INSTITUTO
UNIVERSITÁRIO
DE LISBOA

Competitive Analysis of Artificial Intelligence: A Resource-based View

MIAO Xiang

Doctor of Management

Supervisor:
PhD Virginia Trigo, Professor,
ISCTE University Institute of Lisbon

May, 2022

BUSINESS
SCHOOL

Marketing, Operations and General Management Department

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Abstract

Based on a detailed analysis of artificial intelligence technology, including its basic principles and popular applications, this research focuses on resource-based theory including VRIO analysis framework, combined with dynamic capability theory, to make detailed discussion and analysis of the competitiveness of artificial intelligence technologies for organizations through individual and in-depth interviews with dozens of experts in related fields.

The study shows that, 1) AI is valuable, and this value is more manifested in four words "more, faster, better, and less", that is, more scenarios, faster speed, better quality, and less labor and may gain more opportunities in the three fields of high difficulty, high costs, and high fault tolerance. 2) AI is currently rare due to the will and determination of organizations, as well as judgments about economics and tipping points. 3) AI is also difficult to imitate. This kind of competition barrier is mainly based on big data, including the dimension and quality of data, volume and accumulation, model correlation and reinforcement. 4) AI can be also organized. Therefore, according to the VRIO or VRID framework, artificial intelligence technology is a resource that can bring sustainable competitive advantage to the organization.

The study hopes that more organizations will try to build their own artificial intelligence strategies, and pay more attention to the VRID resource-based view.

Keywords: Strategic management; Resource-based theory; Dynamic capability; Artificial intelligence

JEL: M15; L10

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Resumo

Tendo como base uma análise detalhada das tecnologias associadas à inteligência artificial (IA), incluindo os seus princípios básicos e as suas aplicações mais popularizadas, esta pesquisa foca-se na teoria baseada nos recursos, incluindo o modelo de análise VRIO, combinado com a teoria das capacidades dinâmicas. Para efetuar uma análise e discussão detalhada da competitividade das tecnologias da IA para as organizações realizamos um conjunto de entrevistas a *experts* de atividades relacionadas com IA.

O estudo mostra que; 1) a IA é valiosa, e podemos manifestar o seu valor em quatro palavras " mais, rápida, melhor e menos", isto é, mais cenários, maior velocidade, melhor qualidade, e menos mão-de-obra e pode tirar partido de mais oportunidades em situações de maior dificuldade, de custos mais elevados e de alta tolerância a falhas; 2) a IA é neste momento rara devido à vontade e determinação das organizações, devido a julgamentos sobre questões económicos e pontos de viragem; 3) a IA é difícil de imitar. Esta barreira está muito ligada à qualidade e quantidade de dados; 4) A IA pode ser organizada. Deste modo, de acordo com o modelo VRIO ou VRIDc, a inteligência artificial é um recurso que pode trazer vantagem competitiva sustentável à organização.

Este estudo espera que mais organizações tentarão construir as suas próprias estratégias de IA e dispensar mais atenção à abordagem VRIDc.

Palavras-chave: Gestão Estratégica; Teoria Baseada nos Recursos, Capacidades Dinâmicas, Inteligência Artificial

JEL: M15; L10

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摘　要

本研究在对人工智能技术包括其基本原理和热门应用等进行详细分析的基础上，重点依托资源基础理论RBT包括VRIO分析框架，结合动态能力理论DCT，通过对数十位相关领域专家进行的个体的、深度的研究访谈，对人工智能技术之于普通组织而言的竞争力进行了详细的讨论和分析。

研究认为：1）AI是有价值的，这种价值更多表现为“多、快、好、省”四个方面，并可能在“三高”领域内获得更多机会；2）它在当前也是稀缺的，原因包括组织的意愿和决心，及对经济性和临界点的判断；3）它也是较难复制的，这种竞争壁垒主要建立于大数据之上，包括数据的维度与质量、体量与积累、模型的关联及强化等等；4）它也是可组织的。因此，按照VRIO或VRID框架，人工智能技术是一种可以为组织带去持续竞争优势的资源。

本研究希望会有更多的组织去尝试构建自身的人工智能战略，及对VRID资源基础观引起重视。

关键词：战略管理；资源基础理论；动态能力；人工智能

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I started this doctoral program in 2017, when was near the end of my 24 years working experience as an employed person (15 years in management positions, including 6 years in public administration and 9 years in business administration). In 2018, I voluntarily resigned from a series of executive positions in a well-known public company to establish my own company in the venture capital business. Therefore, I do not study this program due to promotion or career pursue, but more due to the continuous pursuit of self-growth, and I regard this experience as the juncture and stopover of my two careers, that is, from manager to investor. Slightly unexpected, studying for this degree has taken up most of my work energy in the past few years, so that I am studying and doing my research almost on a full-time basis. But I am thankful for this opportunity for myself to learn more, do more, and think more.

First of all, I would like to extend my gratitude to Professor Virginia Trigo and Professor Nelson Antonio. One morning in 2017, I drove from Shenzhen to Guangzhou for an admissions interview. The interviewer was Professor Virginia, who gave me this opportunity to start my doctoral program. Her class was a kind of enjoyment. Even as a senior management person, I also benefited a lot from her class. It was very fortunate that she also became my supervisor. I have learned a lot from her logical thinking and rigorous style. During the research, she also guided me to adjust the research focus in time and determined more suitable theories and methods, so that my research can be carried out smoothly. Professor Nelson is a master in the field of strategic management and he became my supervisor after my research focus turned to strategy and competitiveness. He is a kind, wise and farsighted professor. He read my thesis carefully, pointed out problems accurately, gave clear suggestions, and replied quickly every time. Moreover, he encouraged me a lot every time. With his help, my thesis made a rapid progress. I really cannot imagine that there are better supervisors in the world than them, and I would like to show my respect and gratitude to them once again.

In addition, I would like to thank 21 experts in the study. I was unable to complete the study without their help. All of them are the elite of the industry, but they are willing to spare the time to participate in this research voluntarily. I will always remember their professionalism and friendship in my heart. Please allow me to list their names in alphabetical order, they are: Ms. Chen Huiling, Mr. Han Lanqing, Mr. Hu Pengfei, Ms. Huang Xiaoqiong, Ms. Huang

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Last but not least, I would like to thank myself. It is said that easy does not enter into grown-up life, but the past few years of pursing the doctoral degree have been particularly difficult for me. Firstly, I needed to spend most of time and energy to work on my research and thesis, including reading a large number of literatures, doing many interviews, and writing hundreds of documents. I did everything by myself, got up early and stayed up late in the past few years. For my work, I had to solve tons of affairs for my new enterprise. In life, I took care of three children alone. I must properly arrange their health, study, examination, and extracurricular activities by myself. Looking back over the past few years, my life seemed like a To-do list that will never be completed. However, I am always confident that no matter how difficult things are, there must be the best way. As long as we calm down and think, then solve them one by one, we will succeed and see the sunshine ultimately.

In the future, I will focus my work on investment business, including exploring how to invest artificial intelligence technologies that I have been optimistic about. At the same time, I will continue to engage in management, especially in the field of strategic management. I hope to combine my experience in work and study and contribute to the development of the society.

致　谢

攻读这个博士学位始于2017年。当时，已接近我职业生涯中作为受雇人士的24年的尾声（其中15年位于管理岗位，包括6年公共管理、9年工商管理），次年我主动辞去了一家知名上市公司的一系列高管职务，转而创办自己的公司从事创投类业务。因此，我对这个学位并没有太多功利的想法，更多是源于对自我成长的持续追求，以及将其视为我两段职业生涯——管理生涯与投资生涯——的连接点和中转站。略微出乎意料的，是攻读这个学位，占据了我这几年绝大部分的工作精力，以致于我几乎是以一种全日制的方式在进行学习和研究。但也确实乐在其中，让有机会学得更多、做得更多、想得更多。

首先，我要感谢两位导师——Virginia教授和Nelson教授。我在2017年的一个清晨，从深圳开车到广州参加入学面试，面试我的正是Virginia教授，是她给了我这个机会让我得以走进这扇大门。而听她的课，更是一种享受，既便作为资深的管理人士，我也每次受益匪浅。幸运的是，她还成为了我的导师，她清晰的思路、严谨的作风，真的让我学到很多。在研究进行中，她还指导我及时调整了研究重点，确立了更为适合的理论和方法，让我的研究得以顺利进行。Nelson教授是一位战略管理领域的大师，在我的研究转向战略和竞争力之后，他开始更多地指导我。他是一位和蔼、睿智的教授，每次都会认真地阅读我的论文、准确地指出问题、明确地给出建议、迅速地给予回复，每次还不忘给我鼓励。在他的帮助下，我的论文进展迅速。我真的无法想象，世上还会有比他俩更好的导师，我内心也因此充满了对他们的尊敬和感激。

其次，我要感谢参与本次研究的21位专家。没有他们，就没有这项研究的成功。他们真正是行业的精英，但他们愿意放下一些工作或生活，义务地参加这项研究，这种专业精神和深厚情谊，我将永远铭记在心。请允许我按姓名拼音顺序一一列出他们的名字，他们是：陈慧玲女士、韩蓝青先生、胡鹏飞先生、黄小琼女士、黄泽红女士、黎强先生、黎婷女士、李华女士、王璟女士、王天予女士、肖涟波先生、许秋霞女士、叶宜根先生、尹丽蓉女士、张剑锋先生、张戎先生、张颖女士、张中天先生、赵艳君女士、朱晓明先生、Allen先生，衷心地感谢你们！在这里，我特别提一下王璟、王天予、许秋霞三位专家，她们不仅自己抽时间接受了研究访谈，还引荐了其他专家参加了访谈，多谢你们！还有肖涟波院长，访谈时正值上海疫情高峰，身为上海三甲医院院长的他本可以有数百

个理由推辞我的访谈，但是他还是抽出宝贵的休息时间，与我进行了74分钟访谈，就AI医疗给出很多精彩的观点，衷心地感谢你！

最后，也感谢下自己。都说成年人的世界没有容易二字，但攻博这几年，对我而言也是特别的不容易——学业上，研究和论文工作需要做大量工作，包括读大量的文献、做大量的访谈、写大量的文档，只能自己事无巨细、起早摸黑；工作上，创投业务百废待兴，公司和员工也都有大量的事务要处理；生活上，独自一人照顾三个小孩，他们的健康、转学、升中、中考、兴趣等等，也都要自己一一安排妥当；……。所以回顾这几年，就是永远想不完的事、永远做不完的事、永远清不完的To-do list。但我始终相信，再难的事，也一定有最好的办法，只要我们静下心来、想好办法、一一落实，就一定能迎来拨云见日的那天。

展望未来，我会将工作重点放到投资业务上来，包括探索如何将我一直看好的人工智能技术结合其中。同时，也会继续从事管理类工作，特别是在战略管理领域，希望将自己工作和学习的经验结合起来、奉献出来，为社会的发展贡献自己的微薄之力。

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Chapter 1: Introduction

1.1 Research background

1.1.1 Artificial intelligence

There were three rounds of technological revolutions in history: the first Industrial Revolution powered by steam engines, the second Industrial Revolution advanced by electricity and the third Industrial Revolution (also known as Digital Revolution) triggered by computer technologies (Wu, 2016). These three technological revolutions all improve productivity and influence the human community profoundly. Human beings now are going through the fourth Industrial Revolution driven by artificial intelligence (Wu, 2016).

The term Artificial Intelligence (AI) was coined in 1956, at a historic conference in Dartmouth (Li & Wang, 2019; Wang, 2017; Wu, 2016). Though not many academic results were yielded on that meeting, many research questions including AI, natural language processing and neural network were raised. The seminar is seen as the beginning of human's research on AI (Wu, 2016).

Scholars believe AI is defined in two senses. In a narrow sense, it refers to artificial intelligence developed in the 1950s and the 1960s, also known as Traditional AI. The rationale of it is similar to that of bionics. Specifically, Traditional AI refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. In a broad sense, AI is referred to as Modern AI, which is applied to any machine that aims at passing the Turing Test and exhibits abilities such as machine learning and data-driven processing (Wu, 2016).

The Turing Test, originally proposed by the English mathematician Alan Turing in 1950, is an important test to determine whether a computer can "think like a human". The Turing Test works by asking the human interviewee to talk with the computer without meeting in person. If the interviewee cannot tell whether they are talking with a computer or another human interviewee, then Turing Test is passed and the computer can be called intelligent (Li & Wang, 2019). Loebner Prize, which is held annually, is a competition based on the Turing Test. Altogether, there are 12 human judges and the pass rate is 30% as suggested by Alan Turing. Before 1995, topics for tests were given but in 1995, it was announced that all kinds of topics

were allowed. Before 2010, the test lasted for only five minutes but after 2010, the number was increased to 25. Up until 2014, no machine has ever passed the test (Li & Wang, 2019).

Turing hit on a promising direction for artificial intelligence in his book. “Instead of trying to produce a program to simulate the adult mind,” he wrote, “why not rather try to produce one which simulates the child’s?” This idea guides us to solve AI problems with machine learning (Li & Wang, 2019). The Traditional AI with bionics as its rationale is drawing to a close while Modern AI with machine learning at its core is gaining momentum.

This study adopts the broad definition of AI, namely Modern AI. Kai-Fu Lee, a famous computer scientist, also believes “Artificial intelligence is a computer program that makes reasonable actions based on its perception of the environment to obtain the most benefits.” (Li & Wang, 2019). Wang (2017) believes that “Artificial intelligence is also called machine intelligence, which is created when machines are programmed with some aspects of human intelligence”. And many other scholars also adopt the similar definition. The changes of the definition for AI show that emphasis is no longer placed on the process such as how AI gains intelligence by borrowing from the idea of bionics, but on the nature and results of AI’s intelligent behavior.

AlphaGo, the AI system developed by DeepMind can be counted as one of the milestones in the history of AI development. Because for years, people have thought chess masters as the smartest. The reason why Go (Chinese chess) is more difficult than international chess is that the possibilities for each move in international chess reach about 35 to the 80^{th} power, while the possibilities in Go, 250 to the 150^{th} power, which even exceeds the total number of observable atoms in the universe, so one cannot search for the solution through the method of exhaustion (Tang, 2020). In 2016, the first generation of AlphaGo defeated the world champion of Go Lee Sedol, who ranked the second across the world at the time, by reinforcement learning and Monte Carlo tree search. Subsequently, AlphaGo defeated the best Go player Ke Jie with no difficulty. What is more surprising is that the second-generation product AlphaGo Zero launched in 2017 no longer needs human knowledge to feed itself. By playing with itself for three days, it defeated the previous generation AlphaGo by 100 to 0, which demonstrated the huge potential of reinforcement learning and AI technology (Tang, 2020).

1.1.2 Application of AI in medicine

AI is used widely nowadays. Mao and Sun (2021) believe that “AI in medicine” are products and services in which AI-related technologies such as natural language processing, deep learning, knowledge graphs, and computer vision in different clinical scenarios are applied. By

learning massive amounts of medical data and expertise, AI can carry out screening and diagnosis, risk calculation and prognosis, provide clinical decision support and manage the system of precision medicine system in a short period of time. Xie et al. (2019) believe that AI in medicine includes all aspects of the medical industry. Its ultimate goal is to replace humans with AI to diagnose and treat patients.

In terms of AI application in medicine, some institutions believe that there are four following stages: 1) Clinical Decision Support System (CDSS) and medical records for clinical diagnosis; 2) imaging, pathological examination and genetic testing for clinical examination; 3) new drug development and research for clinical drugs; and 4) surgeries robots as clinical equipment (IResearch, 2020). Shao (2020) also believes that AI is mainly applied in four aspects: diagnosis of diseases, analysis of medical images, drug development, and surgical robots. Besides, some scholars think that AI should also be used in health management and hospital management (Mao & Sun, 2021).

