**ISSN** 1816-6075 (Print), 1818-0523 (Online)
**Journal of System and Management Sciences**
Vol. 14 (2024) No. 1, pp. 561-578
DOI:10.33168/JSMS.2024.0133

# The Interplay of Entrepreneurial Orientation and Business Model Innovation in the Big Data Context: A Survey Study

Lingyun Fang[1,2]

[1]School of Medical and Health Management, Guizhou Medical University，GMU, Guiyang 550025, Guizhou, China

[2]Innovation College, North-Chiang Mai University, Chiang Mai, 50230, Thailand

*18586396666@126.com*

**Abstract.** With the advent of the big data era, businesses are facing tremendous opportunities and challenges. In this context, the impact mechanism of entrepreneurial orientation on business model innovation has become an important research topic. This paper aims to explore the impact mechanism of entrepreneurial orientation on business model innovation in the context of big data and provide relevant theoretical guidance. Through literature review and theoretical analysis, we construct a theoretical model based on the dynamic capabilities perspective and propose corresponding research hypotheses. Through questionnaire surveys and data analysis, we validate these research hypotheses and draw the following conclusions: entrepreneurial orientation has a significant positive impact on business model innovation; entrepreneurial orientation has a significant positive impact on big data capabilities; big data capabilities have a significant positive impact on business model innovation; big data capabilities partially mediate the relationship between entrepreneurial orientation and business model innovation. These research findings contribute to a deeper understanding of the impact mechanism of entrepreneurial orientation and big data capabilities on business model innovation, and provide theoretical guidance for business model innovation in the era of big data. The conclusions of this study have important practical implications and can provide recommendations for businesses to formulate entrepreneurial orientation strategies and enhance their big data capabilities, thereby promoting their competitive advantage in fierce market competition. However, this study also has some limitations, such as sample selection limitations and the generalizability of research results, which provide further research directions for future studies.

**Keywords:** Big data, entrepreneurial guidance, business model innovation, impact mechanisms

# 1. Introduction

With the advent of the big data era, the rapid development of information technology and the explosive growth of data present significant challenges and opportunities for business operations and innovation. As a powerful resource, big data provides enterprises with abundant information and insights, driving the innovation and evolution of business models. In this context, entrepreneurial orientation, as an important organizational characteristic, plays a crucial role in the ability of enterprises to innovate their business models.

However, the research on the impact mechanism of entrepreneurial orientation on business model innovation in the context of big data is still relatively limited. While some studies have explored the relationship between entrepreneurial orientation and business model innovation, as well as the influence of big data capabilities on innovation capabilities, there is still a knowledge gap regarding the specific mechanisms and pathways through which entrepreneurial orientation affects business model innovation in the context of big data (Ferreras-Méndez et al.,2021）. Therefore, this paper aims to fill this research gap by examining the impact mechanism of entrepreneurial orientation on business model innovation in the context of big data from a dynamic capabilities perspective. To achieve this goal, this study first provides clear definitions and explanations of concepts such as big data capabilities, entrepreneurial orientation, and business model innovation, and constructs a corresponding research framework and theoretical model. Then, through questionnaire surveys and data analysis, the research hypotheses are tested, exploring the influence of entrepreneurial orientation on business model innovation, the impact of entrepreneurial orientation on big data capabilities, the influence of big data capabilities on business model innovation, and the mediating role of big data capabilities between entrepreneurial orientation and business model innovation.

The research findings of this paper are expected to contribute to the enrichment and expansion of the theoretical understanding of entrepreneurial orientation and business model innovation, providing robust theoretical support and practical guidance to promote the development of entrepreneurial orientation and business model innovation in the era of big data, enhancing competitive advantages and sustained innovation capabilities of enterprises. Additionally, the conclusions of this study will provide decision-makers and managers with recommendations for formulating innovation strategies and enhancing big data capabilities to better cope with rapidly changing market environments and competitive pressures (Wang et al., 2023）. Finally, this study also has some limitations, such as sample selection and data collection methods, which offer opportunities for further in-depth exploration in future research.

# 2. Literature Review

## 2.1. Connotation and Characteristics of Big Data

Big data refers to the collection of data resources formed by massive, diverse, high-velocity, and complex data sets. The connotation and characteristics of big data have become increasingly important in the context of rapid development of information technology. Firstly, the connotation of big data includes the scale and breadth of data. Compared to traditional data, big data is typically measured in units of terabytes (TB), petabytes (PB), or even exabytes (EB), containing a massive amount of data resources. Big data not only involves an increase in data quantity but also the integration of diverse data sources, including structured data (such as data in databases), semi-structured data (such as XML files, log files, etc.), and unstructured data (such as social media content, images, audio, etc.). This enables businesses to obtain data from multiple channels and gain a more comprehensive and holistic perspective. Secondly, the characteristics of big data mainly manifest in velocity and complexity. In the era of big data, data updates at a high speed, new data sources constantly emerge, and real-time processing and analysis are required. Traditional batch processing methods no longer meet the demands of big data, but techniques such as real-time streaming processing and deep learning are needed to

address the challenges of high-velocity data. Additionally, the complexity of big data is also reflected in the uncertainty of data quality, the diversity of data types, and the complexity of data relationships, among other aspects (Xia Q et al,. 2022）. This requires businesses to possess data mining and analysis capabilities to extract valuable information and make informed decisions. Furthermore, big data has relatively low value density. Due to the scale and diversity of big data, it contains a substantial amount of redundant, junk, or irrelevant data, making valuable information hidden within the massive data. Therefore, effectively extracting and analyzing meaningful information from big data becomes an important prerequisite for conducting business model innovation (Ge & Li, 2023）.

In summary, the connotation and characteristics of big data encompass the scale, breadth, velocity, and complexity of data, posing new challenges and opportunities for business model innovation. Companies need to have the capability to acquire, integrate, analyze, and utilize big data to adapt to the changes in the era of big data, enhance their competitive advantage, and drive innovation realization.

