This study constructs a structural equation model with organizational culture as an independent variable, innovation input (input) and digital technology (TEC) as intermediary variables, and intellectual property innovation of small and medium-sized enterprises as dependent variables. The relationships between Cul (Cc, Lea, Inc, Par), Input (RD, IC, II), TEC (DT, DC, DW), and SME (PS, IP, IA, Km) were further examined using the Pearson correlation method.
The results showed that Cul (Cc, Lea, Inc, Par) was positively correlated with input (RD, IC, II) with R of 0.147 ~ 0.330, P & Lt; Cul (Cc, Lea, Inc, Par) was positively correlated with TEC (DT, DC, DW) with R of 0.176 ~ 0.360, p & Lt; 0.05; Cul enterprises (Cc, Lea, Inc, Par) were positively correlated with small and medium enterprises (SME) with correlation coefficients ranging from 0.186 to 0.400. (RD, IC, II) positively correlated with TEC (DT, DC, DW), R = 0.154 ~ 0.307, P & LT; 0.05; input (RD, IC, II) positively correlated with SMEs (PS, IP, IA, Km), r = 0.186 ~ 0.373, P & Lt; 0.05;. TEC (DT, DC, DW) was positively correlated with SME (PS, IP, IA, Km), and the correlation coefficient (R) was 0.217 ~ 0.407, P & Lt; 0.05. Based on the correlations between the variables, it can be inferred that there are positive correlations

between the variables, which are statistically significant, indicating the possibility of further causal analysis.

The results show that CUL has a positive effect on input (b = 0.403, P & Lt; 0.05), and Cul has a positive effect on TEC (b = 0.335, P & Lt; 0.05) The effect of Cul on SMEs was positive (b = 0.256, P & Lt; 0.05), indicating a significant effect, while the effect of input on SMEs was positive (b = 0.269, P & Lt; 0.05), indicating a significant effect The effect of TEC on SMEs was positive (b = 0.335, P & Lt; 0.05). Therefore, the H1-H6 hypothesis was tested in this study.

The results show that there are significant findings in many aspects. Direct effect (Cul → SME), mediating effect 1 (Cul → input → SME), mediating effect 2 (Cul → TEC → SME), and mediating effect 3 (Cul → TEC → input → SME) all showed significant effects, its 95% confidence intervals do not include 0 and P values less than 0.05. In addition, the total effect was also significant, with an effect value of 0.512 and a 95% confidence interval excluding 0, indicating a significant effect. These findings highlight the complex interplay between organizational culture, innovation inputs, and the ability of digital technology to innovate in intellectual property within the research model. Therefore, the H4-H5 hypothesis was tested in this study.

DISCUSSION AND SUGGESTION

Validation of research hypotheses

According to the results of this study, the following suggestions are made for SMEs intellectual property innovation ability: the research results show that government subsidies are an important means to ease the financing constraints of SMEs, can effectively improve the investment level of small and medium-sized enterprises in innovation activities (Wang Honglang, 2024).

Thinking about Practical Operationalization

For SMEs, through technological innovation, R&D investment can reduce the cost space, develop new market demand, enhance business services and products in the market core competitiveness, gain new profit growth points, help the enterprise to enhance the competitive advantage position, and enhance the enterprise value. The digitization shift could boost intellectual capital in IP-intensive companies and introduce new ways to manage intangible assets and measure performance (Trequattrini Raffaele et al., 2022). The research shows that it is very important for small enterprises to give full play to and enlarge the role of innovation input, which plays a positive role in the promotion of enterprise value (Liu Yingxuan & Li Xiansi, 2022).

Suggestions for Future Research

Through the use of structural equation models or other methods to conduct empirical research, to determine the size and statistical significance of each mediation effect, mining the corresponding data, and investigating the potential factors that may affect the strength of the interaction between variables. To achieve the effect size adjustment. We should apply new technology and explore new models to enrich the construction of innovative organizational culture and enhance the intellectual property innovation ability of SMEs.

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