AI imaging receives the most attention in AI medicine. According to Huachuang Securities, the annual growth rate of medical images in China is about 30%, while the annual growth rate of radiologists is only 4.1%. There exists a huge gap between the supply and the demand. And the heavy task leads to a high rate of misdiagnosis and missed diagnosis. AI technology can help to fill the gap by improving efficiency and service quality (Huachuang Securities, 2017). In October, 2016, in United State, based on the discussion of five seminars, the Subcommittee on Machine Learning and Artificial Intelligence under the Office of Science and Technology Policy of the White House released the report titled Preparing for the future of Artificial Intelligence. In this report, the status quo of AI is presented through a study on AI-assisted X-ray interpretation. The study requires participants (which include both human pathologists and machines) to perform diagnostic analysis on images of lymphocytes to determine whether the cells are cancerous. The error rate of human pathologists is 3.5%, while the error rate of human pathologists with the assistance of AI is only 0.5% (Xie et al., 2019). Global Market Insights, a third-party market research institution, also believes that medical imaging and diagnostic technology will become the fastest growing in AI medicine from 2017 to 2022. It is estimated that by 2024, the total value of these two areas will reach 25 billion US dollars with a growth rate of more than 40% (Dian, 2019). In terms of investment and financing, AI medical imaging has accounted for more than 20% of all AI medical project financing for three consecutive years from 2018 to 2020 (IResearch, 2020).

1.1.3 Threat of AI

Though some hold positive opinions on AI development, others have concerns to some extent. Wu (2016) believes that the Intelligent Revolution represented by AI technology will have a greater impact on human society than the previous three ones. The first reason is that the impact of the last information revolution is still there, so the impact of the Intelligent Revolution will be reinforced. Secondly, the impact of previous technological revolutions can be cushioned as they reached more new markets. But now the world is highly globalized, there are no more buffer zones. Lastly and more importantly, AI is about to overtake human beings. By then, not only low-end manual labor will be replaced, doctors, lawyers, financial analysts and other jobs that were thought to require much brainpower may be replaced as well. When the number of employees in all walks of life is reduced because of machine intelligence, the billions of labors in the world will be in danger (Wu, 2016).

Some scholars are even more pessimistic about AI development. In 2001, Ray Kurzweil put forward the Law of Accelerating Returns. He believes that evolution applies positive feedback in that the more capable methods resulting from one stage of evolutionary progress are used to create the next stage. Each epoch of evolution has progressed more rapidly by building on the products of the previous stage, which will result in paradigm shifts, optimization of orders and increasing returns (Li & Wang, 2017). In 2006, based on the Law of Accelerating Returns, he explained the idea of Technological Singularity. He believes that in the future, technological paradigm shifts would occur more frequently, and returns from chips and cost effectiveness will grow exponentially. Therefore, in the next 100 years, human beings may make progress that could have had taken past 20,000 years. By then, machine intelligence will surpass human intelligence and lead to the advent of the singularity in the end. As a result, technological changes will be so rapid and profound that the human society could be disrupted. That leads to human beings connecting neo-cortex, the part of human brain where we do our thinking, to the cloud and even immortal humans based on software. Kurzweil predicts that all the singularity will occur in 2045 (Li & Wang, 2017).

Scholar Good shares similar ideas. As early as 1965, Good elaborated on technological singularity with the idea of “Intelligence Explosion”. He thinks that the design of ultra-intelligent machines itself is a kind of intelligent activity. Therefore, an ultra-intelligent machine can continue to update itself and undoubtedly, that will lead to an intelligent explosion. By then, human beings will be far behind and the first ultra-intelligent machine will become the last invention of humans (Li & Wang, 2017).

The famous scientist, Stephen Hawking, has also warned the thread of AI several times. He was worried that AI would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, could not compete, and would be superseded and the development of full artificial intelligence could spell the end of the human race (Cai, 2020). Google CEO at the time Larry Page, who is for technological utopianism and Tesla CEO Elon Mask once argued over AI. But the focus was not on AI's abilities in the future but people's attitudes towards AI. Mask thinks that the development of AI should be limited; while Page believes that digital lives will make it to live at every corner of the Milky Way and even the whole universe. But he was worried that people's doubts and suspicion for AI would delay the arrival of the technological utopia and might even trigger the evil AI to orchestrate a military coup against humans in order to take over the human society (Cai, 2020).

1.2 Research problem

To explain the differences of performances between enterprises and thus help enterprises to improve their performances has been the research goal pursued by scholars in strategic management and is important to determine whether a study falls into the category of strategic management (Ma, 2019). Performances of enterprises can be measured by competitive edge. But competitive edge plays different roles in different periods of time. It can serve as the prior variable, substitute variable or the mediating variable to measure the performances of enterprises. Competitive edge is the fundamental variable for the measure of enterprise performances (Ma, 2019).

AI is developing rapidly and it is believed that in the future, it will play a more important role. But there is no much research to explore whether AI technology can generate competitive edge for enterprises, and AI technology will be the source of sustainable competitive edge. And this is the research gap this study fills. This study would like to know what are the skills and characteristics of AI technology, and whether these skills and characteristics can become a source of sustainable competitive edge for enterprises.

1.3 Research questions

1. According to the Resource-Based View (RBV), what are the attributes of resources that can generate sustainable competitive edge?

2. Are the skills or characteristics of AI technology in line with the requirement of resources

based on Resource-based Theory?

3. How to apply a suitable paradigm or framework to analyze the competitiveness of AI?

1.4 Research significance

The significance of this study lies in the following aspects. First is to provide some references for enterprises that whether it is feasible to use AI technology as a sustainable competitive edge so that enterprises can take the feasibility into account when making organizational strategy and thus to avoid wasting time and energy in terms of homogeneous resources for a long term. Second, this study can help enterprises identify those specific skills that can generate sustainable competitive edge and build up their own strength when apply and use AI technology. Third, even if it turns out that some attributes of AI show underperformances, AI can still help enterprises in competition. In a market with full competition, enterprises should identify the competitiveness of AI and always make progress in order to catch up with or even surpass the competitor.

1.5 Research fields

This study will analyze the competitive edge brought about by AI technology based on Resource-Based View (RBV). RBV is a managerial framework used to determine the strategic resources a firm can exploit to achieve sustainable competitive edge. It focuses on performance differences between enterprises. RBV proposes an analysis framework that is completely different from that of Michael Porter's and the Structure-Conduct-Performance (SCP) paradigm. RBV focuses more on the company's internal capabilities rather than the external market (Barney & Clark, 2011).

At the same time, this research touches upon dynamic capability theory to some extent as a complement and reinforcement of resource-based theory. Dynamic capability is a higher-order capability to cope with environmental changes, and this study believes that it is also a capability resource that an organization may possess, making the traditional resource-based paradigm more comprehensive and scientific.

This research also touches upon strategic management. For instance, RBV is often used as an analysis tool and provides references for strategic management. In strategic management, it is important to make sure the formulation and implementation of strategies should be coherent with the mission and goals of the enterprise. This is a very important and indispensable part of

the strategic management process.

Besides, this study also explores AI technology. The author studies the application of AI in medicine in particular in medical imaging. Because Management is an interdisciplinary subject, and AI technology is the research object and specific carrier of this research. Moreover, AI technology is deemed as the core of the next technological revolution and will influence our way of life profoundly (Wu, 2016). Therefore, it is necessary to dig into it as early as possible.

1.6 Research methods

This study adopts the in-depth interview with experts as the major research method and literature research method. First, the author went through the literature on RBV, dynamic capability theory and AI technology and reviewed the attributes and elements of resources that can generate sustainable competitive edge; then, the author reviewed the principles, sub-skills or specific skills and characteristics of AI technology and AI medical imaging technology; finally, through expert interviews, the author analyzed whether AI technology is in line with the components of a sustainable competitive edge.

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Chapter 2: Literature Review

2.1 Resource-Based Theory

As mentioned before, core issue of strategic management is to explain the reason that leads to different performances among organizations (Barney & Clark, 2011). In a broad sense, there are two kinds of explanations for this statement. One is based on the structure-conduct-performance (SPC) paradigm. This paradigm mainly believes that performance differences are caused by different market positions of the firms. For instance, some firms can create entry barriers by manipulating prices with their dominance in the market. The other explanation is based on Resource-Based Theory. This explanation holds that performance differences are the results of differences in efficiency among firms (Barney & Clark, 2011). These two explanations do not contradict each other in some circumstances. The difference between them lies in perspectives.

2.1.1 Industrial Organization

Industrial organization is also sometimes referred to as "industrial economy" and is generally considered to be a subset of microeconomics (Huang & Wang, 2011; Ma, 2000). Some scholars divide the development of the Industrial Organization into three stages: the period of pre-structuralism, the period of structuralism, and the period of behaviorism (Hu, 2011).

During the pre-structuralism period, Classical Price Theory and the theory of perfect competition developed and improved by scholars such as Marshall, Chamblin, and Clark laid the foundation for the development of the Industrial Organization. In the book *Principles of Economics* published in 1890, Marshall pointed out that the dilemma between free competition and competitive vitality (also known as Marshall's Dilemma) is the core issue that market structure theory in modern times tries to address. In 1933, Chamblin and Robinsen both explained in their works that among the four types of market structures, monopoly and perfect competition are extreme cases while monopolistic competition is the market normal. Subsequently, Clark put forward the concept of effective competition, believing that it is possible to reach equilibrium under Marshall's Dilemma. Studies in this period have served as the foundation for the establishment of the market structure theory (Qi, 1998).

During the period of structuralism, two major schools coexist with each other. The mainstream one is the Harvard School led by Mason. As the Harvard School emphasizes the decisive role of the market structure, it is also thought of as a kind of structuralism (Hu, 2011). Mason is known as the pioneer of the industrial organization as he not only set up a course on the industrial organization for the first time but also conducted special research on market structure issues. Besides, Mason is also the first one to propose using the S for market structure, C for market conduct, and P for market performance to analyze the effectiveness of competition. Mason holds that that performance depends on conduct while conduct depends on the structure. Following the footsteps of Mason, Bain, who is a student of Mason, published the book *Industrial Organization* in 1959. This book marks the formal establishment of the theory of market structure in industrial organization. Bain also created a classical theoretical system of research paradigm with monopolistic competition as the dominant model, market structure as the central thread, and SCP as the research paradigm (Qi, 1998).

In the period of structuralism, the Chicago School was on par with the Harvard School. It is represented by scholars such as Stigler and Demsetz who put forward a view different from the Harvard School. The Chicago School's main propositions are as follows: First, the theory of price, namely the theory of perfect competition is the theoretical foundation of Industrial Organization rather than the theory of monopolistic competition theory put forward by the Harvard School; second, in terms of research content, the Chicago School places more emphasis on factors influencing firm performances including efficiency; third, in terms of methodology, unlike the Harvard School, the Chicago School adopts theoretical research and normative analysis more frequently rather than empirical methods; fourth, as for research propositions, the Chicago School is more diversified and not just simply aims at maximizing firm profits (Qi, 1998). Similar to the Chicago School, the New-Austrian School, which is less influential, also agrees with the theory of perfect competition and opposes all forms of human intervention. However, they recognize the rationality of business mergers and believe that this is one of the mechanisms for selecting the superior and eliminating the inferior in the market (Li & Wang, 2017).

After the period of structuralism comes the period of behaviorism, represented by scholars such as Baumol, Sawyer, and Tirole, and is based on the New Industrial Organization. Scholars of this period still follow the SCP paradigm to a certain extent but held different views compared with the market structure determinism by Mason and Bain. In the book *Industrial Market Structure and Economic Performance* published in 1970, Scherer emphasized the importance of conduct. In the book *Contestable Markets and the Theory of Industry Structure* published in

1982, Baumol highlighted the reverse influence of the SCP paradigm and the interactive relationship between the three components. In 1982, Sawyer first conducted an analysis centered on firm conducts in the article titled "On the specification of structure-performance relationships". During this period, some new tools and disciplines emerged. Against such a backdrop, Tirole introduced the methods and tools of game theory in the book *The Theory of Industrial Organization*, which is published in 1988. Tirole believes that the strategic interaction between firms determines their conduct, which then decides their performances. Later, Coase and Williamson developed the new institutional economics, which is seen as the deepening of the theory of industrial organization. Therefore, the period characterized by the new institutional economics is also called the period of post-structuralism.

2.1.2 Limitation of the SCP paradigm

The structure-conduct-performance (SPC) paradigm is the core and a classical model of the industrial-organizational theory. Structure refers to the construction, formation, and makeup of an industrial organization, which can be measured through dimensions including the number of competitors in the industry, heterogeneity of products, entry costs, and exit costs. Conduct refers to the behavior of adopting strategies such as pricing strategies and marketing strategies by firms. Performance at the beginning referred to the economic performances of the whole society, but later when the SCP paradigm was applied in strategic management, performance was used to identify the industries that can bring competitive advantages and good performances. So, performances were then referred to performances of individual firms (Barney & Hesterly, 2005).

As mentioned above, the SCP paradigm first appeared in the 1930s. The Harvard school, represented by Bain and Mason, believes that there is a causal relationship between the market structure, firm conduct, and market performances. To be specific, market structure is a determinant of firm conduct, which in turn determines performance. Market structure can be measured by many factors such as the number of competitors in an industry, the heterogeneity of products, and the cost of entry and exit. To achieve ideal market performances, public policies are needed to adjust the unreasonable market structure (Hou, 2011). Scherer plays an important role in enriching the SCP paradigm. In the book *Industrial Market Structure and Economic Performance*, which was published in 1970, Scherer filled the gap in terms of the explanation of market conducts in Bain's book *Industrial Organization* by developing the two-stage SCP paradigm into a three-stage one, which has become the authoritative explanation and foundation of the SCP paradigm (Hou, 2011). After that, the academic community has introduced some new theories and new methods, and some changes have taken place in terms

of the research focus and analysis methods. These changes have led to the creation "new industrial organization". The SCP paradigm is improved in three aspects. First, the research focus has gradually shifted from market structure to market conduct; second, a two-way and dynamic research framework was established; the third, game theory was used (Hou, 2011). Michael Porter's Five Forces Model is the most important application and deepening of the SCP paradigm. It identifies and clearly describes five forces of supplier power, buyer power, competitive rivalry, the threat of substitution, and the threat of new entry through a comprehensive analysis of the structure and industry (Barney & Hesterly, 2005). The significance of Porter's Five Forces Model lies in two perspectives. First, it identifies these forces that together determine the potential ultimate profit of the industry. Second, the key to strategy formulation is to analyze the source of competition through analysis of various forces to clarify the firm's advantages and disadvantages and the strategic positioning that can generate the greatest return. "The strategic goal for the competition of a firm is to position itself in the best place within the industry, defend itself, and fight against the five competitive forces" (Porter, 2004).

But as time goes by, the SCP paradigm has met with more and more challenges. Besides challenges raised by the Chicago School and other views put forward during the period of post-structuralism, there are many challenges as well. The first challenge is about the legitimacy of the methods. The competitive advantage of a firm may come from satisfying customers' needs more effectively than competitors, rather than relying on improper ways such as suppressing competition. The second challenge is about the rationality of assumptions. The SCP paradigm is based on the economic assumption that the fiercer the industrial competition, the more the social welfare. The paradigm assumes that when the industry is in perfect competition, features such as low costs, high quality, and appropriate innovation of the competing industry are consistent with the interests of consumers and the social total welfare. Therefore, the original intention to study the SCP paradigm is to identify those industries that have not reached a state of perfect competition, so that the government can take actions to increase industrial competition and promote social welfare. However, some antitrust cases later showed that the interests of firms with stronger competitive advantages or with weaker competitive strengths may also be consistent with consumer interests or social welfare. The third challenge is from empirical research. A four-year empirical study by Rumelt showed that only 16% of performance differences among firms are caused by industrial characteristics, but more than 80% can be attributed to corporate characteristics (Barney & Hesterly, 2005); the fourth challenge is about the universality of this paradigm in different regions. In the case of China, due to the

complexity of the economic component, the narrow scope of the research, the ambiguity of endogenous variables, and the mechanism, it is difficult to apply the SCP paradigm in China universally (Hou, 2011).