## 2.2. Theoretical Foundations of Big Data Competencies-Dynamic Competencies

Dynamic capability refers to an organization's ability to adapt, learn, and innovate in a constantly changing environment. It emphasizes the organization's capacity to identify, integrate, and leverage opportunities and challenges to achieve long-term competitive advantage and continuous innovation. Firstly, dynamic capability consists of three core elements: sensing, learning, and integration. Sensing capability refers to the organization's sensitivity and insight into the external environment and internal resources, enabling accurate identification of changes, opportunities, and threats. Learning capability refers to the organization's ability to accumulate experience, absorb knowledge, and transform knowledge to continuously improve innovation and adaptability. Integration capability refers to the organization's effective integration of diverse resources, knowledge, and capabilities to form innovative new capabilities (Klein et al., 2021）. Secondly, dynamic capability is an organizational-level capacity that emphasizes the synergy of internal and external resources. Developing dynamic capability requires cross-departmental collaboration and coordination, as well as leveraging internal and external resources to build a continuously changing dynamic capability system. For example, internal resources such as technology, human resources, and management systems, as well as collaboration with suppliers, partners, and customers, can all play a crucial role in supporting dynamic capability. Furthermore, dynamic capability is time-dependent. It not only focuses on adapting to the current environment but also emphasizes foresight and proactive preparation for future changes. Organizations need to be flexible and agile, adjusting and revising strategies in a timely manner to respond to evolving market demands and competitive pressures. Finally, dynamic capability is a malleable ability. It can be enhanced through active organizational learning and training, and supported by institutional shaping and culture. Organizations need to continuously innovate and improve their management and operational approaches, strengthen interaction and learning with the external environment, and drive the formation and development of dynamic capability (Daradkeh & Mansoor, 2023）.

In summary, dynamic capability is an organization's ability to respond to challenges and opportunities in a constantly changing environment. It emphasizes the core elements of sensing, learning, and integration to adapt to the changes and demands for innovation in the external environment. Developing dynamic capability requires organizational-level collaboration, continuous learning, and improvement. In the context of business model innovation, companies need to focus on nurturing and applying dynamic capability to drive continuous innovation and achieve competitive advantage.

## 2.3. Big Data Capabilities

With the increasing impact of big data on society, big data is widely regarded as the next frontier of innovation and an important source of innovative products, services, and business opportunities. In this context, scholars have paid increasing attention to the study of big data capability. Big data capability refers to an organization's ability to utilize big data resources, technologies, and analytical methods to gain sustained competitive advantage and innovation opportunities (Mahmood et al., 2023）.

Different scholars have defined and conceptualized big data capability from different perspectives. For example, some scholars define big data capability as a firm's unique ability to perform optimal pricing, product quality testing, inventory management, or loyal customer identification in the big data environment. Other scholars associate big data capability with a firm's business strategy, considering it as the ability to use big data for decision-making to create differentiated competitive advantage. There are also scholars who define big data capability as the awareness and skills that organizations cultivate in the process of developing, managing, and utilizing big data.

From the perspective of dynamic capability theory, big data capability can be understood as an organization's ability to analyze and integrate internal and external big data resources, predict, and adapt to changes in the external environment. This capability includes dimensions such as resource acquisition, analytics and integration, and application abilities. Big data capability encompasses not only data management, technology, and talent capabilities but also integrated capabilities such as data cleansing, mining, and analysis (Makhloufi,2023）.

In summary, big data capability refers to the tacit knowledge and skills accumulated by organizations in utilizing big data resources, technologies, and analytical methods. It enables organizations to adapt to environmental changes, predict trends, provide business insights, and gain sustained competitive advantage. The core of big data capability lies in effectively acquiring, integrating, and utilizing big data resources to drive innovation and development. As the era of big data continues to evolve, the cultivation and application of big data capability will become crucial factors for organizations to gain competitive advantage and achieve sustainable development.

## 2.4. Business Model Innovation

### 2.4.1. Connotation of Business Model Innovation

Business model innovation refers to the process by which a company redefines its customer value proposition, redesigns its profit formula, and identifies key resources and processes in order to pursue higher performance and competitive advantage. It describes how companies apply business models to their respective industries, based on existing reference models, in order to seize opportunities and gain sustained competitive advantage (Covin et al.,2006）.

Scholars from various disciplines and perspectives have conducted research and provided definitions of business model innovation. In the field of marketing, it is conceptualized as changes in target customers and related value propositions, or as new consumption/distribution patterns and new products. In the field of organizational studies, business model innovation is seen as changes accomplished by managers and management teams through learning from experience or as a trial-and-error process. In the field of strategic management, business model innovation is primarily defined as the creation and capture of value for individual or multiple stakeholders through the introduction of innovative approaches. Additionally, in the field of entrepreneurship, business model innovation is closely related to disruptive innovation, aiming to seize new economic opportunities and maximize profits.

In summary, business model innovation is the process by which companies redefine their customer value proposition, redesign their profit formula, and identify key resources and processes, in order to pursue higher performance and competitive advantage. It encompasses perspectives from multiple disciplines and fields, providing different definitions and interpretations of business model innovation. As research on business model innovation continues to deepen, we can better understand its importance for enterprise development and provide guidance for practical applications. However, the field of business model innovation still requires more theoretical foundations and consistent definitions to further advance research and practice in this area (Widjaja & Dewi, 2017）.

### 2.4.2. Dimensions of Business Model Innovation

Business model innovation can be viewed from a single-dimension perspective and a three-core-dimension perspective. The single-dimension perspective considers business model innovation as a

single-dimensional variable for research. In contrast, the three-core-dimension perspective divides business model innovation into three dimensions: value creation innovation, value proposition innovation, and value capture innovation. Each dimension contains more specific sub-levels. Let's summarize these three dimensions:

(1) Value creation innovation: Many business models can be refined as innovations in value creation approaches. By leveraging new capabilities, technologies, processes, or partnerships, companies can achieve business model innovation. This includes developing and applying new capabilities to exploit opportunities in the external environment, adopting new technologies and equipment consistent with the business model, optimizing process structures in the activity system to improve operational efficiency, and developing new collaborative relationships to enhance the utilization of external resources. Through these means, companies can achieve value creation innovation and establish entirely new business models.

(2) Value proposition innovation: The value proposition involves a deep description of customer needs. Companies can achieve value proposition innovation by exploring new customers and markets, developing new channels, establishing new customer relationships, or introducing new products. New products can address customer problems or meet their needs in new or improved ways, while new customers and markets represent the target audience for the company's offerings. By developing new channels, especially by combining online and offline services, and establishing new customer relationships, companies can tap into the source of business model innovation, particularly in mature product or market situations (Genc et al, 2019）.

(3) Value capture innovation: Value capture describes how the value proposition is converted into revenue. This includes new revenue models and cost structures. New revenue models are used to incentivize customers to pay for the provided value proposition and increase new sources of income. The new cost structure covers direct or indirect costs related to the business and needs to be aligned with product-market strategy. Through innovative value capture approaches, companies can more effectively maximize their profits.

The combination of these three dimensions defines the form of a business model. Business model innovation takes the business model as the focus of innovation, going beyond product, service, or technological innovation. Regardless of the level of innovation compared to other dimensions, business model innovation requires changes in these three dimensions (as shown in Figure 1).