2.1.3 Foundation of RBT

Four early studies have an important impact on RBT. They are the study of unique capabilities, Ricardo's Theory of Rent, Penrose's Firm Growing Theory, and the study of antitrust in the field of economics. At the same time, the two parallel studies on intangible assets and competence-based diversification of firms share similarities with the previous four studies even though the research approaches taken in these two are different (Barney & Clark, 2011).

Scholars including Tichy and Selznick first studied unique capabilities. They believed that unique capabilities refer to capabilities that enable firms to achieve strategic goals in a more efficient manner (Barney & Clark, 2011). The comprehensive management capabilities of a firm are one of the first unique capabilities that receive attention, while the general manager of the firm, in charge of strategy implementation and overall performance, is the focus of attention. It is believed that the general manager determines the performance of the firm. In particular, the attributes and of a leader and the abilities of a leader to create and maintain the mission and vision of the organization can determine the performance of the firm. For example, Tichy et al. pointed out the influence of transformational leadership on firm performances, while Selznick believes that organizational vision and organizational structure together can define the unique capabilities of a firm (Barney & Clark, 2011). Barney did not deny the influence of the general manager or other leaders on firm performances but holds that there are considerable limitations if leadership is used as the only explanation for persistent performance differences between firms because the characteristics of leaders are not easy to identify and are changeable. There exists not always a causal relationship between leader characteristics and performance, either. A one-sided emphasis on the role of leaders may also lead to the neglect of other contributing factors (Barney & Clark, 2011).

Consulting firm Accenture also defines "unique capabilities" as a set of unique, interrelated, customer-centric processes and resources owned by a firm. Accenture puts unique capabilities with market positioning and performance profile as the three cornerstones of a high-performance firm (Peng, 2007). Wei and others believe that unique capabilities are the unique resources and skill combinations possessed by a firm, which is an important source of the core competitiveness. However, due to the dependence of the firm on the external environment, unique capabilities may also become a resistant force when the firm is choosing or transforming

its strategies, which requires the attention of the firm (Wei & Tian, 2010).

The classical political economist David Ricardo pays a lot of attention to primitive and indelible natural endowment that cannot be amplified of the owners of production factors (Barney & Clark, 2011). When Ricardo dug into this theory from 1770 to 1815, the price of wheat was rising and the Corn Laws which protect the interests of landlords were promulgated in the United Kingdom. Besides, social tension was increasing after Britain entered the industrial age. Based on the labor theory of value, Ricardo proposed the concept of differential rent, and further explained that differential rent refers to differences resulting from location, the fertility of the land, and the margin between labor and capital input (Zhang, 2018). He also believes that, unlike other factors of production, the supply of land is relatively stable. Even under high demand and with high prices, the supply of land cannot increase significantly. Therefore, such factors of production whose supply is stable and is not influenced by changing prices are completely inelastic, and thus the resulting performance differences will continue to exist (Barney & Clark, 2011).

Different from Ricardo, Penrose emphasized more on the internal force of the growth of the firm. She believes that the growth of the firm was subject to the following three factors: First, the productive resource bundle controlled by the firm. She specifically pointed out that the resource bundle is heterogeneous and extensive. Different firms control different resource bundles; the second is the productive opportunities constrained by productive resource bundles; the third is the management ability and platform to coordinate teams for using these resource bundles (Barney & Clark, 2011).

Penrose particularly emphasizes the endogenous nature of firm growth, and believes that the force of inherent growth must be identified in the nature of the firm; at the same time, she believes that such growth should be controlled through management. For example, the firm's manager should have the ability to grasp productive opportunities, fully tap into internal resources and improve the planning and coordination abilities accordingly as the firm grows. Otherwise, when the firm expands faster than its management abilities, Penrose Effect which leads to internal coordination disorders impaired growth efficiency will occur (Li, 2011).

While at the same time, some scholars that study antitrust, represented by Demsetz, began to raise views of RBT based on the SCP paradigm. In 1973, Demsetz published a paper that pointed out that the industrial structure is not the only determinant of firm performances, and that a firm's persistent performance advantage cannot be regarded as the evidence for engaging in anti-competitive activities. Because these firms may enjoy the competitive advantage as a result of being lucky or their extraordinary ability in management and meeting customer

demand, or the high cost of obtaining their information and difficulty in replicating their skills. These first-mover advantages will only exist for a short period (Barney & Clark, 2011). Intangible assets are another perspective. Itami believes that tangible assets can only be used for the operation of the firm while intangible assets whose accumulation is time-consuming and application is broad should be the source of a firm's competitive advantage (Barney & Clark, 2011). The following scholars hold the same view: 1) Theodore Schultz proposed the Human Capital Theory in 1960. According to this theory, human capital is also one of the important components of intangible assets, and because human capital adheres to the law of increasing marginal returns, its contribution to firm performances is greater; 2) the Technical Innovation Theory put forward by Schumpeter holds that technological innovation of a firm takes the form of intangible assets; 3) Wernerfelt proposed in 1984 that firms should fully tap into internal heterogeneous resources to promote the value-added and operating performance of the firm. Therefore, this heterogeneous resource often presents itself as intangible assets; 4) the Core Competency Theory proposed by C. K. Prahalad and Gary Hamel in 1990 also holds that the core competitiveness of a firm is largely developed by integrating intangible assets (Tao & Yao, 2020).

Prahalad emphasized the importance of dominant logic and core competence. He defined dominant logic as a set of systems of thinking, or a kind of global vision, or conceptualization of goals, business decisions, and management tools in business operations, while he defined core competence as the competence of collective learning of an organization, especially the ability to coordinate diversified production and integrating multiple technological flows. Prahalad believes that corporate competence is the foundation of competitive advantage while diversification is the representation and monetization channel of these competencies (Barney & Clark, 2011).

2.1.4 Establishment of RBT

The basic outline of RBT is believed to have been initially depicted by four scholars: Wernerfelt, Rumelt, Barney, and Dierickx (Barney & Clark, 2011). The articles published by these scholars between 1984 and 1989 clarified that it is completely feasible to develop a performance theory by taking the resources owned by a certain firm as the object of analysis. Since then, more and more scholars have followed their footsteps and discussed elements and attributes of the resources controlled by the firm, as well as theoretical assumptions, judgments, and predictions from various perspectives and levels. The results of these discussions, together with the findings of the previous four scholars, are called the resource-based theory (RBT).

Wernerfelt is the first scholar to propose resource-based views with the original intention of studying the relationship between resources and market positioning of a firm to enrich the SCP theory proposed by Porter. Therefore, in his paper published in 1984, he called his ideas resource-based because although his perspective is firm resources only, the study was mainly done to prove the proposition that market position determines competitive advantage (Barney & Clark, 2011). But during the research process, he found that the market position of a firm is a reflection of the resources it controls, so the competition for market position among firms is in fact competition for the resources controlled by them. In this sense, Wernerfelt identified certain key elements of RBT in the 1990s, that is, competition between firms based on resources and resource combinations is essential for firms to implement market strategies and obtain competitive advantages (Barney & Clark, 2011).

In the same year when Wernerfelt published his article in 1984, Rumelt published the second book on resource-based theory, focusing on exploring the source of economic rents of firms. According to Rumelt, generally, in terms of the ability of firms to create economic rents, firms, as an organization, is more able to achieve this goal than the market. He further proposed that firms are a series of productive resource bundles. The value of these resource bundles will change with environments, and their imitability also depends on the degree of protection offered by the isolation mechanism (Barney & Clark, 2011).

In 1996, a group of scholars such as Conner, Grant, Liebeskind, Kogut, and Spender further studied the relationship among transaction costs, corporate governance, and economic rents. They believed that both transaction specificity and investment specificity can be regarded as the economic rent of firms. At the same time, problems such as opportunism caused by specificity must also be resolved through corporate governance (Barney & Clark, 2011).

Many of Barney's views were raised after Wernerfelt's, but the reason that Barney is considered the pioneer of RBT is that his views are results based on a comprehensive refutation of the SCP theory. In his paper published in 1986, Barney creatively introduced the concept of "strategic factor market" and defined it as "a place where firms obtain or nurture the resources, they need to implement product marketing strategies". He found that if the strategic factor market is in perfect competition, then the cost of acquiring resources in the factor market will be equivalent to the performance created by implementing the market strategy; Since the strategic factor market is always in perfect competition, unless the firm is lucky enough or has extraordinary insight into a certain resource, otherwise, even if the firm successfully implements the market strategy, resources acquired in the strategic factor market, due to costs, still cannot be transformed into economic rents (Barney & Clark, 2011).

This is completely different from the core principle of the competitive advantage theory based on market positioning. Barney believes that the perfect competition in the strategic factor market is the reason that product market competition theory is not sufficient to explain the persistent performance differences among firms. On the contrary, he points out that compared with external resources, the resources controlled by the firm are more likely to become the economic rent. This also marks the development and transformation of "resource-based view" to "resource-based theory"(Barney & Clark, 2011).

Dierickx and Cool (1989) extended Barney's argument by further describing how the resources a firm already controls can help the firm generate economic rents. They suggest that resources that are subject to time compression diseconomies, that are causally ambiguous, or that are characterized by asset mass efficiencies are less likely to be influenced by strategic factors than other resources and are more likely to become the source of economic rents and persistent competitive advantage (Barney & Clark, 2011).

2.1.5 Paradigm of VRIO

Resource-based theory (RBT), like other strategic management theories, is essentially to explain the source of persistent competitive advantage of firms (Andersen et al., 2015; Barney & Clark, 2011). To obtain a persistent competitive advantage, firms have to meet the following condition: to create more economic value that cannot be easily imitated by others. This leads to a hypothesis of the RBT, which is, sustained competitive advantage is premised on resource heterogeneity and resource immobility because the resources in all competing companies are equally distributed and can move freely, the firm will not be able to obtain a competitive advantage, let alone a sustained competitive advantage. This is also the case with first-mover advantage, entry barriers, or mobility barriers because they are also based on resource heterogeneity (Barney & Clark, 2011).

Andersen et al. (2016) also believe that heterogeneity and immobility are the two basic concepts of RBT. Focusing on immobility, Andersen et al. (2016) analyzed the relationship between resources and performances, the characteristics of the resources, and the process of immobility.

But not all resources that satisfy the two conditions of heterogeneity and immobility can become sources of sustained competitive advantage. Barney believes that resources that become a source of sustained competitive advantage must have the following four attributes.

2.1.5.1 Value

First, resources must be valuable. Only valuable resources can become a source of sustained competitive advantage. The value of resources is presented as follows: the first is strategic value, that is, it can be used to grasp opportunities in the environment or tackle threats in the environment, which will help firms develop and implement strategies to improve efficiency and effectiveness, which implies that to a certain resource, rather than treating different resources the same, specific corporate strategy and market environment should be taken into account; the second is the economic value of resources, valuable resources can help firms generate economic value by increasing income or reducing costs or both; the third is the linking value. The value attribute of resources can also be seen as a link and complementarity between the environmental model and the resource model of competitive advantage. The environmental model is used to identify opportunities that need to be seized and risks that need to be resolved while the resource model is aimed at positioning resources and identify their attributes (Barney & Clark, 2011).

2.1.5.2 Rarity

The second attribute of a resource is whether the resource is currently being controlled by only a small number of competing firms. Resources controlled by many competing firms, even if they are valuable, cannot become a source of sustained competitive advantage. Because if a certain resource is owned by many firms, and each firm uses the same resource in the same way, the result is often that no firm can gain marginal value and competitive advantage. As for the degree of rarity, generally speaking, when the number of firms owning a certain valuable resource is less than the total number of firms when the industry is in perfect competition, then firms that own these resources are likely to gain competitive advantage (Barney & Clark, 2011).

2.1.5.3 Imitability

Valuable and rare resources may be the source of competitive advantage, but only when these resources cannot be obtained by other firms through direct replication or substitution. In other words, these resources will become a source of sustained competitive advantage only when they cannot be completely imitated (Barney & Clark, 2011).

This non-replicable attribute can be explained from three aspects: First, the uniqueness of time and space. RBT holds that the ability of firms to acquire and develop certain resources is subject to specific time and space. Without the proper timing and space, firms may not be able to obtain such resources. Therefore, the unique historical position and development path may enable firms to obtain a competitive advantage through first-mover advantage or path

dependence; the second is the lack of understanding of the cause and effect. The relationship between the resources controlled by the firm and the sustained competitive advantage is not well known or poorly understood. Hence it is very difficult for firms trying to imitate because they have no clue which resource they should imitate at all. What is interesting is that if such poor understanding should become a source of sustained competitive advantage, then all firms, including those with competitive advantages, are also required not to fully understand the relationship, because once the firms with competitive advantages understand the cause and effect well, then other firms may imitate them by poaching insiders or through other methods; The third reason that a firm's resources may be imperfectly imitable is that resources may be very complex social phenomena. When the complexity of such social resources exceeds the ability of a firm to manage systematically, the ability of other firms to imitate these resources will be greatly constrained. In other words, knowing that a certain resource can promote the efficiency of the firm does not mean that other firms must be able to obtain this resource through hard work, nor does it mean that after obtaining this resource, they must have the corresponding skills to use this resource (Barney & Clark, 2011).

It should be noted that even if resources cannot be completely imitated due to history, causal ambiguity, and social complexity, there is still the possibility of substituting resources that are duplicated at a low cost. Substitutability takes two forms: substitution of similar resources or substitution of similar functions. One example for the former form is to substitute a top management team with a competitive advantage with a similar one. One example of the latter is to substitute top management teams with competitive advantages with fine management systems. Although these resources are different, the strategic function and value that they bear are almost the same (Barney & Clark, 2011). Some scholars highlight the non-substitutability of resources, and call value, rarity, imitability, and non-substitutability the VRIN attributes of resources (Mikalef et al., 2018). But it is still believed that the roles of imitability and non-substitutability in resource analysis are the same.

2.1.5.4 Organization

Organizational processes are the fourth condition for obtaining resources of sustainable competitive advantage. Valuable, rare, and imitable resources can only become a source of sustained competitive advantage if the firm is well organized. Therefore, a large number of organizational components including the formal reporting structure, the management control systems, and compensation policies can influence how the firm tap into the full competitive potential of its resources and capabilities. Having an appropriate organization in place can help

firms make full use of their resources and capabilities, and maximize the realization of the competitive advantage based on these resources and capabilities while the inappropriate organization will prevent firms from leveraging high-quality resources (Barney & Clark, 2011).

2.1.5.5 Analysis framework

VRIO is not only a representation of attributes of resources but also a strong framework for analyzing resource competitiveness. In the VRIO analysis framework, there are two premises: resource heterogeneity and resource immobility. As pointed out earlier, if the resources in a particular market are completely homogeneous and can move freely, firms cannot have a competitive advantage.

The VRIO framework expresses the four key parameters for resource-based analysis as a series of questions concerning value, rarity, imitability, and organization. To be specific, these four questions are: 1) Do a firm's resources and capabilities enable the firm to respond to environmental threats or opportunities? 2) Is a resource currently controlled by only a small number of competing firms? 3) Do firms without a resource face a cost disadvantage in obtaining or developing it? 4) Are a firm's other policies and procedures organized to support the exploitation of its valuable, rare, and costly to imitate resources (Barney & Clark, 2011)?