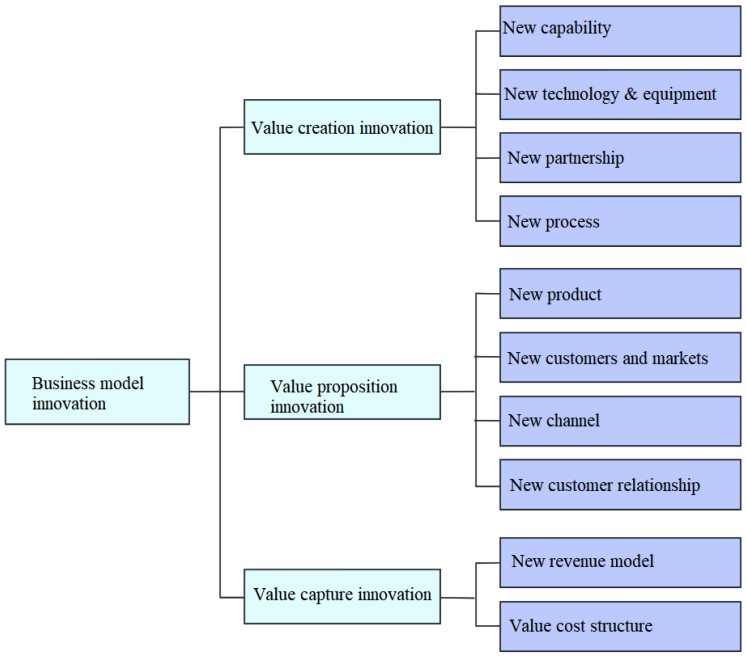


Fig.1: Three-dimensional division of business model innovation

In summary, business model innovation can be divided into perspectives from a single dimension and three core dimensions. The three core dimensions include value creation innovation, value proposition innovation and value capture innovation, which together constitute the shape of a business model. By innovating in these three dimensions, enterprises can explore new business opportunities, gain competitive advantage, and realize sustained business success. Enterprises need to pay attention to integrating and balancing these three dimensions when pursuing business model innovation in order to realize the goal of innovation (Chien & Tsai, 2021）.

## 2.5. Entrepreneurial Orientation

### 2.5.1. Concept of Entrepreneurial Orientation

Entrepreneurial orientation refers to a series of characteristics and behaviors exhibited by companies in the process of strategic formulation. It can be traced back to the theory of strategic management, strategic choice theory, and research in the field of innovation and entrepreneurship. The concept was first introduced by scholar Danny Miller in 1983 in academic literature. Entrepreneurial orientation is a representation in the strategic formulation of a company. It is closely related to innovation, which is one of the important drivers for company development. In entrepreneurial orientation theory, the factor of innovation differs in the entrepreneurial relationships of different types of companies. In particular, entrepreneurial companies are expected to possess three characteristics: innovation, risk-taking, and proactiveness. This means that CEOs of entrepreneurial companies tend to pursue product market innovation, take greater risks, and play a leading role in competition rather than simply following competitors. The core idea of entrepreneurial orientation is that companies should achieve growth and transformation by continuously exploring new opportunities and challenges. Entrepreneurial-oriented companies focus on innovation and possess an open attitude toward change. They are not afraid of risks, are willing to accept the possibility of failure, and have flexible decision-making and execution capabilities.

Entrepreneurial orientation has important practical value. Firstly, it helps companies better utilize internal and external resources, seek new business opportunities, and drive innovation. Secondly, entrepreneurial-oriented companies are better able to respond to competitive pressures and market changes, maintaining a competitive advantage. In addition, entrepreneurial orientation can shape the organizational culture of a company, inspire employees' innovative awareness and entrepreneurial spirit, and promote sustainable development. However, entrepreneurial orientation also faces challenges and risks. Entrepreneurial-oriented companies need to maintain sensitivity to market demand and commercial reality while pursuing innovation and transformation. They need to effectively manage risks and avoid blind ventures that lead to failure. Additionally, in a rapidly evolving environment, entrepreneurial-oriented companies face challenges in organizational management and resource allocation, requiring good strategic planning and execution capabilities.

### 2.5.2. Entrepreneurial Orientation Dimension

The dimensions that constitute entrepreneurial orientation have been widely studied and have various approaches. Some scholars argue that entrepreneurial orientation should be a single-dimensional strategic plan, where the dimensions are indivisible and interconnected. On the other hand, other scholars believe that entrepreneurial orientation is a multidimensional construct, where different dimensions do not necessarily coexist.

In terms of the dimensions that constitute entrepreneurial orientation, many studies have produced different conclusions. One of the most representative viewpoints comes from Danny Miller's research (1983), where he defines the dimensions of entrepreneurial orientation as innovativeness, risk-taking, and proactiveness. Specifically, innovativeness refers to the company's inclination towards pursuing product market innovation; risk-taking is the company's ability to undertake greater risks, and proactiveness means the company focuses on leading competitors rather than following them. Miller emphasizes the holistic perspective of these three dimensions, stating that companies must possess all

three dimensions, and one cannot be lacking. This three-dimensional approach to entrepreneurial orientation has gained recognition from many scholars.

Additionally, Lumpkin and Dess (1996) proposed two additional dimensions based on previous research: autonomy and competitive aggressiveness. Autonomy refers to a company's complete decision-making authority in strategic decision-making and action execution, free from external influences. Competitive aggressiveness means the company tends to predict future market demands and takes action in front of competitors to gain a first-mover advantage. Taking into account these two dimensions, entrepreneurial orientation is defined as having five dimensions, including autonomy tendencies, innovativeness, risk-taking, autonomy, and competitive aggressiveness.

In summary, entrepreneurial orientation has diverse approaches to its dimensions. Besides the earliest dimensions of innovativeness, risk-taking, and proactiveness, other dimensions such as autonomy and competitive aggressiveness have been added to the construct of entrepreneurial orientation. The research on these dimensions contributes to a deeper understanding of the essence and influencing factors of entrepreneurial orientation, guiding companies to better leverage the advantages of entrepreneurial orientation in strategic formulation and development. However, further exploration and empirical analysis are needed in the study of the dimensions that constitute entrepreneurial orientation.

# 3. Research Methodology

## 3.1. Theoretical Model and Research Hypotheses

### 3.1.1. Theoretical Model

Based on the theories of big data capability, dynamic capability, business model innovation and entrepreneurial orientation, this paper discusses the relationship between the three variables of entrepreneurial orientation, big data capability and business model innovation, and constructs a theoretical model between them. The following figure shows the theoretical model shown in Figure 2.