After answering the above four questions, we can categorize the competitive advantage of resources into four types: competitive disadvantage, competitive parity, temporary competitive advantage, and sustained competitive advantage. Competitive disadvantage means that the competitiveness is below normal; competitive parity means that the competitiveness is at the normal level; temporary competitive advantage means that the competitiveness is above the normal level but may not be sustainable, and sustained competitive advantage means that the competitiveness is higher than the normal level and sustainable.

According to RBT, first of all, if a resource is not valuable, then that resource will not enable a firm to choose or implement strategies that exploit environmental opportunities or neutralize threats. The use of this resource will increase costs or decrease revenue, so it should be avoided and if used, firms may be at a disadvantage in the competition compared with those that do not use it; secondly, if a resource is valuable but not rare, then all firms may use this resource. If it is used well, it may bring about competitive parity, but if not used well, it may also put the firm at a competitive disadvantage; third, if a resource is valuable and rare, but not difficult to imitate, then this resource can help firms generate a temporary competitive advantage. However, once other firms discover this competitive advantage, they will be able to acquire or develop the resources needed to implement this strategy through direct duplication

or substitution at no cost disadvantage. Over time, any competitive advantage that the first mover obtained would be competed away and go back to competitive parity; fourth, if resources are valuable, rare, and difficult to imitate, then the development of such resources may enable the firm to obtain a sustainable competitive advantage because to directly replicate these resources is costly for competing firms and no substitutes for these resources exist; Organization operates as an adjustment factor in the VRIO framework. For example, if a firm has a valuable, rare, and costly to imitate resource and capability but fails to organize itself to take full advantage of this resource, some of its potential competitive advantages could be replaced by competitive parity or even competitive disadvantage (Barney & Clark, 2011). From this perspective, the organization can be seen as a necessary and insufficient condition for resources to generate sustainable competitive advantage. In summary, the VRIO analysis framework is summarized in Figure 2.1.

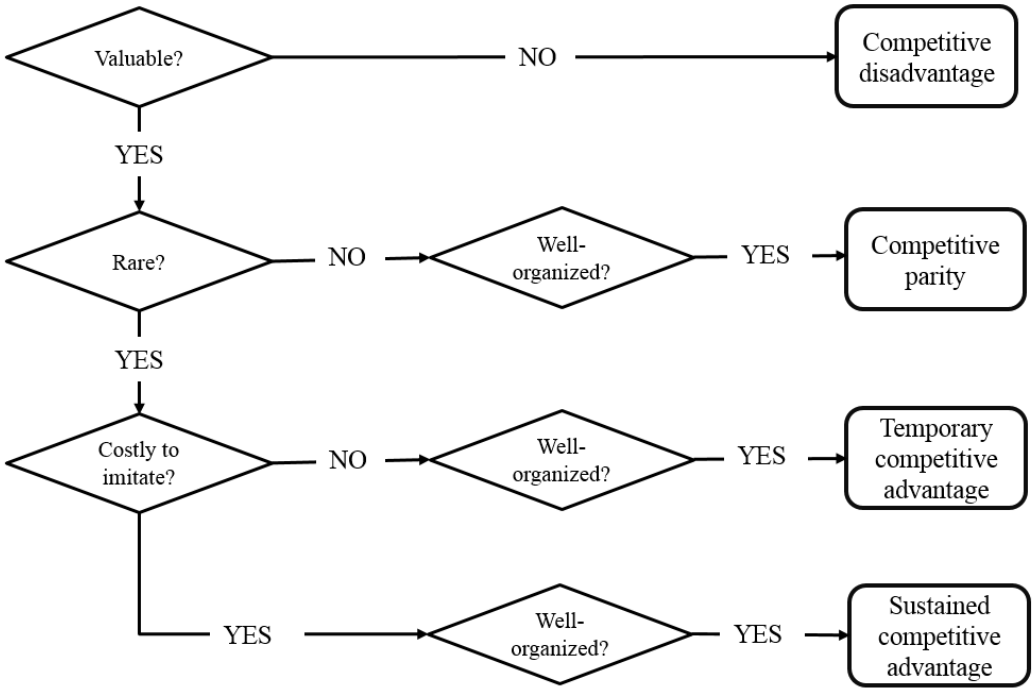


Figure 2.1 VRIO analysis framework

Source: Barney and Clark (2011)

RBT has been constantly enriched based on the above-mentioned core content. Barney in 2004 said that the two basic assertions of the strategic human resource management (SHRM) theory, namely the importance of human resources and the value of corporate human resource management, can also be used as a complex and flexible extension of the RBT(Colbert, 2004) . Ocala et al. (2013) also studied the dynamic capability view (DCV) and the relational view (RV). They believed that these two were born from the RBT, but they have improved the RBT. Badrinarayanan et al. (2018) believe that one of the latest focuses of applications of RBT is on

the ability of firms to coordinate and dynamically manage resources. Patrick et al. said that in 1991, Grant divided resources into three categories: tangible resources such as financial and material resources, intangible resources such as organizational culture and learning, and human skills such as employee knowledge and skills (Mikalef et al., 2018). Huang and others believe that the resource patchwork theory, resource arrangement theory, and network arrangement theory that have emerged in the past two decades can be regarded as “new resource theory”, and their development was first driven internally and later externally (Huang & Xie, 2021).

2.2 Dynamic Capability Theory

RBT is a theory with great influence. It looks into the firm and explains the reasons for firms to generate continuous competitive advantage. However, as a society and research progress, some scholars believe that RBT cannot well explain why certain firms can still possess and maintain their competitive advantage in a rapidly changing and unpredictable external environment under certain circumstances (Du & Feng, 2020). In this context, Dynamic Capability Theory (DCT) emerged as an important supplement and research hotspot of RBT.

2.2.1 Origins of dynamic capabilities

The formation of dynamic capability theory roughly includes four origins. First, it is the limitation of resource-based theory and capability theory. Although the resource-based theory successfully brings the resources of an organization into the analytical perspective of strategic management and competitive advantage, it: 1) does not provide a good explanation of where organizational resources come from and how to obtain them; 2) is even less able to explain how organizations can maintain a competitive advantage in an environment of continuous, rapid, and massive change(Cardeal & António, 2012; Diao & Li, 2014; Su & Sun, 2012).

Similar problems exist in competency theories such as core competitiveness. Although it expands the internal competition elements of the organization to the organizational capabilities beyond the material, it is still introverted and static, and it still cannot answer the question of "whether the original resources, capabilities and even core competitiveness of enterprises can still bring sustainable economic benefits to the enterprise under earth-shaking changes of the external environment” (Diao & Li, 2014). The dynamic capability theory makes up for this deficiency. The word "dynamic" requires enterprises to expand or build their own capabilities to adapt to the external environment; while the word "capability" requires enterprises to pay attention to the capability of strategic management, and to focus more on the enterprise itself

(Diao & Li, 2014).

From the perspective of resources, the focus of researches in Western countries has also experienced changes from tangible resources to intangible resources, from static resources in stock to dynamic resources in flow, and Western scholars pay more attention to the complementarity of resources and organizational boundaries, including: 1) Helfat (1997) found that complementary technologies and assets contribute to the accumulation of dynamic R&D capabilities; 2) Rindova and Kotha (2001) argued that the continuous changes of organizational forms is one of the precursors to develop dynamic capabilities; 3) King and Tucci (2002) believed that the experience of not change and change can both promote the development of dynamic capabilities; 4) Blyler and Coff (2003) believed that social capital is the core of dynamic capabilities, and relationships are an important resource for enterprises; 5) Pil and Cohen (2006) believed that the design of organizational modules, including strategic scope and timing, would have an impact on the development of dynamic capabilities; 6) Døving and Gooderham (2008) believed that an alliance of external complementary service providers would affect the development of dynamic capabilities; 7) McKelvie and Davidsson (2009) argued that the role of resources will change with the development of dynamic capability, and that the human capital of founders, employees, technical experts, and other experts will bring bigger impacts than the other two tangible resources (Su & Sun, 2012).

The second origin of the dynamic capability theory is the great changes of external environment. Factors that are often mentioned are: 1) environmental changes caused by business globalization; 2) increasingly personalized and diversified consumer demand; 3) increasing uncertainty of the market environment (Su & Sun, 2012; Mei & Wu, 2016). Under the combined effect of these trends, companies are often required to have the ability to quickly respond to the market and have strong environmental adaptability. The core competence theory proposed by Professor Parhalad and Hamel in the 1990s has been difficult for enterprises to establish and maintain a long-term competitive advantage in the era of globalization in the face of various uncertainties. Moreover, the theory itself has rigid defects. Under the combined influence of internal and external factors, scholars who advocate the idea of gaining a competitive advantage by accelerating the integration of resources have gradually formed the dynamic capability theory of the capability. D'Aveni believes that enterprises must continue to innovate and adjust their own development strategies to keep up with changes in the external environment. He also comprehensively described the overall framework of dynamic capabilities in his book in 1994. Collis not only pointed out that dynamic capability is "the greatest capability", but also pointed out that this capability is formed in the process of adapting

to changes of the external environment. In giving the definition of dynamic capability in 1997, Teece, Pisano, and Shuen also pointed out that dynamic capability is aimed at "adapting to the rapidly changing external environment" (Mei & Wu, 2016).

The third origin is the study of organizational behavior and organizational cognition. In terms of organizational behavior, some scholars believe that hotspots of western research have been changed from abstract and general organizational behaviors to specific and microscopic individual behaviors, as well as specific organizational behaviors such as corporate mergers and acquisitions. For example, in 2009, a study of Taylor and Helfat showed that establishing and maintaining connections between middle managers and exploratory departments is critical to dynamic capabilities in technological transformation (Su & Sun, 2012). In terms of organizational cognition, some scholars believe that cognition of managers and employees, emotions, and unconscious processes may all have an impact on the formation and development of dynamic capabilities. Emotions and unconscious processes in the process of strategic adaptation have been underestimated in previous dynamic capability theories (Su & Sun, 2012).

The fourth origin of dynamic capabilities is the theory of organizational evolution, which plays an important role but is neglected by most of literature. Holland, the founder of Genetic Algorithm, put forward the theory of "Complex Adaptive System (CAS)" and "Dynamic Research Paradigm" in his book *Hidden Order: How Adaptation Builds Complexity*. The Paradigm is based on the interaction of multiple subjects within a system that constitutes an enterprise's organizational capabilities, which explains the process of enterprises exchanging, sharing and creation resources with other subjects in the complex and dynamic environment, in order to acquire new resources and optimize resource structure in a dynamic and complex environment, as well as the emergence and evolution mechanism of enterprise organizational capabilities (Ke et al., 2013).

Regarding the evolutionary mechanism, some scholars believe that the evolution of an enterprise's organizational capability system can be understood as the evolutionary process of organizational conventions. In the process of interacting, the adaptive subjects generate new organizational conventions by three mechanisms: 1) identification mechanism, referring to the interaction between the subject and the environment and subjects between the subjects, mainly providing an identification mechanism for the mutual identification, screening and cooperation between the subjects; 2) block mechanism, referring to complex systems normally composed of permutations of simple blocks; 3) internal model mechanism, which means that in a complex adaptive system, when the adaptive subject receives a large influx of input, it will select corresponding modes to respond to these inputs, and these modes will eventually solidify into

a structure with a certain function. Under the constraints of new conventions, the operation of organizational processes changes, and the changes in processes make organizational operations more adaptable to changes in the environment, which is reflected in the overall change of the enterprise organizational capability system, resulting in systematic quantitative changes, and ultimately leading to the emergence of systems. Therefore, the various resources of the enterprise have been optimally allocated, so as to realize the evolution of the organization system (Ke et al., 2013).

Regarding the stages of organizational evolution, Ding and Ji (2004) believe that it can be divided into six stages: 1) Organizational digital view, which takes scientific management and X theory as the core ideas, the scale production for the seller's market as the basic driving force, and the material-oriented mechanical efficiency as the organizational gene; 2) Organizational humanistic view, which takes Y theory as the core idea, the buyer's market as the basic driving force, and the people-oriented management concept as the organizational gene; 3) Organizational strategy view, which takes the SBU theory of selecting strategies according to the environment as the core idea, the competitive advantage under globalization as the basic driving force, and takes organizational vitality and rapid response as the organizational gene; 4) Organizational team view, which takes Z theory that highlights team spirit as the core idea, the overall quality movement and corporate culture shaping as the basic driving force, an corporate culture such as core values as the organizational gene; 5) Organizational learning view, which takes the system archetype theory as the core idea, takes modern logistics, digitization, and informatization as the basic driving force, and takes knowledge sharing, value innovation, and organizational learning as the organizational genes; 6) Organizational virtual view, which takes the virtualization of the overall social environment as the basic driving force, and the virtualization and unboundedness of knowledge and intelligence as the organizational gene, thereby promoting the invisibility of the organizational form until it finally disappears (Ding & Ji, 2004).

Organizational learning is closely related to dynamic capabilities. There are few opinions: 1) the concept of organizational learning was first proposed by March and Simon in 1958, and many scholars have put forward different definitions since then. However, all of them agreed that organizational learning is to innovate information processing, organizational structure, and business processes by finding new ways and methods to establish a dynamic match between organizational elements and environmental elements. This definition is quite close to dynamic capabilities. 2) Dynamic capability is intellectual with learning spirit. Verona and Ravasi in 2003 believed that the ability to create, absorb, integrate and reconfigure knowledge is the

intrinsic basis of dynamic capabilities. 3) In 2004, Dong believed that the process of an enterprise's ability to change is the process of pursuit of new knowledge. 4) In 2006, Wang believed that dynamic capabilities are deeply imprinted with knowledge. 5) In 2010, Shen believed that dynamic capabilities, as the fundamental guarantee to promote the sustainable competitive advantages of enterprises, are essentially the problem of organizational learning. 6) Hu proposed in 2006 that organizational learning and dynamic capabilities are co-evolutionary, and it is the continuous and benign interaction between organizational learning and dynamic capabilities that enables organizations to continuously gain competitive advantages. 7) Scholars including Yang believe that organizational learning does not directly affect enterprise performance, but plays a role through dynamic capability as mediating variable (Su & Sun, 2012).

In terms of organizational evolution, researches related to "Universal Darwinism" and "Self-organization Theory" cannot be neglected. First, the basic statement of "Darwinian Evolution" or "Natural Selection Theory" is: 1) the number of any creature can grow geometrically; 2) the number of organisms has been approximated and maintained at a constant for a long period; 3) the contradiction between the possible increase (of geometric multiples) and the constant maintenance (over a certain period of time) can be presumed that there must be a competition for survival between organisms; 4) organisms have heredity and variation (variation may also be inherited). As variation is a characteristic of organisms, so there does not exist two exactly same individuals; 5) variants that can better adapt to the environment can survive in competition, otherwise they cannot survive; 6) since variation can be inherited, the proportion of variation that is better adapted to the environment will increase, thus resulting in evolution (Guo, 2004).

And "Universal Darwinism" also has a long history. As early as 1898, Veblen linked biological evolution to some economic phenomena. By 1952, evolutionary economics took off and attempted to model economic evolution. Hodgson, a big fan of "Universal Darwinism," argued in 2002 that selection, variation, and genetic mechanisms are not unique to biology, but should be viewed as universal principles of all evolutionary programs. Dopfer and Potts' believed in 2004 that economic evolution has a staged evolutionary law of origin, application, adaptation and retention. Nelson defined "Universal Darwinism" in 2006 as a dynamic theory involving variation and selection, and considered it the best model for economic evolution (Cai & Nie, 2012).

But scholars of Self-Organization Theory do not fully agree with the view of "Universal Darwinism", arguing that economic evolution is fundamentally different from biological

evolution for two reasons. Firstly, economic actors can consciously respond to external changes, so as to avoid external choices. Witt argued in 2004 that human behavior is governed by consciousness and therefore can be changed by itself. Secondly, the source of economic development is not "choice", but continuous and spontaneous innovation (Cai & Nie, 2012).

Nonetheless, there are still scholars trying to combine the two. In 2012, Cai and Nie believed that economic evolution can be regarded as "Darwinian evolution of self-organized operation", and believed that only in this way can micro-individuals and macro-environment be well combined dynamically (Cai & Nie, 2012), which shows a distinct property of dynamic capability.

2.2.2 Definition of dynamic capabilities

Definitions and dimensions of dynamic capabilities vary in the academic world.

In chronological order, the definition of dynamic capability includes at least the following fourteen definitions. 1) Teece first proposed in 1997 that dynamic capabilities are the ability of enterprises to integrate, establish and reconstruct internal and external competencies to adapt to the rapidly changing external environment. 2) In 1997, Helfat believed that dynamic capabilities are a subset of the ability of enterprises to create new products and new processes in the face of changing market conditions. 3) In 2000, Eisenhardt and Martin held that dynamic capabilities are the process of enterprises to integrate, reconstruct, acquire and release resources to match or even create market changes. 4) In 2001, Griffith and Harvey believed that dynamic capability is the creation of a combination of resources, including the coordination of management among organizations. 5) In 2002, Lee et al. believed that dynamic capabilities are an updated source of competitive advantages for firms to respond to specific environmental changes. 6) In 2002, Rindova and Taylor believed that the evolution of dynamic capabilities at the macro and micro levels, where the macro level is the ability to reconstruct the entire market, and the micro level is the ability to improve enterprise management. 7) In 2002, Zahra and George believed that dynamic capability is a kind of ability to reallocate the resource controlled by the enterprise in order to meet various consumer demand and competitors' the strategic adjustment. 8) In 2002, Zollo and Winter said that dynamic capabilities are a kind of stable and collective learning behavior model which allows firms to systematically generate and change operation routines to improve performances. 9) In 2003, Winter pointed out that dynamic capabilities are the ability of firms to extend, change, or create operational capabilities. 10) In 2006, Pavlou and ElSawy argued that dynamic capabilities are the ability to reconfigure functional capabilities to deal with dynamic environments. 11) In 2006, Zahra et al. held that dynamic capabilities are a firm's

ability to restructure resources and change routines in a way perceived and deemed proper by the decision-makers of the firm. 12) In 2007, Helfat et al. pointed out that dynamic capabilities are the capability of an organization to purposefully create, extend, or purposefully modify its resource base. 13) Teece added in the same year that dynamic capabilities can be further decomposed into a firm's capability to sense and shape opportunities and threats, seize opportunities, and maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets. 14) In 2010, Barreto pointed out that dynamic capabilities are the potential of a firm to solve problems (Mei & Wu, 2016; Su & Sun, 2012).

From the nature of the above definitions, most scholars define dynamic capabilities as capabilities or potentials, while a few consider them as processes or behavioral patterns. In terms of purpose, most scholars believe that dynamic capabilities are designed to respond to rapidly changing market conditions. A few scholars further believe that the targeted environmental changes mainly come from the diversity of consumer demands or the possible strategic adjustment of competitors. There are also a few scholars who explain more generally that the ultimate purpose of dynamic capabilities is to improve performance or competitive advantage. The relevant situation of the definition of dynamic capability, as shown in Table 2.1.

Table 2.1 Definition of dynamic capability

Year	Scholar	Purpose	Methods	Nature
1997	Teece et al.	adapt to the rapidly changing external environment	integrate, establish and reconstruct internal and external competencies	Ability
1997	Helfat	face changing market conditions	create new products and new processes	Ability
2000	Eisenhardt and Martin	match or even create market changes	integrate, reconstruct, acquire and release resources	Process
2001	Griffith and Harvey	——	creation of a combination of resources	——
2002	Lee et al.	respond to specific environmental changes	updated source of competitive advantages	——
2002	Rindova and Taylor	——	the macro level is the ability to reconstruct the entire market, and the micro level is the ability to improve enterprise management	Ability
2002	Zahra and George	meet various consumer demand and competitors' the strategic adjustment	reallocate the resource controlled by the enterprise	Ability
2002	Zollo and Winter	improve performances	systematically generate and change operation routines	Model
2003	Winter	——	extend, change, or create operational capabilities	Ability

Year	Scholar	Purpose	Methods	Nature
2006	Pavlou and ElSawy	deal with dynamic environments	reconfigure functional capabilities	Ability
2006	Zahraet al.	——	restructure resources and change routines	Ability
2007	Helfat et al.	——	purposefully create, extend, or purposefully modify its resource base	Ability
2007	Teece	maintain competitiveness	sense and shape opportunities and threats, seize opportunities, and maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets	Ability
2010	Barrelo	——	solve problems systematically	Ability

Source: Mei and Wu (2016); Su and Sun (2012)

Definitions given by the above-mentioned scholars are different, but they also have the following in common. First, the scholars all regarded the dynamic capabilities, as a kind of capability to modify the resource base, are high-level capabilities. Second, because dynamic capability is high-level capabilities, it is, to some extent, creative and destructive. Third, as a routine behavior mode, dynamic capability has to follow a certain pattern. Fourth, more and more emphasis is placed on taking an initiative to learn about dynamic capabilities (Diao & Li, 2014; Mei & Wu, 2016; Su & Sun, 2012).

In terms of dimensions, there are mainly two types of classification methods: one is to categorize dynamic capabilities from the organizational and cognitive perspective; the other is to categorize dynamic capabilities based on the specific process. But in general, the three dimensions of integration, building, and reconfiguration proposed by Teece are more widely used (Du & Feng, 2020; Mei & Wu, 2016).

2.2.3 Evolution

Su et al. believe that the evolution process of dynamic capability can be divided into five types in general. First is driven by learning. In the early stage, dynamic capabilities were guided by learning mechanisms mainly in developed countries, and later extended to emerging economies or economies in transition. For example, Eisenhardt and Martin proposed repetitive practice, empirical coding, past errors, empirical rhythms in 2000. Zollo and Winter in 2002 introduced quasi-automatic experience accumulation, knowledge elaboration, and knowledge coding. Zahra et al. proposed trial and error, improvisation, and imitation in 2006. In 2009, Malik and Kotabe proposed organizational learning, reverse engineering, and flexible manufacturing. Kale studied India's overseas employment to boost innovation and R&D capabilities. In 2010, Dixon et al. proposed three stages of breaking the past, mining and deploying, and exploring and innovating. Second is driven by management. For example, Pablo et al. in 2007 proposed three

stages: executive identification, trust enablement, and middle-level balance. In 2009, Narayanan et al. believed that the cognitive orientation of top managers determines the survival and development of dynamic capabilities. Third is driven by grass-roots levels. Salvato studied the role of daily behavior in the evolution of product development in 2009. Fourth is organizational integration. As argued by Akwei in 2007, dynamic capability is composed of a series of iterative and simultaneous actions, in which managers develop and update their capabilities by integrating tangible or intangible resources and performing patterned repetitive actions. Last but not least, network development should be included. Dyer et al. in 2000 took Toyota as an example to study the influence of organizational network on the ability of sharing knowledge, and believed that enterprise network is superior in creating or reintegrating knowledge.

Diao and Li believe that the evolution of dynamic capabilities can be attributed to both internal and external factors. Internal factors include three aspects. Organization includes the three elements of process, potential and path proposed by Teece et al. in 1997, and the updated research on organizational knowledge by many scholars from 1995 to 2002. Second is about entrepreneurship, including Gavetti's research on management cognition in 2000, Subba's research on entrepreneurship in 2001, and Jiao’s research on entrepreneurial ability in 2008. For other aspects, Wang mixed management cognition with enterprise management in 2006. External factors include ecological environment, social environment and other factors. The ecological environment may cause the reallocation of resources, and social environment requires regulation to adapt to changes. Other factors include partner decision-making power proposed by Griffith et al. in 2001 (Diao & Li, 2014). Moreover, some scholars conducted researches on system dynamics and its roadmap (Bari et al., 2022; Bayu et al., 2022).

2.2.4 Dimensions

There are many divisions of dimensions in academia.

In 1994, Teece and Pisano first proposed three dimensions of adaptation, integration and reconstruction. In 1997, Teece and Pisano changed to construction, integration, and reconstruction. In 2000 and 2007, Teece divided it into opportunity perception, opportunity utilization, and reconstruction. The research of O'Reilly and Tushman in 2008 also agreed with this dimension. In 2000, Eisenhardt and Martin divided into three dimensions: product development, alliance, and strategic decision-making. Some scholars believe that their views are closer to Teece's, dividing dynamic capabilities into four dimensions: integration, construction, reconstruction, and release. In 2001, Miner divided into three dimensions: trial,

trial and error, and improvisation. In 2002, Zollo and Winter divided into four dimensions: R&D, competitiveness reconstruction, resource reconstruction, and process reengineering. In 2006, Marsh and Stock believed that dynamic capability is mainly the dimension of product development capability. In 2007, Wang and Ahmed divided into three dimensions: adaptation, learning and innovation. In 2007, Schreyögg proposed a dual process model, which divides the dynamic capability into two dimensions: the capability progressive process and the flexible monitoring process. In 2008, Danneels divided into two dimensions: marketing and R&D. In 2008, Døving and Gooderham divided into two dimensions: human capital, and internal development and alliance. In 2009, Liao et al. divided into two dimensions: opportunity perception and utilization integration. In 2009, Prieto divided into three dimensions: knowledge creation, integration and reconstruction. In 2009, Mckelvie and Davidsson divided into four dimensions: creativity, market disruption, development of new products and new processes. In 2009, Macher and Mowery argued that dynamic capabilities are primarily the development or introduction of new processes or technologies. In 2010, Wu divided it into three dimensions: integration, learning, and reconstruction. In 2016, Mei divided into three dimensions: innovation, absorption and integration. The dimensions of the above-mentioned splits are different, but in general, the three-dimensional dimension of construction, integration, and reconstruction proposed by Teece et al. in 1997 is the most mentioned and recognized dimension (Su & Sun, 2012), as shown in Table 2.2.

Table 2.2 Dimensions of dynamic capability

Year	Scholars	Capacities
1994	Teece and Pisano	adaptation, integration and reconstruction
1997	Teece and Pisano	construction, integration, and reconstruction
2000, 2007, 2008	Teece O'Reilly and Tushman	opportunity perception, opportunity utilization, and reconstruction
2000	Eisenhardt and Martin	product development, alliance, and strategic decision-making integration, construction, reconstruction, and release
2001	Miner	trial, trial and error, and improvisation
2002	Zollo and Winter	R&D, competitiveness reconstruction, resource reconstruction, and process reengineering
2006	Marsh and Stock	product development capability
2007	Wan and Ahmed	adaptation, learning and innovation
2007	Schreyogg et al.	a dual process model：the capability progressive process and the flexible monitoring process
2008	Danneels	marketing and R&D
2008	Doving and Gooderham	human capital, and internal development and alliance
2009	Liao et al.	opportunity perception and utilization integration
2009	Prieto	knowledge creation, integration and reconstruction

Year	Scholars	Capacities
2009	Mckelvien and Davidsson	creativity, market disruption, development of new products and new processes
2009	Macher and Mowery	the development or introduction of new processes or technologies
2010	Wu	integration, learning, and reconstruction
2016	Mei	innovation, absorption and integration

Source: Su and Sun (2012)

2.2.5 Measurement

The academic world has not reached an agreement on how to measure dynamic capabilities. There are generally two approaches. One is to measure dynamic capabilities as a single-dimensional concept. For example, Deeds et al. in 1999 used the number of new product development to measure dynamic capabilities. In 2001, Griffith and Harvey measured dynamic capabilities based on the decision-making power of partners. In 2007, Cepeda and Vera conducted the measurement by studying the capability of a firm to restructure knowledge (Diao & Li, 2014).

Another approach is to use two or more constructs to measure dynamic capabilities from various dimensions. For example, in 2006, Wu measured dynamic capabilities by looking at the resource integration capabilities, learning capabilities, and responsive capabilities towards the rapidly changing environment. In the same year, another scholar surnamed He used five dimensions which include organizational flexibility, organizational change, organizational learning, market potential, and strategic isolation to measure dynamic capabilities. In 2008, Prieto et al. used the three dimensions of knowledge generation, knowledge synthesis, and knowledge reconstruction for the measurement. In 2008, Danneels used the capacities of firms to identify and enter new markets and to identify and acquire new technologies for dynamic capability measurement. In 2009, Liao measured dynamic capabilities from the two dimensions of recognition and integration ability for opportunity and utilization and integration ability for the opportunity. In the same year, Mckelvie and Davidsson used creativity generation ability, new product development ability, market disruption ability, and innovation ability to measure dynamic capabilities (Diao & Li, 2014).

2.2.6 Relations

Dynamic Capability Theory is closely related to Resource-Based Theory. Firstly, in theory, some scholar believe that management roughly covers the three research fields of organizational behavior, organizational theory, and strategic management, among which, the core issues and

main research lines in the field of strategic management are the reasons for differences in enterprise performance and the methods for improvement. Its mainstream theories generally experience: 1) Environmental determinism, including the SCP paradigm, the Five Forces model proposed by Porter. 2) Self-determinism. Resource-based view, knowledge-based view, system-based view, and dynamic capability view all fall into this category. 3) Determinism. For example, view of managerial freedom balances the conflict between environmental determinism and executive libertarianism to a certain extent. 4) Process determinism focuses on the impact of the quality, comprehensiveness, speed, participation, implementation and change of the strategic decision-making process on enterprise performance (Ma, 2019). Among them, dynamic capability theory is the development and extension on the basis of enterprise resource base theory and core competency theory, which not only makes the strategic analysis unit transfer from the external to the internal of the enterprise, but also makes the enterprise start to think about "where" and "how" to improve its own capabilities (Mei & Wu, 2016).

Secondly, there are relations above the capability hierarchy, and dynamic capabilities are seen as a higher-order resource. Wang and Ahmed (2007) believed that enterprise resources can be divided into four levels: the resource base of an enterprise as zero-order capabilities; survival skills as first-order capabilities; core capabilities as second-order capabilities; capabilities such as updating, adjustment, integration, reconstruction, reconstruction, and environmental adaptation, as third-order capabilities, and the dynamic capacities reflected in the paradigm shift period as a third-order ability (Diao & Li, 2014). Especially, they also pointed out that the resource base of an enterprise, especially the material resources, is a lower-level capability compared with the ordinary capability of the enterprise; and the ordinary capability is also a lower-level capability compared with the dynamic capability.

Third is about the relations of attributes. Du and Feng (2020) believe that the resource-based view is concerned with "resources", especially specific and available material resources, including equipment, human resources, and public resources. Dynamic capability is the process and capability to change these resources, or a behavioral norm that changes the basic resources (Du & Feng, 2020).

In this regard, Professor António et al. creatively and comprehensively pointed out in 2012 that dynamic capabilities should be incorporated into the original traditional and mechanical resource-based theory, and the original VRIO analysis framework should be upgraded to VRIDc, with Dc referring to dynamic capability (Cardeal & António, 2012). The advantages of VRIDc framework are: 1) It uses dynamic capability as a bridge or mediating variable between resource base and enterprise performance, thus solving the problem that traditional resource base theory

is too mechanical and static, making it better adapt to dynamically changing environment. 2) It also solves the problem that the O of organizational attributes is too abstract and broad in the original VRIO framework, and replaces it with a clearer and more effective dynamic capability perspective.