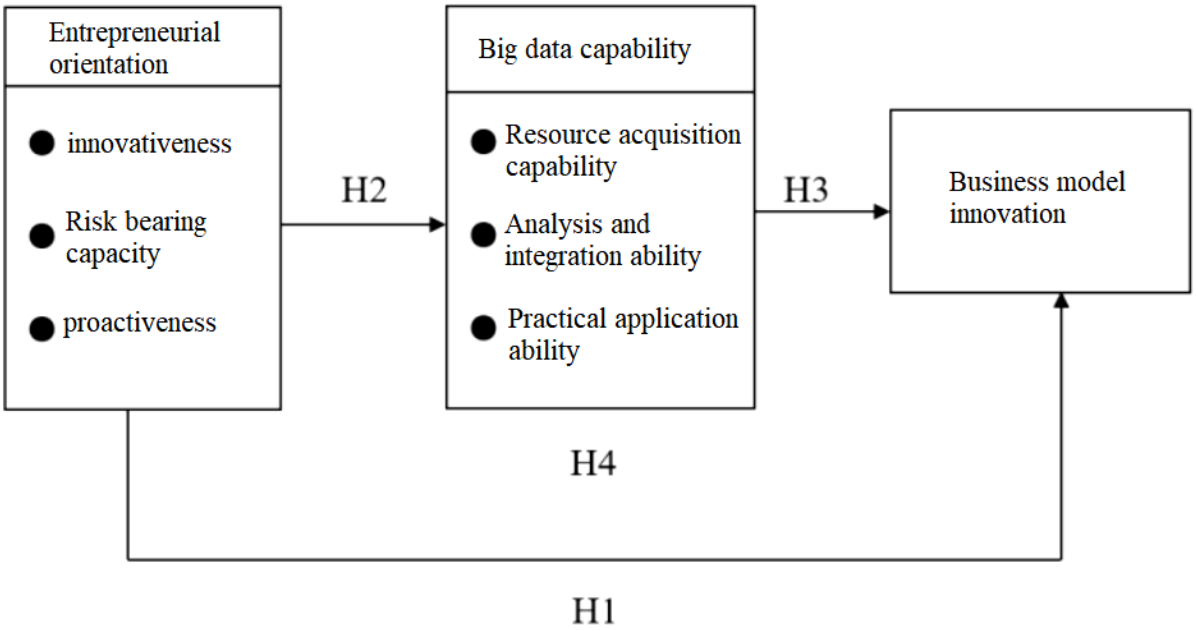


Fig.2: Theoretical model

In this theoretical model, entrepreneurial orientation, big data capability, and business model innovation are considered as interrelated factors. Specifically, here are the explanations of each element in the model:

(1) Entrepreneurial orientation refers to the tendencies and behaviors exhibited by individuals or organizations in entrepreneurial activities. It represents the willingness of enterprises to actively pursue

innovation, take risks, and pursue growth and development. Entrepreneurial orientation has an important impact on a company's innovation capability, competitive advantage, and long-term development.

(2) Big data capability refers to an enterprise's ability to acquire, manage, and analyze large-scale data. This includes data collection, storage, processing, and mining. Having strong big data capability enables companies to extract valuable information and insights from massive data, supporting key activities such as decision-making, market forecasting, and customer insights.

(3) Business model innovation refers to companies seeking to create unique value in the market by redesigning and transforming their business models. It involves innovation in areas such as product and service positioning, value propositions, profit models, and partner relationships. Business model innovation helps companies explore new markets, enhance competitiveness, and achieve sustainable development (Ma X et al., 2023）.

The arrows in the theoretical model represent the interrelationships and influences among these variables. Specifically, entrepreneurial orientation can promote a company's attention and investment in big data capability. Entrepreneurially-oriented companies are more willing to explore the application of data technology and play a pioneering role in data-driven decision-making and innovation. At the same time, big data capability can provide more data information and insights as support and basis for a company's entrepreneurial orientation.

On the other hand, big data capability can also support business model innovation. Through analysis and mining of massive data, companies can accurately identify market demands and customer behaviors, providing direction and opportunities for value creation in business model innovation. Business model innovation further drives a company's entrepreneurial orientation, constantly pursuing market innovation and a pioneering position through continuous practice and adjustment.

### 3.1.2. Research hypothesis

3.1.2.1. Entrepreneurial orientation and business Business Model Innovation

Entrepreneurial orientation is the strategic decision-making process that provides a foundation for management actions. Many scholars have explored the relationship between entrepreneurial orientation and product/service innovation, innovation performance, etc., making it an important topic in entrepreneurial orientation research. Scholars generally believe that companies with entrepreneurial orientation are better equipped to cope with rapidly changing competitive environments, shortened product lifecycles, and the increasing trend of globalization, thus demonstrating higher innovation performance (Kreiser, Marino, Weaver, 2002; Wiklund and Shepherd, 2003). Entrepreneurially-oriented companies often discover and exploit opportunities faster than their competitors and are willing to accept business and financial risks associated with bold competitive actions (Faloye etal., 2017）. As empirical research on the influence of entrepreneurial orientation on innovation performance accumulates, the positive relationship between entrepreneurial orientation and performance becomes increasingly evident (Alegre and Chiva, 2013; Wiklund and Shepherd, 2005; Zahra and Covin, 1995). Rauch et al. (2009) conducted a meta-analysis on this relationship and found a significant positive correlation between entrepreneurial orientation and various performance indicators. Moreover, the potential impact of entrepreneurial orientation on company innovation is often not immediately apparent and may take several years to manifest (Dess and Lumpkin, 1999; Zahra and Covin, 1995).

Business model innovation refers to the renewal or change of key elements of a business model. Business model innovation is an important component of a company's competitive strategy and determines its profit model and survival foundation. Through business model innovation, companies can achieve greater growth (Amit and Zott, 2012). Although there is currently limited research on the direct relationship between entrepreneurial orientation and business model innovation, many scholars have conducted research from the perspective of organizational management features related to entrepreneurial orientation (Bekkouche, 2022）. Hambrick and Mason believe that the heterogeneity of

top management teams has a decisive influence on driving business model innovation. Foss, Pedersen, Pyndt, and Schultz (2012) argue that business model innovation is often influenced by the values of the company, and if the values of business model innovation are inconsistent with the values of the company, there may be internal resistance (Zhang et al., 2021）.

Entrepreneurial orientation is generally believed to consist of three basic dimensions: innovativeness, risk-taking propensity, and proactiveness. Innovativeness represents the inclination and preference of a company in terms of innovation, reflecting the company's innovation consciousness and autonomous innovation capability. Companies with innovativeness focus more on innovation in areas such as products/services, business processes, and management, thereby driving changes in the business model and exerting a positive influence on business model innovation. Risk-taking propensity represents the preference of a company in dealing with risks during decision-making. Companies with weak risk-taking propensity are often less willing to explore new markets or change existing business models, which is unfavorable for business model innovation. Proactiveness represents the preference of a company to actively seek new opportunities and implement new initiatives when facing competitors or complex external competitive environments. Companies with proactiveness typically actively seek new market opportunities, seize market opportunities, and proactively change the logic of value creation, which contributes to business model innovation (Wang et al., 2023）.

Based on the above, we propose the following hypotheses:

H1: Entrepreneurial orientation has a positive impact on business model innovation.

H1a: The innovativeness dimension of entrepreneurial orientation has a positive impact on business model innovation.

H1b: The risk-taking propensity dimension of entrepreneurial orientation has a positive impact on business model innovation.

H1c: The proactiveness dimension of entrepreneurial orientation has a positive impact on business model innovation.

Through further empirical research and analysis, we can gain a deeper understanding of the mechanisms through which entrepreneurial orientation promotes business model innovation, and provide valuable insights and guidance for practical business operations.

3.1.2.2 Big Data Capabilities and Business Model Innovation

With the advent of the big data era, scholars have begun to closely examine the impact and influence of big data on academia and practice. Big data capability, as an advanced dynamic capability, requires organizations to restructure resources and practices, continuously adjust and update through organizational learning, and ultimately integrate into business processes, providing new avenues for value creation in enterprises (Zhang, 2019).

Using UNIQLO as an example, existing scholars have discussed the advantages of UNIQLO's business model under the drive of big data compared to traditional business models, emphasizing the significant importance of big data in business model innovation (Zhao et al., 2017). Additionally, Liu (2019) explored four types of business model innovation in the context of big data, including the data rental/purchase model, digital media model, data-enabled model, and data space rental model. Through case studies, Brownlow (2015) investigated key factors in big data-driven business model innovation, such as what big data can achieve, what types of products can be discovered, what data is needed, and how to obtain that data (Wahyuni et al.,2020）. The era of big data will fundamentally change the logic of value creation for companies, including the process of product innovation (Mayer-Schonberger & Cukier, 2013). According to a report by the McKinsey Global Institute (Manyika et al., 2011), big data will be a critical foundation for innovation, primarily in terms of increased information transparency, improved ease of conducting controlled experiments, enhanced precision customization capabilities, improved decision analysis, and direct improvements in the development of next-generation products and services.

In terms of studying the relationship between big data capability and business model innovation, Xu (2018) verified the positive influence of big data capability on business model innovation through empirical research. Tian (2019), based on a survey of 249 enterprises, constructed a "capability-knowledge-innovation" path framework, and the empirical results indicated that external knowledge search played an intermediary role between big data capability and business model innovation. Although there is currently limited empirical research on the relationship between big data capability and business model innovation, many scholars have studied the relationship between information technology capability and business model innovation or innovation performance. Since big data is a type of information technology, big data capability is also seen as a form of information technology capability. Therefore, we can summarize the relationship between big data capability and business model innovation based on previous research on information technology capability and business model innovation.

In summary, big data capability helps drive the continuous evolution of existing processes, operational methods, and organizational structures towards directions beneficial for enterprise development, and it promotes business model innovation. Based on the above research, we propose the following hypotheses:

H2: Big data capability has a positive impact on business model innovation.

H2a: Resource acquisition capability has a positive impact on business model innovation.

H2b: Data integration and analysis capability has a positive impact on business model innovation.

H2c: Practice application capability has a positive impact on business model innovation.

Through further empirical research and analysis, we can gain a deeper understanding of the mechanisms through which big data capability promotes business model innovation and provide valuable reference and guidance for practical business operations.

## 3.2. Research Design

### 3.2.1 Measurement of Variables

According to the research model and assumptions mentioned above, the variables involved in this study include entrepreneurial orientation, big data capabilities, and business model innovation. To measure these abstract variables, this study will use the Likert 5-point scale rating method. The Likert scale is a commonly used survey measurement tool that helps survey respondents rate from "completely disagree" to "completely agree" in a comprehensible and distinguishable manner. In this study, participants will choose the most fitting rating based on the description of each variable, according to their actual circumstances (KWIOTKOWSKA,2022）.

The entrepreneurial orientation scale will include evaluation items related to proactiveness, innovativeness, and risk-taking. Survey participants will assess their own level of entrepreneurial orientation based on these descriptions. The big data capabilities scale will cover evaluation items in the areas of data acquisition, data analysis, and data application. Survey respondents will assess their own level of big data capabilities based on the given descriptions. The business model innovation scale will include evaluation items related to value proposition, value creation, value delivery, and business environment dimensions. Respondents will evaluate their own level of business model innovation based on these descriptions. By using the Likert 5-point scale rating method, this study will quantify these variables for subsequent data analysis and validation of research results. This rating method provides a certain degree of subjective evaluation while also facilitating understanding and differentiation of differences between variables.

### 3.2.2. Data Collection

The data collection for this study will rely on various resources both within and outside the university, using a combination of online surveys and paper-based surveys. The survey recipients will primarily be

practitioners with a background in big data application in the manufacturing industry. To ensure diversity and representativeness of the sample, paper-based surveys will be distributed through visits to MBA students at various schools and other relevant practitioners, while online surveys will be disseminated through channels such as SurveyStar, WeChat, and email.

The data collection period will span from May 2019 to August 2019, totaling over 3 months. For the collected questionnaires, we will exclude those from industries that are not part of the manufacturing sector, as well as questionnaires with missing items or excessively short completion times. After screening, there were 52 valid questionnaires from paper-based surveys conducted through face-to-face interviews, and 122 valid questionnaires from electronic surveys. In total, 400 questionnaires were distributed, and 174 of them were deemed valid.

Considering the response rate and validity rate of the questionnaires, our response rate was 57.75%, and the validity rate after excluding questionnaires that did not meet the requirements was 43.5%. These data collection results will serve as the foundation for subsequent data analysis and testing of research hypotheses. By analyzing the collected data comprehensively, we hope to derive valuable research findings and feasible recommendations regarding the impact mechanism of entrepreneurial orientation on business model innovation in the context of big data (Minatogawa et al.,2019）.