2.3 Artificial intelligence technology

As mentioned earlier, many scholars believe that the rapidly developing artificial intelligence (AI) technology will lead to the next technological revolution and will have a significant and far-reaching impact on human society. Before conducting a detailed analysis of the competitiveness of AI technology, first, the definition of AI should be clarified, because, like many other popular things, AI is also mentioned by many people on different occasions, but their definitions could be different. Therefore, it is necessary to give a clear definition and offer a standard to identify whether technology belongs to AI technology and so distinguish AI technology from Internet technology, software technology, automation technology, and other technologies. Second, we must also understand the working principles of AI technology, such as the basic principles of typical and popular applications such as AI chess players and AI medical imaging, which helps us and experts to truly understand the characteristics of AI technology, especially the characteristics that may generate competitive advantages to lay the foundation for the subsequent systematic analysis.

2.3.1 Definitions of AI

As to whether a technology is AI technology, there does not seem to be a clear and accepted definition. The earliest criterion is the Turing test. Turing put forward a method in the article *Computing Machinery and Intelligence* in 1950. According to this method, a machine and a person are both asked to talk to the referee behind the scenes at the same time. If the referee cannot tell whether he or she is talking to the machine or the person, then that implies machine intelligence (Wu, 2016). However, the Turing test method is too empirical and very vague in terms of definition and the scope of its application is relatively small.

Some scholars once mentioned the four criteria for define “intelligence”, which can also be used to define AI. Wang thinks that AI is intelligence realized on machines by artificial methods, and the so-called intelligence has four characteristics: First, it can perceive, and perception is the basic approach to obtain external information; the second is the ability of memory and thinking, which is the fundamental reason that humans can have intelligence. Memory is used

to store knowledge and thinking is used to process information, including the use of knowledge to analyze, calculate, compare, judge, reason, associate, and decide on information and so on; the third is the ability to learn; the fourth is the ability to act or express (Wang, 2017). According to this definition, if AI is regarded as a system, perception ability can be seen as the input of the system, action ability as the output of the system, memory and thinking ability, and learning ability as the processing of the system. Among these abilities, the learning ability is more demanding. These four characteristics of intelligence clearly describe the abilities that AI should possess in theory, and they are also quite applicable in practice.

Li and Wang (2017) emphasize the purpose of AI. The book *Artificial Intelligence* pointed out that there are five common definitions of AI. They believe that one of the definitions is more comprehensive and balanced, which says, "Artificial intelligence is a computer program that makes reasonable actions to obtain the maximum benefits based on its perception of the environment. This definition not only highlights the perception ability and the acting ability but also emphasizes the purpose of the overall process. In other words, perception, action, and planning behind the scene should all aim at accomplishing a specific task or maximizing related benefits, rather than a random and meaningless act.

When studying the subjectivity of AI, some scholars also pointed out that the fundamental difference between AI and traditional automation lies in the "autonomy and purpose of actions and plans". If automation is controlled by the procedures set by humans, it cannot be regarded as having autonomy or subjectivity (Xie & Yuan, 2020).

Based on the above criteria, AI should have the following five characteristics: First, AI should have a purpose. A series of behaviors of AI should be for accomplishing specific tasks or pursuing the maximization of related benefits. All of the processes are meaningful; second, AI is being able to perceive. To achieve a specific purpose, AI should take the initiative to obtain the input of external information; third, AI can think, process the perceived external information including planning, decision-making, and formulating a series of action plans through a machine method without human intervention; fourth, AI can take action. It can implement the results of thinking to complete specific tasks; fifth, AI has learning ability. The results of actions can be good or bad, and AI should be able to further analyze the results of the action and then re-tune them according to the goal. This process is similar to the PDCA Deming circle. Essentially, the process is a manifestation of the AI's learning ability, and it is also one of the key features of an intelligent subject that distinguishes it from an automated program that requires manual intervention and adjustment.

2.3.2 Principles of AI

AI is essentially a brand-new way of thinking. It is completely different from the original mechanical thinking based on causality. Mechanical thinking starts from causality and seeks definite solutions. However, when facing complex problems or uncertainty, the level of understanding of human beings cannot keep up; and AI technology and big data thinking replace the original causal thinking with correlation thinking, and solve problems by seeking strong correlation. As a result, AI can get rid of the limitations of mechanical thinking, while ensuring the quality of decision-making, the number and efficiency of problem-solving have been greatly improved (Wu, 2016).

In terms of specific technologies, Kai-Fu Lee and others have repeatedly emphasized in the book *Artificial Intelligence* that deep learning algorithms, large-scale computing capabilities, and big data are the three most critical elements in the field of AI (Li & Wang, 2017). The third wave of AI starting from 2006 is mainly due to the revival of deep learning algorithms. Without breakthroughs in deep learning algorithms, large computing power and big data will be irrelevant. Among the algorithms in the history of AI, deep learning is not the only one, but it is recognized as the most effective and leading algorithm for a long time for right now and even for the future (Li & Wang, 2017).

2.3.2.1 The basic principle of deep learning

The predecessor of deep learning is the artificial neural network. This is a hypothetical model of human neural processing information proposed by neuroscientists in 1943. It is gradually used in the early research of neural perception principles and machine learning. For example, Hebb established the Hebbian theory based on the hypothesis; in 1954, Clark from MIT realized the basic Hebbian learning model; in 1958, Rosenblatt extended the artificial neural network to two layers and proposed the concept of Perceptron for simple pattern recognition; in 1965, Ivakhnenko proposed to build a multi-layer artificial neural network. “Such machine learning model based on multi-layer neural network” was later called “deep learning”, and Ivakhnenko was also known as “The Father of Learning”.

But in 1969, deep learning technology got into trouble due to the XOR problem proposed by Marvin. It was not until the problem was completely solved in 1975 that the development of deep learning went back to normal. 2006 was a watershed in the history of deep learning. Hinton published important papers including “A Fast-Learning Algorithm for Deep Belief Nets”, which marked a major theoretical breakthrough in deep learning algorithms, and then deep learning entered a stage of heyday development. In 2015, the Three Pioneers of deep learning: Hinton,

Bengio, and LeCun looked forward to deep learning in a joint review article. They wrote, “Soon, we believe that deep learning will achieve more. As it requires very little human involvement, so it can easily benefit from the increase in computing power and the increase in data volume. The new learning algorithms and architectures currently being developed for deep neural networks will surely accelerate this process” (Li & Wang, 2017).

The principle of deep learning, in simple terms, is to regard what the computer needs to learn as a large amount of data, throw this data into a complex, multi-level, preset parameter data processing network, and then check after the processing to see if the results obtained to meet the requirements if it does, keep this network as the target model; if it does not, adjust the network parameters repeatedly until the output results meet the requirements. Deep learning is such a pragmatic, semi-theoretical, and semi-experiential modeling method. It uses human mathematical knowledge and computer algorithms to build an overall architecture and then combines as much training data and large-scale computing power as possible to adjust the internal parameters to approach the preset target (Li & Wang, 2017; Nguyen et al., 2022).

2.3.2.2 Basic principles of AI chess players

The Go AI system AlphaGo produced by DeepMind is mainly known to the public through three versions: the first version, AlphaGo Lee, was rolled out in March 2016, which defeated Lee Sedol from South Korea by 4:1; the second version Master was launched in January 2017. With a score of 60:00, AlphaGo Master defeated many top players from China, Japan, and South Korea, and defeated the world’s number one Chinese chess player Ke Jie with a score of 3:0 in May 2017 (Li & Wang, 2017). The third is the AlphaGo Zero released in October 2017. This version has no public reports of fighting against human masters, but it played the game with the old version. After 3 days of training, it defeated AlphaGo LEE by 100:0, and after 40 days of training, beating AlphaGo Master by 89:11 (Li & Wang, 2017).

The core technology of AlphaGo includes four parts in the early stage, namely: Policy Network, Fast Rollout, Value Network, and Monte Carol Tree Search (Yuan, 2017). A policy network is used to comprehensively predict the position of the next move. With this technology, AI can read 30 million copies of human game records for supervised learning (Supervise Learning, which refers to machine training under the given input and output) to guess as many possible tricks as possible and comprehensively and accurately; Fast Rollout is also used to predict the position of the chess, but it is mainly used to make up for the speed disadvantage of Policy Network. Though Policy Network is responsible for exploring all of the chessboard solutions, it takes a long time to conduct the calculation at the beginning. But Fast Rollout only

takes into account the possibility of certain parts of the chessboard and compromises comprehensiveness and accuracy, thereby reducing the amount of calculation required at the moment, and increasing the calculation speed by thousands of times; Value Network predicts the subsequent wins and losses of each move. While Monte Carlo Tree Search connects the above three systems to its search algorithm to predict the next step, then expands the corresponding path nodes, simulates the game results, and finally provides feedbacks to the upper level of the system and generates a new tree so that AlphaGo can choose the best way to go after evaluating all possible outcomes (Avram, 2016; Bae et al., 2017; Chen & Lu, 2020; Woosuk, 2022; Yuan, 2017) .

Although the system design and training methods of the second version, AlphaGo Master, are the same as the first version, the game performance score Elo value of the second version has increased by 30%, and the dependence on computing resources has decreased from 48 TPU (referring to computer tensor processor) plus 176 GPU (referring to computer image processor) to only 4 TPUs, which is completely suitable for stand-alone operation (Tang et al., 2017). The biggest difference between the third version of AlphaGo Zero and the previous versions is that it no longer uses human game records to train the Policy Network but performs a lot of reinforcement learning after learning the basic rules (Yuan, 2017). The third version perfectly combines reinforcement learning which is good at decision making but reliant on humans for feature capturing and deep learning which is good at perception but weak in decision-making (Tang et al., 2017).

Reinforcement Learning is the interaction between wrong actions and environmental results to maximize cumulative rewards and punishments to learn the optimal strategy. It is considered to be the future of machine learning. Supervised learning of manually labeled samples may be the optimal solution currently, but unsupervised learning such as reinforcement learning is the key to surpassing the human being (Tang et al., 2017).

2.3.2.3 Basic principles of AI imaging

Medical imaging diagnosis is the most important clinical diagnosis and differential diagnosis tool in modern medicine. Nearly 70% of clinical diagnosis requires medical imaging (Shi, 2019). The efficiency and results of imaging diagnosis will directly affect the effectiveness of clinical diagnosis and treatment and the patient's experience (Ifenxi, 2019). According to data from a third-party market research organization Global Market Insights, medical imaging diagnosis technology will become the fastest growing industry in smart medicine from 2017 to 2022. It is estimated that by 2024, the industry scale will reach 25 billion U.S. dollars, with a growth

rate of more than 40% (Dian, 2019).

However, the current medical imaging diagnosis has several prominent problems: First, the number of radiologists cannot catch up with the increasing demand for medical imaging. According to industry insiders, the current annual growth rate of medical imaging data in China is about 30%. The annual growth rate of radiologists is only 4.1%, and on average, it takes more than eight years to train a radiologist. Therefore, there is a huge gap to fill between the demand and supply (Shi, 2019; Xiao & Liu, 2019). Second, besides insufficient supply, the distribution of medical imaging service institutions is also very uneven, which is similar to the distribution of other medical resources: the primary medical institutions, which account for 66%, only undertake 17% of the imaging services, while secondary hospitals which account for 26% of the total have undertaken 46% of the demand, and tertiary hospitals are even more overcrowded, accounting for only 8% of the total but undertaking 37% of the services (Ifenxi, 2019). The third problem is that diagnostic skills vary among doctors. Doctors in tertiary hospitals are relatively more skilled but are also more likely to make mistakes due to heavy workloads (Xiao & Liu, 2019). Although the workload of doctors in primary and secondary hospitals is lighter, they are also prone to mistakes due to a lack of experience. The report shows that in a study on imaging diagnosis with a sample size of 8,850 cases in a provincial tertiary hospital (the highest-level hospitals in China), the comprehensive detection rate of doctors at different levels of hospitals is only 80.1%; in another study on imaging diagnosis at a county-level hospital in 2019, the detection rate of lung cancer of radiologists is as low as 65% (Ifenxi, 2019).

Since 90% of medical data comes from medical imaging (Li, 2019), and since the processing of images are naturally better organized and the diagnostic process is more standardized, medical imaging has become the first field in clinical medicine to benefit from AI technology (Xiao & Liu, 2019). Public data shows that medical imaging attracts the most capital in terms of AI medicine. Medical imaging receives the most financing in 2013-2017, accounting for 31% of the total financing of AI medicine. Industry insiders generally believe that AI medical imaging is most likely to achieve commercialization as a specific field in AI medicine (Shi, 2019).

One of the advantages of AI imaging diagnosis is its fast speed. For example, AI imaging products of lung nodules will first select the suspected nodules in the image, and then perform quantitative analysis, and generate a structured report. The doctor only needs to check the diagnosis results, eliminate false positives and then confirm the final results. This process greatly shortens the time required for doctors to screen the images and edit the report, and thus improves work efficiency. The whole procedure can be finished in just 20 seconds (Ifenxi, 2019).

Moreover, the accuracy rate of AI imaging diagnosis is very high. In the two studies mentioned above, the comprehensive detection rate of AI imaging diagnosis in the provincial tertiary hospital is as high as 94.2%, which is 18% better than the performance of human doctors; in the lung cancer screening study of county-level hospitals, the detection rate of AI is as high as 98%, which is 51% better than that of human doctors (Yu et al., 2018).

The use of AI imaging products in primary hospitals has also improved medical care at the grassroots level to a certain extent, because AI imaging products have undergone training based on excessive data, and the training data are selected based on stringent standards proposed by senior experts and checked at various levels. It is like the AI is receiving training from a senior doctor. Therefore, doctors from primary hospitals can use AI products and at the same time learn from AI and thus improve themselves (Xiao & Liu, 2019).

In terms of how AI imaging works, the first step is image generation, which aims to automatically generate more effective pseudo-A images from A images, such as using single-section tomographic CT images to generate multi-section MRI images or using low radiant MRI images to generate high-resolution CT images. The algorithms involved include noise reduction and artifact processing; the second step is object segmentation, which means segmenting the organs and substructures in the image for further analysis. U-NET and FCN are both commonly used segmentation models based on convolutional neural networks (CNN); the third step is image classification, such as the recognition of nodules and other lesions. The model automatically puts category labels on the images. The core algorithm extracts image features and constructs classifiers. Traditional image classification methods are mainly based on artificially designed features, which are complicated but might not be accurate. While Convolutional Neural Network (CNN) can mine the hidden statistical patterns in massive data, automatically learn the most distinguishing image features for classification tasks, and the classification accuracy will increase as the network goes deeper. As a result, efficiency will be greatly improved. When some annotated data are small in amount, AI can still improve its classification efficiency through transfer learning (weights are initialized mainly through the pre-training model); the fourth step is target detection, which aims to locate and identify specific lesions in the image. AI should not only identify the category of the target but also give the location and scope of the target in the image. The algorithms used are mainly one-phase methods with faster speed and two-phase methods with higher accuracy (Yu et al., 2019). In an AI-assisted diagnosis and treatment of COVID-19, the U-Net or variant image semantic model is also used to cut out the area of the lung from the original image; then in the CT classification diagnosis, matrix algorithm is used to extract features, and then “Support Vector Machine

(SVM)" is used for classification. The final accuracy rate is as high as 99.68% (Liu et al., 2022; Meng & Li, 2020).

2.4 Competitive attributes of technology

Regardless of whether AI belongs to information technology (IT), there are a lot of similarities between the two. Barney believes that the five attributes of IT, namely switching costs, access to capital, proprietary technology, technical IT skills, and managerial IT skills may be the source of sustained competitive advantage, and analyzes them one by one (Barney & Clark, 2011). On the other hand, Bernard Marr, in his book *Data Strategy* pointed out that the business goals for firms to implement data strategies are nothing more than improving decision-making, enhancing operations, and generating data benefits (Marr, 2018). The specific measures to implement these goals are not only part of the organization's business processes and capabilities, but also the source of a firm's sustained competitive advantage.