### 3.2.3. Data Analysis Methods

This study will use a variety of data analysis methods to analyze the collected data in depth. The specific steps and applications of each of these analysis methods will be described below:

(1) Descriptive statistical analysis: Descriptive statistical analysis is to count the basic characteristics of the collected questionnaire data. An intuitive understanding of the sample data can be obtained by calculating indicators such as frequency counts, distribution, and concentration trends. This step is usually a necessary and first part of data analysis. Through descriptive statistical analysis, we will learn the distribution, center position, and degree of variation of each variable in order to provide a basis for subsequent data analysis. The descriptive statistics metrics are shown in Figure 3:

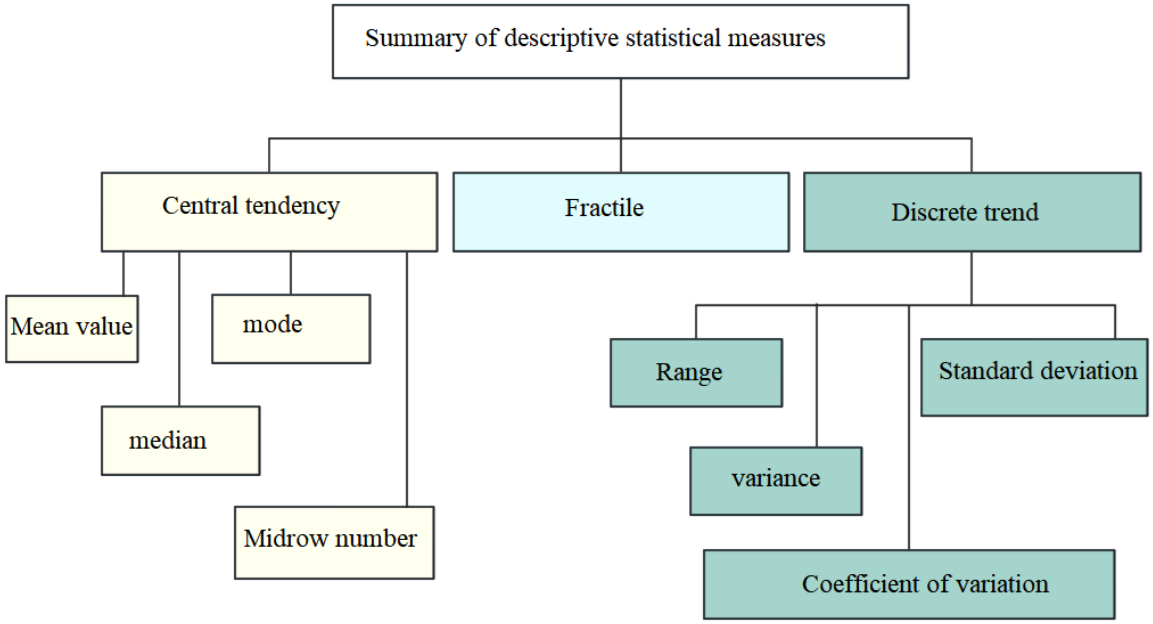


Fig.3: Descriptive statistical measure

(2) Reliability and validity testing: Reliability and validity are important methods for assessing the consistency and accuracy of a scale. Reliability reflects the internal consistency and stability of the scale, and is typically determined using Cronbach's alpha value. In this study, the reliability of each variable and item in the scale will be tested using SPSS and AMOS software. In the reliability testing, we will focus on whether the Cronbach's alpha value reaches the acceptable minimum threshold of 0.65 to 0.70

or above, to ensure the reliability and internal consistency of the scale. Validity assessment will examine the degree of alignment between the variables in the scale and their measurement items, to determine the measurement accuracy of the scale. The steps for reliability and validity testing are shown in Figure 4.

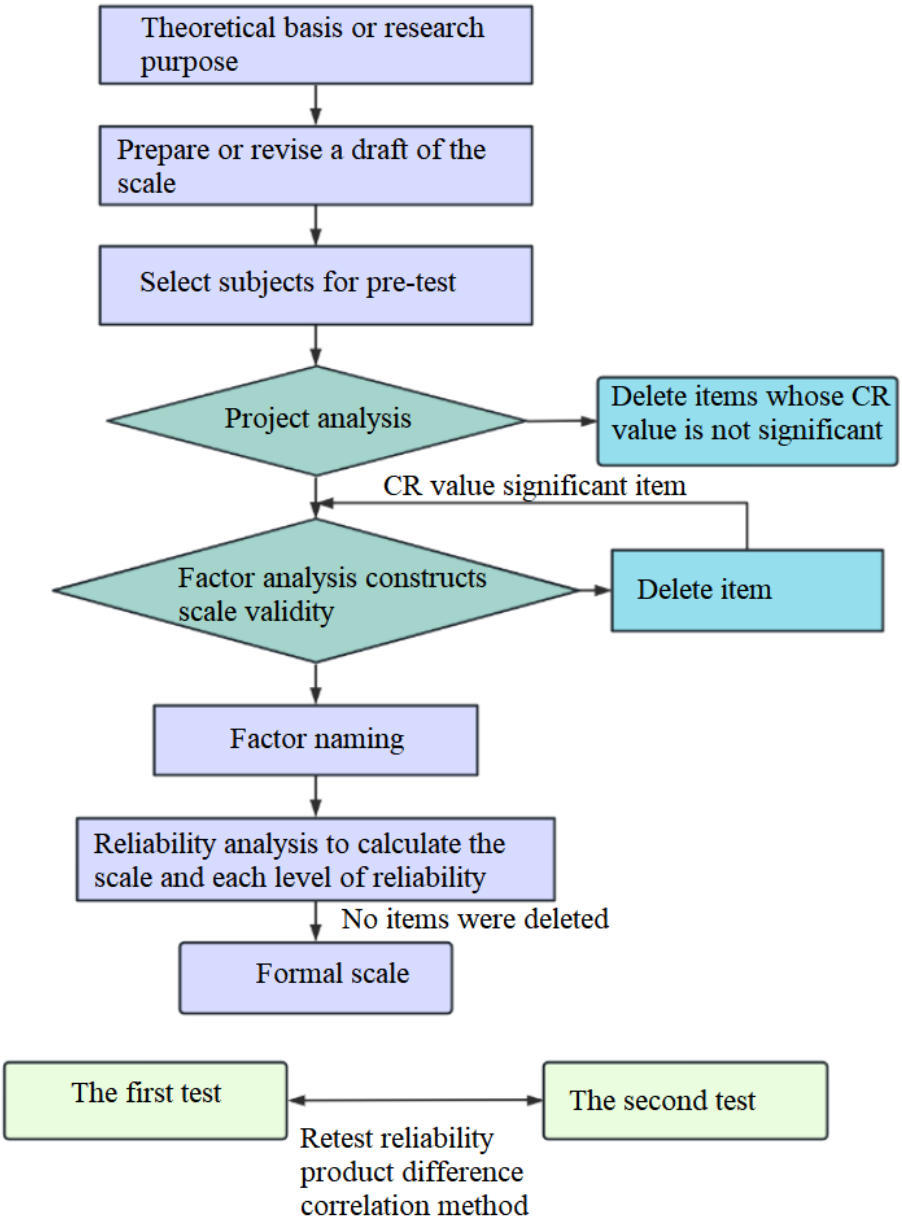


Fig.4: Procedure of reliability and validity test

(3) Correlation analysis: Correlation analysis is used to determine the dependency and direction of relationships between variables and to test the associations between two or more variables. Pearson's correlation coefficient (r) is the most commonly used measure of correlation, which reflects the strength of the relationship between variables and ranges from -1 to +1. Correlation coefficients close to absolute value 1 indicate a strong relationship between variables. Correlation analysis not only examines the dependency between variables but also provides a foundation for subsequent regression analysis.