2.4.1 Competitive attributes of IT

Regarding customer switching costs, Barney believes that acquiring and using IT systems through supplier-specific investment is not a source of competitive advantage for firms, because once the investment is made, IT suppliers may be engaged in a holdup or appropriate a disproportionate share of the value through the "create-capture-keep" paradigm. As a result, firms that do not make these specific investments or firms that do not buy IT from suppliers that do not engage in holdup will gain a competitive advantage (Barney & Clark, 2011).

As for access to capital, Barney holds that if the development of an IT system is costly and the development itself is also high-risk due to technological uncertainty and market uncertainty, then some firms that can obtain such a large amount of venture capital may gain a competitive advantage by developing IT; but if the IT investment is not large nor risk or the IT system deployed can only give users standardized and same capabilities, in this context, access to capital is not likely to be a source of sustained competitive advantage (Barney & Clark, 2011).

Concerning proprietary technology, Barney believes that it usually is not a source of sustained competitive advantage, and its ability to become a source of sustained competitive advantage "is gradually fading" (Barney & Clark, 2011). Although "valuable and secret" proprietary technology may indeed enable firms to gain a sustainable competitive advantage, secrecy is very difficult to keep. IT applications are difficult to patent as well and patents cannot prevent imitation either. Competitors can still imitate through workforce mobility, reverse

engineering, technical communication, and publication reading (Barney & Clark, 2011).

Technical IT skills refer to the know-how needed to build IT applications using the available technology and to operate them to make products or provide services (Barney & Clark, 2011). But these skills are usually not heterogeneously distributed across firms and are highly mobile since firms can make up for this shortcoming through training and recruitment, Barney thinks technical IT skills are usually not sources of sustained competitive advantage.

Managerial IT skills include management's ability to conceive of, develop, and exploit IT applications to support and enhance other business functions. Examples of such skills include the ability to understand the business needs, to work with others, coordinate activities, and predict future needs (Barney & Clark, 2011). Different from technical IT skills, managerial IT skills are often developed over longer periods through the accumulation of experience by trial-and-error learning and are causally ambiguous and socially complex. Besides, managerial IT skills are difficult to imitate unless they can be written down, codified, or transferred at low cost or without significant or without loss of understanding. In this sense, managerial skills can usually be a source of competitive advantage (Barney & Clark, 2011).

2.4.2 Competitive attributes of big data

Marr believes that the competitive characteristic of big data technology is also included in the data process. After clarifying the goals of the big data strategy, the first step is to obtain data. Data collected should include internal data use, external data access, external data purchase, new data collection through sensors or other methods, the firm's ability to obtain data, including its capability, speed, diversity, authenticity, and value, as well as how the data match its strategy, the efficiency and automation of collection methods. All of these can become sources of sustainable competitive advantage for firms (Marr, 2018).

The second step is data analysis, which aims to generate insights that can help firms improve operating methods by using algorithms and analysis tools to extract the necessary information to answer key business questions, improve operational performance, cash in on data monetization to the firm's strategic goals (Marr, 2018). The specific data analysis technology has evolved from the earliest SQL statement analysis to text analysis, sentiment analysis, image analysis, video analysis, voice analysis, and data mining which refers to the process of finding business insights from the relevant data sets of super-large-scale businesses and analyzing process of variables of models), business experiments which are mainly used to test the effectiveness of objects, visual analysis, correlation analysis, regression analysis to study the relationship between variables, scenario analysis, time series analysis which refers to

the use of timing data to explore trends and make predictions, Monte Carlo simulation which refers to techniques that rely on data to solve problems and assess risks, linear programming which refers to identifying optimal results under constrained variables, cohort analysis which refers to the continuous study of the behavior of a group over a period of time, factor analysis which refers to statistical techniques for data simplification and structure detection, neural network analysis which refers to pattern recognition in a manner similar to the human brain, meta-analysis which refers to the comprehensive analysis of the results in a certain field to find patterns, trends or valuable relationships and other methods (Marr, 2018).

The third step is to build a technical architecture. To transform data into insights, the corresponding software and hardware are needed. These tools include four types of infrastructure in data collection, data storage, data analysis and processing, and data access and communication (Marr, 2018). Small businesses or firms that do not aim to commercialize data can consider directly purchasing Big Data as a Service (BDaaS) because it provides a series of services so that those who lack data, have a tight budget, or have difficulty can also easily enjoy the value of data. For firms to improve decision-making or data commercialization, they should build a full range of facilities for collection, storage, analysis, and access. Common collection tools include sensors, Apps, CCTV, website cookies, and social media; common storage tools are mainly distributed storage systems such as Hadoop. The analysis procedure includes three steps: data preparation, analysis and modeling, and extraction of insights. Companies such as Amazon, IBM, and Microsoft also have corresponding analysis products; in terms of data access, more and more firms are using self-service business intelligence (BI) systems that allow users to independently query data, rather than highly standardized BI reports (Marr, 2018).

The fourth step is to develop the organization's ability to organize data. In addition to developing appropriate data technologies and capabilities, organizational capabilities that link data to business needs are also crucial. Methods include recruiting talents and outsourcing business (Marr, 2018). A qualified talent in a data organization should be equipped with the following five skills: business ability, analytical ability, computer science knowledge, knowledge in mathematical statistics, and creativity; if the firm lacks such professional talents, then a data crowdsourcing competition platform like Kaggle is also an option to consider. Firms on Kaggle bring their problems, data, and prizes, while a large number of data scientists on the platform are competing to offer the best solutions. This crowdsourcing method has advantages in identifying invisible talents and improving corporate data organization capabilities; another aspect of organizational capability is the organization's data culture and continuous optimization of data strategy. In terms of data culture, data should be regarded as a key asset

for firms, and data should be used to improve all levels of the firm and should be regarded as the foundation of the operation of the firm (Marr, 2018).

The fifth step concerns data governance capabilities. Inherent with the convenience of artificial intelligence and big data are concerns about data privacy and security. Data governance refers to the overall management and daily management of data, including data availability, integrity, and security. This means that firms should recognize the ethics and legal requirements faced in each step of data operations, take practical measures and roll out effective policies and procedures to manage each step (Marr, 2018).

2.5 Research Model

The purpose of this research is to study the competitiveness of artificial intelligence (AI) technology. It can also be said that it is to study whether AI technology can bring sustainable competitive advantage to an organization if this organization applies AI technology, because the source of sustainable competitive advantage is exactly the core issue of strategic management (Barney & Clark, 2011).

We mainly analyze the artificial intelligence technology one by one according to the VRIO analysis framework. The framework of the analysis is following four aspects. First, if a feature is not valuable, the organization can only gain a competitive advantage by adopting it. Second, if a feature is valuable but not rare, a competitive balance may be achieved. Third, temporary competitive advantage may be gained if a feature is valuable and rare but easy to imitate. Last but not least, only when a certain feature is valuable, rare, non-imitable, and can be organized effectively can this resource bring sustainable competitive advantage to the organization.

Among them, in the organizational attributes, we hope to combine this with dynamic capabilities. As mentioned above, we agree that organizational capability can be regarded as a higher-order resource of the organization, and dynamic capability is a higher-order capability in organizational capability, which can help the organization better cope with changes in the external environment. Therefore, we believe that what dynamic capabilities an organization or a technology has that can be concluded into the assessment of its organizational attributes. This can be referred to as the new VRIO paradigm, or the VRIDc framework as pointed out by Prof. António et al. (Cardeal & António, 2012). Certainly, dynamic capability is not the only factor that needs to be considered in organizational attributes. Organizational attributes also include other factors besides dynamic capabilities, but as an important aspect of organizational attributes, we still make a special explanation here.

In addition, it should be noted that to make accurate judgments about these attributes, we need to understand one of the potential problems involved is: Compared with other technologies, what characteristics AI technology has could be a source of sustainable competitive advantage. Only by finding these characteristics can we find the essential difference of AI, and then use it as a resource of the organization to analyze competitiveness.

In their book *Resource-Based Theory: Creating and Sustaining Competitive Advantage*, Barney and Clark, the founders of Resource-Based Theory, analyzed the competitive advantages of organizational culture, organizational trust, human resources, and information technology in accordance with the same logic. In the analysis of the competitive advantage of information technology, they also first refined the five characteristics of the IT system that may give the organization the competitive advantage, namely, customer conversion cost, capital acquisition, proprietary technology, IT technical skills, and IT management skills, and then he analyzed these five characteristics one by one according to the VRIO framework of Resource-Based Theory, and finally drew conclusions about their competitiveness (Barney & Clark, 2011).

Therefore, when we conduct VRIO or VRIDc analysis of AI technology, we will appropriately combine and discuss the competitive characteristics of AI. Firstly, whether the process of applying AI in an organization is divided into three stages: decision-making, research and development, and use. The decision-making stage refers to the stage where an organization has never had any AI technology, but driven by various factors, and through intelligence, design, decision making, and review, it finally plans to adopt AI technology and put it into action. The stage of research and development is the stage in which an organization successfully obtains the required AI technology through procurement, self-research, and outsourcing in order to obtain AI technology, and finally completes the deployment. The use stage is the stage where an organization gains a competitive advantage by using AI technology after the AI deployment is completed. The above three stages are not competitive in themselves, so there is no need to use the VRIO framework for analysis. However, breaking down the process of organizing and applying AI into different stages in chronological order will help us and the research participants to sort out the competitive characteristics of each stage in detail and without omission.

We also refer to the competitive characteristics of information technology and big data mentioned in the literature review, and believe that the possible competitive characteristics of AI include the following propositions. In the decision-making stage, the possible competitive characteristic is AI thinking, or big data thinking. Because for people or organizations who truly understand AI technology, AI is a new way of solving problems that is more efficient than

traditional cause-and-effect methods and can solve complex and abstract problems. Companies can apply this way of thinking to a wider range of fields to gain the competitive advantage.

In the research and development stage, we have two competitive propositions, namely technology accumulation and data accumulation. Technology accumulation includes the mastery of research and development technology, algorithm development, corresponding intellectual property rights, improvement of research and development management experience, and others. Data accumulation is not only an increase in the volume of data, but also the expansion of data dimensions. Since AI is essentially based on data correlation, the data accumulation can improve the effectiveness of AI beyond linearity, which may also bring the competitive advantage to organizations.

In the use stage, we put forward three propositions on the competitive characteristics from the perspective of application effects, namely, less manpower input, faster delivery speed, and better delivery quality. Take AI medical imaging diagnosis as an example. As mentioned above, after medical institutions adopt AI imaging diagnosis systems, they can first reduce the demand for radiologists, because the AI imaging system can diagnose a large number of cases at high speed, and give a preliminary diagnosis conclusion, which is then handed over to human doctors for review, thereby freeing a large number of human doctors from complicated transaction work. Secondly, it can increase the delivery speed. Even with sufficient manpower, AI technology can also shorten the diagnosis time of a single case. For example, in lung cancer screening, about 200 high-resolution CT images may be reconstructed for a single case, which is time-consuming for human doctors to diagnose. However, the working time under the same amount of examination can be reduced by at least half after the application of AI for auxiliary diagnosis (Xiao & Liu, 2019). There are countless similar cases. Thirdly, it can improve the accuracy. Human doctors are prone to fatigue when they do a lot of repetitive work, especially when diagnosing small lesions, it is easy to misdiagnose, but the machine will not fatigue. An image diagnosis project for esophageal cancer shows that the accuracy of the AI system is at least 16% higher than that of human doctors (Shi, 2019).

In summary, the entire research model is shown in Figure 2.2.

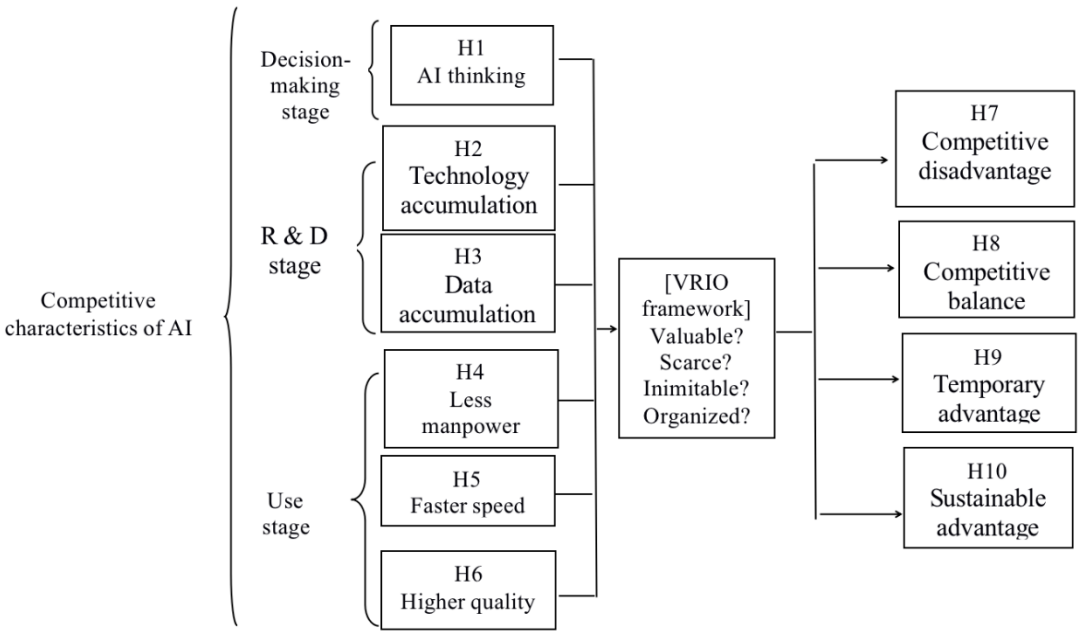


Figure 2.2 Research model

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Chapter 3: Methodology

3.1 Research methods

Research methods are generally divided into quantitative research and qualitative research. Quantitative research, usually based on empirical standpoint, mainly systematically measures variables and analyzes their relationship through statistics, to verify previous propositions. Objectivity and certainty are emphasized in the research process. Qualitative research, on the other hand, is mostly based on the tradition of philosophy. It mainly understands the experience, viewpoint and formation process of the research object through non-digital texts or visual materials, to bring new research results (Cassell, 2018).

Herbert Rubin and Irene Rubin also further explain the philosophical basis of qualitative research. They believe that there are two main types of research philosophy, the Positivist and the Constructionist. Positivist assumes that the objects and events concerned by researchers exist independently of people's cognition, so there is only one real face. However, the interpretative constructionist on which qualitative research is based is opposed to imposing standards and definitions on different people, believing that such practices can easily lead to misunderstanding and confusion. For example, two respondents may mean different things when they answer "yes" to the same question. Therefore, for constructionists, what matters is how people view things or events and the meaning attached to them. They are committed to establishing explanations based on details (Rubin & Rubin, 2010).

The researchers also hold that quantitative research has certain limitations in social science research. First, numbers themselves are not easy to communicate with and be easily understood by people. Second, if the specific situation of social science research is all taken out and the answers are forced to be converted into numbers, the research will lose its richness and complexity. Therefore, they think that if the answers sought cannot be answered simply and directly, or people need to explain, illustrate or describe, the qualitative research method of in-depth interview is needed (Rubin & Rubin, 2010).

Interview is one of the most common methods in qualitative research. Although the interview method can be used in some quantitative studies under standardized procedures, in fact, it is generally regarded as a qualitative method. Moreover, it is indeed more suitable for

qualitative research, because the interview process is more flexible and researchers can "focus on emerging topics" at any time. At the same time, the types and volumes of data obtained are richer and more diverse (Cassell, 2018).

Tracing its origin, the interview method is believed to originate from the research on organizational behavior and psychological counseling in the last century. The earliest classic case is the Hawthorne studies started in 1924 (Cassell, 2018). Between 1928 and 1930, the research team conducted individual interviews with more than 21,000 employees of the Hawthorne Plant of Western Electric Company, which achieved surprising results that went beyond the study itself (Jia, 2016). By the 1970s and 1980s, the interview method had been quite popular in social science research, and it was also common in publications of organization and management, including its development on epistemology, and interview is regarded as a "positive" process rather than a completely detached or isolated event (Cassell, 2018).