(4) Regression analysis and Bootstrap testing: Regression analysis is used to construct regression equations to understand the causal relationships between variables. In validating the significance of the regression model, we will analyze the results based on t-tests and F-tests, where the regression coefficients should be significant in t-tests with a p-value of less than 0.05. The F-value and adjusted R-squared are valid indicators for the F-test. In testing for mediation effects, we will use the hierarchical

regression method proposed by Baron and Kenny (1986) for analysis. Additionally, as needed, we can also use bootstrap methods to generate more accurate estimates of standard errors by simulating the sampling distribution process.

By employing the comprehensive application of these data analysis methods, this study will thoroughly explore the collected data. Through the analysis results, we hope to answer research questions, validate hypotheses, uncover the impact mechanism of entrepreneurial orientation on business model innovation in the context of big data, and provide effective theoretical support and guidance for practice.

# 4. Results and Discussion

## 4.1. Common Method Bias Test

Common Method Bias (CMB) refers to potential errors introduced by the measurement method, which are caused by factors such as the same data source, raters, measurement environment, item context, and item characteristics. These factors can lead to artificial covariance between predictor variables and criterion variables. To examine the possibility of common method bias, exploratory factor analysis (EFA), particularly the Harman's single-factor test, is commonly used.

In this study, we conducted exploratory factor analysis using SPSS 24.0 software on the scale. By analyzing all items of the scale, a total of 6 factors were automatically extracted with eigenvalues greater than 1. The cumulative variance explained by these factors was less than 50% (the maximum explained variance by a single factor before rotation was 42.978%). According to the criteria for testing common method bias, there was no indication of having only one factor or a significantly dominant first factor in this analysis. Therefore, we can conclude that common method bias is not a concern in this study. Given that common method bias can potentially mislead research results, this study adopted rigorous data collection and analysis methods to ensure the reliability and validity of the research findings (Arunachalam et al.,2018）. We can now proceed with the subsequent data analysis and derivation of research conclusions.

## 4.2. Reliability Analysis of Variables

4.2.1. Reliability analysis

Reliability analysis is used to assess the internal consistency of a scale when answered by different respondents, in order to determine the reliability of the measurement responses in the sample. In this study, SPSS 24.0 software was used for reliability analysis of the collected sample data. In reliability analysis, Cronbach's alpha coefficient is commonly used as a measure. According to common criteria, a Cronbach's alpha coefficient above 0.7 indicates good reliability, between 0.6 and 0.7 indicates acceptable reliability, and below 0.6 indicates low reliability. By organizing and summarizing the items of the relevant variables, the corresponding scale (as shown in Table 1) was extracted, and reliability analysis was performed using SPSS software. In the reliability analysis results, we will focus on the Cronbach's alpha coefficient of each scale to determine the quality of scale reliability.

Table 1. Reliability analysis of each dimension and variable

| variable | Dimensionality | Cronbach a in all dimensions | Each variable Cronbach a | Item number | Total table Cronbach a |
|---|---|---|---|---|---|
| Entrepreneurial orientation | Innovativeness | 0.802 | 0.876 | 3 | 0.947 |
| | Risk bearing capacity | 0.820 | | 3 | |
| | proactiveness | 0.772 | | 3 | |
| Big data capability | Resource acquisition capability | 0.830 | 0.910 | 4 | |
| | Analysis and integration ability | 0.879 | | 5 | |
| | Practical | 0.780 | | 3 | |

| | | | |
|---|---|---|---|
| | application ability | | |
| Business model innovation | | 0.848 | 5 |

Through reliability analysis, we are able to assess the internal consistency of the scales and verify the reliability of the measurements. This will ensure that the scales used in the study accurately reflect the responses of the respondents and increase the credibility of the findings.

4.2.2. Validity Analysis

Validity analysis is used to assess the scientific rationality of research items (usually questionnaire items). Generally, validity can be divided into content validity and construct validity. Content validity focuses on whether the design of research items possesses professionalism and purposefulness, usually described in detail in combination with reference bases, professional significance, and expert suggestions. To ensure the content validity of the questionnaire, this study extensively referred to mature scales developed by domestic and foreign scholars for each variable and conducted moderate interviews to adjust the items. Based on pre-survey research, the structure, content, and wording of the scale were repeatedly revised to form the final formal questionnaire for the formal survey. To validate the construct validity of the scale, this study used AMOS 24.0 software to conduct Confirmatory Factor Analysis (CFA) on the variables and items in the scale to evaluate the convergent validity between variables. The analysis results are summarized in Table 2. From the results, it can be seen that the factor loadings of each item are all greater than 0.6, the Construct Reliability (CR) values are all greater than 0.7, and the Average Variance Extracted (AVE) values are all greater than 0.5. This indicates that the adopted scale has good construct validity. Additionally, fit indices reflect whether the fit between the model and the sample data is acceptable. The X2/df values are all less than 3, and the GFI, AGFI, RFI, IFI, TLI, CFI values are all above 0.9. Meanwhile, the RMSEA values do not exceed 0.1. This indicates that the scale used in this study has good convergent validity.

Table 2. CFA aggregate validity test for each variable

| variable | dimensionality | Item | Factor loading | AVE | CR |
|---|---|---|---|---|---|
| Entrepreneurial orientation | innovativeness | A1 | 0.841 | 0.582 | 0.805 |
| | | A2 | 0.637 | | |
| | | A3 | 0.808 | | |
| | Risk bearing capacity | A4 | 0.805 | 0.607 | 0.822 |
| | | A5 | 0.771 | | |
| | | A6 | 0.757 | | |
| | proactiveness | A7 | 0.830 | 0.537 | 0.775 |
| | | A8 | 0.628 | | |
| | | A9 | 0.736 | | |
| Big data capability | Resource acquisition capability | C1 | 0.830 | 0.555 | 0.832 |
| | | C2 | 0.648 | | |
| | | C3 | 0.793 | | |
| | | C4 | 0.703 | | |
| | Analysis and integration ability | C5 | 0.790 | 0.593 | 0.879 |
| | | C6 | 0.757 | | |
| | | C7 | 0.782 | | |
| | | C8 | 0.739 | | |
| | Practical application ability | C9 | 0.778 | 0.561 | 0.789 |
| | | C10 | 0.832 | | |
| | | C11 | 0.628 | | |
| | | C12 | 0.754 | | |
| Business model innovation | —— | B1 | 0.747 | 0.535 | 0.851 |
| | | B2 | 0.670 | | |
| | | B3 | 0.693 | | |
| | | B4 | 0.703 | | |
| | | B5 | 0.825 | | |

Through the analysis of content validity and structural validity, we can confirm that the design of

the scale possesses scientific rationality and the validity of the measurement results is guaranteed. This will provide a solid foundation for the subsequent data analysis and the derivation of research conclusions.

## 4.3. Regression Analysis and Hypothesis Testing

4.3.1. Entrepreneurial Orientation on Business Model Innovation Hypothesis Testing

This study examined the effect of entrepreneurial orientation on business model innovation through linear regression analysis using SPSS 24.0 software. The regression results are shown in Table 3. First, Model 1 analyzes the effect of control variables on business model innovation as the basis for Model 2. Next, three dimensions of entrepreneurial orientation: innovativeness, risk-taking, and pioneering were added to the independent variables, and business model innovation was still analyzed in the regression analysis as the dependent variable.

Table 3. Entrepreneurial orientation regression analysis of business model innovation

| Model | Beta | sig | $R^2$ | Adj.$R^2$ | F-number |
|---|---|---|---|---|---|
| Nature of enterprise | 0.181 | 0.020 | | | |
| Enterprise scale | 0.132 | 0.131 | 0.054 | 0.038 | 3.257(0.023*) |
| Enterprise age | 0.068 | 0.429 | | | |
| Nature of enterprise | 0.006 | 0.915 | | | |
| Enterprise scale | 0.008 | 0.907 | | | |
| Enterprise age | 0.012 | 0.847 | 0.483 | 0.465 | 26.029(0.000***) |
| innovativeness | 0.380 | 0.000*** | | | |
| Risk bearing capacity | 0.285 | 0.000*** | | | |
| proactiveness | 0.156 | 0.034* | | | |

The results of regression analysis show that the regression coefficient of innovativeness is 0.380 (P=0.000<0.001), which means that innovativeness has a significant positive effect on business model innovation, supporting the hypothesis of H1a. The regression coefficient of risk-taking is 0.285 (P=0.000<0.001), which means that risk-taking also has a significant positive effect on business model innovation, supporting the hypothesis of H1b. And the regression coefficient of precedence is 0.156 (P=0.034<0.05), which means that precedence also has a significant positive effect on business model innovation, supporting the hypothesis of H1c.

4.3.2. Hypothesis testing of big data capabilities for business model innovation

This study also used linear regression analysis using SPSS 24.0 software to examine the impact of big data capabilities on business model innovation. The regression results are shown in Table 4. First, Model 1 analyzes the effect of control variables on business model innovation as a basis for Model 3. Next, three dimensions of big data capability: resource acquisition capability, analysis and integration capability, and practical application capability were added to the independent variables, and business model innovation was still taken as the dependent variable for regression analysis.

Table 4. Regression analysis of big data capability on business model innovation

| Model | Beta | sig | $R^2$ | Adj.$R^2$ | F-number |
|---|---|---|---|---|---|
| Nature of enterprise | 0.181 | 0.020 | | | |
| Enterprise scale | 0.132 | 0.131 | 0.054 | 0.038 | 3.257(0.023*) |
| Enterprise age | 0.068 | 0.429 | | | |
| Nature of enterprise | 0.001 | 0.989 | | | |
| Enterprise scale | 0.026 | 0.695 | | | |
| Enterprise age | -0.007 | 0.917 | 0.464 | 0.445 | 24.139(0.000***) |
| innovativeness | 0.173 | 0.027*** | | | |
| Risk bearing capacity | 0.368 | 0.000*** | | | |
| proactiveness | 0.239 | 0.002* | | | |

The results of regression analysis show that the regression coefficient of resource acquisition ability

is 0.173 (P=0.027<0.05), implying that resource acquisition ability has a significant positive impact on business model innovation, supporting the hypothesis of H3a. The regression coefficient of analyzing and integrating ability is 0.368 (P=0.000<0.001), implying that analyzing and integrating ability also has a significant positive effect on business model innovation, supporting the hypothesis of H3b. The regression coefficient of practical application ability is 0.239 (P=0.002<0.01), implying that practical application ability also has a significant positive impact on business model innovation, supporting the hypothesis H3c.

# 5. Conclusion

In this study, we employed multiple data analysis methods to thoroughly examine and interpret the collected data. Firstly, descriptive statistical analysis was conducted to obtain an overview of the basic characteristics of the sample data. Next, reliability analysis was performed to assess the internal consistency and reliability of the scale. Through reliability analysis, we confirmed that the scale used has good reliability, accurately reflecting the respondents' answers. In regression analysis and bootstrap testing, regression equations were constructed to further investigate the causal relationships between variables. Based on the results of t-tests and F-tests, we assessed the significance of the regression model and examined the mediating effect. Through systematic analysis and testing, we concluded that the scale has good construct validity and convergent validity, indicating that the scale design is appropriate and aligns well with the actual data. Additionally, I would like to mention the examination of common method bias. Through exploratory factor analysis, we tested the scale items and confirmed that there is no issue of common method bias in this study. This enhances the reliability and accuracy of the research findings. In this study, we believe that through the use of sound data analysis methods and rigorous data processing, we can gain a deep understanding of the research question and provide effective answers. Through reliability analysis and validity analysis, we evaluated the measurement quality and effectiveness of the scale. In future research, further improvements in research methods and expansion of the sample size can lead to more accurate and universally applicable conclusions. Additionally, integrating more data sources and analytical techniques can facilitate in-depth exploration of related issues and lead to new discoveries and explanations.

In conclusion, through data analysis in this study, we obtained a comprehensive understanding of the sample data and evaluated the reliability and validity of the scale. The results indicate that the scale has good construct validity and convergent validity. Although there are still some limitations, this study provides important data foundations and preliminary conclusions for exploring the research question. We hope that this study contributes to the academic progress and practical applications in the relevant research field.

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