Some scholars divide the interview method into nine categories according to the width and category of topics. Among the topics with narrow range, "investigative interview" is descriptive, "clarifying concept" is related to meaning, while the topic of "resignation interview" is between description and meaning. Among the topics with a wide range, the topic of "expository case study" is descriptive, that of "ethnographic interpretation" is about meaning, and the topic of "life history" is between description and meaning. Among topics between narrow and wide, "action research" is descriptive, "theoretical clarification" is meaningful, and the topic of "organizational culture" is between description and meaning (Rubin & Rubin, 2010). All examples are shown in Table 3.1.

Table 3.1 Application examples of research methods

	Descriptive	between description and meaning	Meaning
narrow range	investigative interview	resignation interview	clarifying concept
range between narrow and wide	action research	organizational culture	theoretical clarification
wide range	case study	life history	ethnographic interpretation

The interview structure usually falls into three categories: structured interview, semi-structured interview, and unstructured interview. Structured interviews usually involve a set of written questions, which are then asked to all interviewees in turn to ensure consistency. Semi-structured interviews also include some prepared questions and hints, but interviewers can deviate from the preset outline during the process, so researchers have the opportunity to ask questions about interesting topics that they did not think of before but were introduced by

interviewees. In the unstructured interview, however, only one central topic for discussion will be determined, and no questions will be formulated in advance. The interview can be extended in any direction during the process, but it also requires more of the interviewer's mastering ability (Cassell, 2018).

In the semi-structured interview, there are two specific modes. One is a theme pattern that follows a framework, and the other is a more open feature pattern. The theme pattern also includes two modes, the "exploratory semi-structured interview", which explores specific issues from different perspectives, and the "theoretical semi-structured interview", which aims at promoting theory and whose process is affected by theory. In the more open feature pattern, there are event, comparison, narrative, biographical, visual and other commonly used modes (Cassell, 2018).

There are three specific interview methods. One is the face-to-face interview, which was commonly used before the 1970s and was considered more suitable for academic interview or government investigation. The second is telephone interview. As telephone is the most popular communication means in today's society and its cost is lower than that of face-to-face interview, it has also become the most common interview method. The third is online interview. With the increasing penetration of the Internet, online interview is considered to "soon become the main" interview method (Fowler, 2014).

As for the research on AI competitiveness, our previous models mainly focus on, compared with other non-AI technologies, how the characteristics of AI are judged and concluded under the analysis framework of VRIO. We hope to study and demonstrate the above propositions and related issues through appropriate methods.

What the study needs to consider is that the above proposition has two characteristics: One is that AI is a relatively new technology, and it really caught the world's attention when Alpha Go beat Go champion Lee Se-dol in 2016 (Tang et al., 2017), and that milestone event was only about a few years ago, before which, AI technology was mostly based on the exploration of basic theories, trial and error of various technologies and the accumulation of local applications; the other is that at present, AI technology still has a very high cognitive threshold for most people, even for those who have received higher education, or even those who have received relevant professional higher education, and not all of them can have accurate cognition and understanding.

The characteristic of the proposition also determines our research methods. First, because this is a relatively new topic, there may not be a lot of literature and information for reference and analysis; second, the research objects should focus on a small number of professionals who

can truly understand AI technology and its specific applications, rather than a large number of non-professional ordinary people. The researchers believe that if the research is based on non-professionals, even if the sample size is large, it does not make much sense, because they are unable to have a correct enough understanding of the emerging technology of AI and the medical and health industry. Therefore, the research is based on a small number of experts. The researchers hope to find truly capable and willing experts to interview and let them share their insights on the competitiveness of AI. The study believes this is the most suitable research method.

There are also different ways to implement expert interviews. Firstly, the researchers choose individual interviews, because we believe that if properly designed, individual interviews with experts are most conducive to experts expressing their own mature views. Similar to the expert interview method, the researchers do not intend to adopt a group interview method such as focus groups. Although group interviews can obtain more opinions of research subjects per unit time, and to a certain extent, they can inspire and influence each other, but its shortcomings are also obvious: First, the research subjects are more easily influenced by others' opinions, so they are unable or unwilling to fully express their own opinions, especially when the research subjects are introverted or their opinions are different, it often requires greater courage to fully express themselves; second, the research hopes that experts can fully express their views on specific issues instead of rushing to reach a unified conclusion; third, from the perspective of research feasibility, focus groups generally require better skills of moderators to guide and control the discussion of the whole group, and the difficulty of getting many experts to sit together has obviously increased significantly in the context of the epidemic.

Secondly, the study will adopt an interview structure dominated by semi-structured online interviews. The researchers believe that this can not only enable experts to express their views, but also ensure that effective conclusions can be drawn by this kind of theoretical topic research.

3.2 Data collection

As mentioned above, the research method in this thesis is mainly to conduct individual and in-depth interviews with experts. The research will collect the opinions of relevant experts for analysis and research to make judgments on the competitiveness of AI technology. The data collection process generally includes four steps: expert selection, signed documents, voice interviews, and data collation.

3.2.1 Expert standard

The selection criteria for experts are mainly in the following three aspects:

Firstly, regional standard. Although people have become more and more accustomed to remote communication and work through the Internet under the highly developed information technology and the continuous influence of COVID-19 on social interaction, in this study, considering the researchers' own personal connections, communication language and other reasons, the study will give priority to selecting experts from China.

Secondly, professional standard. The study hopes that the majors of experts are mainly in the two major categories of medicine and management. AI technology was born out of computer technology, and with its present development, but it can no longer be talked about in general. It could be placed in a specific application scenario such as clinical medicine, so that such analysis will be more in-depth and meaningful. Meanwhile, the competitiveness of AI compared with other technologies, including the so-called AI threat theory, is essentially a matter of management. At the education level, as an interview expert on a research subject, we also hope that the expert has obtained a master's degree in the above-mentioned majors, so that he/she can have certain insights on related topics.

Thirdly, quantity standard. The study hopes to interview about 20 experts, each for 30 - 60 minutes video interviews. The final interview time will be 600-1200 minutes in total. The researchers believe that such a number and duration is a balance made after fully considering the research quality, willingness to interview, research funding and workload, which can guarantee high quality and considerable feasibility.

3.2.2 Screening range

The preferred interviewees are postgraduates in Sino-foreign cooperative education, majoring in health management and doctoral programs. First, such postgraduates are in full compliance with the aforementioned screening criteria. They come from China and have an international perspective. As doctoral students majoring in health management, most of them also have a master's degree in medicine or management. In addition, taking into account the researchers' own contacts and the identity of the interviewees as postgraduates rather than workers, they are often more willing to take part in the interview, which will greatly improve the quality and efficiency of the interview. Further, most of these postgraduates have the professional background of hospital management, which makes them more suitable for this kind of cross-professional management topics.

In addition, as a supplement, the researchers will also try to contact relevant scholars from top universities in China (including Hong Kong, Macao and Taiwan) to see if they are willing to participate in this research together. Eight of the world's top 100 universities in China from four well-known university rankings in the world (at least among the top 100 in three of the rankings) were selected, respectively: Tsinghua University, Peking University, Zhejiang University, Shanghai Jiaotong University, University of Science and Technology of China, Fudan University, the University of Hong Kong and the Chinese University of Hong Kong. The researchers will contact the school of management and medical school in the above universities through email and other means, hoping that they join in the interview. But in fact, due to the considerable uncertainty in the connection with these unfamiliar scholars, the research is still dominated by postgraduates in the doctoral program of health management.

3.2.3 Interview process

After reaching an oral interview intention with these experts, the researchers will send an email to each interviewee, which includes: 1) Research Overview, including the researcher's information, research background, interview purpose, interview returns, process requirements, and other matters; 2) Interview Consent, indicating that the interviewee voluntarily accepts the interview, waives related intellectual property rights, agrees to provide written documents and accepts voice and video recordings; 3) The tentative interview time. Experts were required to reply to the above email for confirmation, and return the relevant documents to us in an appropriate manner after the relevant documents are signed in writing.

For interview returns, the arrangement is to give real-name appreciation to all interviewees in the acknowledgment section of the thesis and also give respondents an allowance of RMB 100 per hour based on the median income of HK $19,600 per month in the Hong Kong Special Administrative Region in 2021. The researchers do not believe that such a limited interview allowance matches the qualifications and contributions of the experts, but is mainly a reasonable compensation for the interviewees to spare time. The researchers believe this will also help the interviewees to take the interview more seriously.

After the experts confirmed the interviews, the voice and video interview will be conducted as soon as possible after receiving experts' response to the written interview. In principle, the interview will be conducted through Zoom, an online social software. Although Zoom is not as popular as WeChat for Chinese users, it can record the entire voice or video process, which WeChat needs to record through third-party software or external recording; meanwhile, Zoom can prevent the interview from being easily interrupted by other notifications.

The voice interview lasts 30 to 60 minutes, and its main purpose is to confirm, deepen and extend the answers to the pre-prepared semi-structured questions. Due to the two-way communication characteristics of voice interview, the researchers will arrange more open questions in the interview. Such extension will help the researchers obtain more information, so as to explore the competitive advantages of AI technology more deeply.

It should be noted that the opinions of the experts are very important in this study, but the opinions of any expert are not conclusive and will not be simply counted in a manner that the minority obeys the majority. The study hopes that this study can speculate on related issues with experts, so as to show more perspectives and deeper views, and this is also one of the advantages of qualitative research.

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Chapter 4: Result

As is mentioned above, this study used the qualitative research method of "expert interviews" to examine the strategic competitiveness of AI technology for organization. In this chapter, the study will introduce the process of conducting expert interviews as well as the data that were obtained, and summarize the experts' opinions.

It should be noted again that although the experts' views are of great value, the final results of the research are not just a simple repetition or generalization of their opinions. Instead, these results include some theoretical perspectives that the researcher came to understand or drew inspiration from the interviews. This section has also been explained in the next chapter of "Discussion".

4.1 Interview process

In general, the interview process includes four stages: preparation, invitation, interview and documentation.

4.1.1 Preparation

In the preparation stage, documents such as "Interview Invitation Letter", "Interview Outline", and "Interview Consent Form" were prepared, and the researchers collected e-mail address books of relevant scholars from top Chinese universities, as well as the address books of some PhD students majoring in health management.

The Interview Invitation Letter, previously named as Introduction to the Study, specifically includes five parts: researcher profile, subject background, the purpose of interview, the returns from interview, and the process of interview, with a full text of about 1600 Chinese characters. This intended to help interviewees who are unfamiliar with this interview to develop a general understanding and a great interest in a short time. The Invitation Letter is not set in stone. Instead, the study continued to optimize it over the course of the interviews on the basis of the responses and feedback from the interviewees. The aim is to strike a balance among the thorough preparedness of interview procedures, the interviewees' accurate comprehension of the research subject and their willingness to be interviewed. The researchers do not want the

interviewees to misunderstand the subject, which might lead to increased communication costs. Nor do the researchers want to leave flaws in the procedures, or make the whole process too cumbersome for the interviewees. From this perspective, the Invitation Letter is appropriately written. The researchers generally send this document (including the attached Interview Outline) and the Interview Consent Form to the candidate after he/she has verbally accepted to participate in the interview and before the interview is conducted, so that the interviewee can read and sign the relevant documents and make preparations.

At first, the researchers have specifically prepared the outline of interview, which covers 14 questions with more than 1100 Chinese characters. The researchers attached the Interview Outline to the Interview Invitation Letter, and made full use of it during the early stage of interview. The Interview Outline is not set in stone. Instead, it changed more frequently than the Interview Invitation Letter, because the researchers are still unfamiliar with the process and the focus of the interview. However, as the interview progressed, it was found during the interview: within a limited time or at the time when the interviewee gives his/her undivided attention to our interview, the researchers should quickly get straight to the focus of the interview – the VRIO framework – after giving a clear definition to AI and guidance on its specific application, which is of great importance to the quality of our interview. In the meantime, the researchers found that most of the interviewees did not need too much background information. On the contrary, too much background information or too many presupposed questions might confuse the focus of the interview, or cause the interviewee to unconsciously ignore some important introductions made by the interviewer or the relevant questions on the basis of the his/ her answer. Therefore, during the later stage of interview the researchers deleted the attached Interview Outline, revised and simplified the content for this part, and combined it with the third part of the Interview Invitation Letter: the purpose of the interview. This adjustment proved to be effective.

When it comes to the Interview Consent Form, allowance has been made for rules and regulations. The candidates were asked to clearly and concisely express in written form that they voluntarily participate in the interview as well as the audio and video recording, and waive unnecessary intellectual property rights. One thing to note is that our Interview Consent Form was reviewed and revised by practicing lawyers, which will help the study avoid possible legal and ethical risks. The interviewees were asked to sign this document in person, and send a scanned or recording copy back to the researchers.

The researchers went through a more tedious process to collect the communication information, especially the information of scholars of relevant majors from prestigious

universities. The researchers set up three criteria to select scholars: (1) These scholars should come from the top universities in China, including Hong Kong, Macao and Taiwan. As was mentioned above, among the four lists for the comprehensive rankings of global universities, the selected candidates should be working in the top 100 universities in at least three of these lists. Eight Chinese universities were thus selected during our research, namely: Tsinghua University, Peking University, Zhejiang University, Fudan University, Shanghai Jiao Tong University, University of Science and Technology of China, University of Hong Kong and the Chinese University of Hong Kong. (2) The researchers selected the relevant departments in the above universities associated with the following three disciplines: business administration, computer science and technology, and applied economics. For instance, the researchers invited scholars from the Department of Organization and Strategy Management, the Department of Innovation, Entrepreneurship and Strategy, the Department of Business Management, and the Department of Business Administration in the category of business administration. In addition, the researchers selected scholars from the category of computer science and technology, such as the Department of Computer Science, the School of Big Data, the Institute of Computer Applications, the Key Laboratory of Artificial Intelligence of the Ministry of Education, and the Institute of Artificial Intelligence. Also, the researchers chose the scholars from the Department of Finance in the category of Applied Economics. (3) The researchers only selected the full-time or full professors in the above departments. The associate professors, lecturers or scholars with other honorary titles were not taken into consideration for the interview.

Based on the three criteria mentioned above, the researchers searched the official websites of these institutions for the email addresses of qualified professors. As a result, the researchers found 63 scholars and 63 email addresses for business administration, 140 scholars but only 131 email addresses for computer science and technology, and 59 scholars and 59 email addresses for applied economics.

The doctoral program “Doctor of Management in Healthcare co-organized by Southern Medical University and ISCTE- University Institute of Lisbon is one of the few Sino-foreign educational cooperation programs officially approved by the Ministry of Education of the People’s Republic of China. Therefore, the doctoral candidates in health administration in this program are undoubtedly the focus. The researchers collected the contact information of all 23 doctoral candidates of 2017 intake of this program. With extensive practical experience and theoretical knowledge, as well as enough interests and understandings in new AI technologies, they can be regarded as elites in the field of health management in China.

4.1.2 Invitation

From January 6, 2020 to January 11, 2022, the researchers sent invitation emails to 253 professors whose valid email addresses were found via personal Hotmail, including 63 professors in business administration, 131 professors in computer science and technology, and 59 professors in applied economics. In order to express our sincerity and get more responses, the researchers did not send mass mails to them. Instead, the researchers sent these emails one by one. In the meantime, w the researchers personalized the invitee's family name and title at the beginning of the headline and body of the email, so as to attract their interest and prevent the email system from misjudging them as spam emails.

Not surprisingly, these initiatives did not yield the desired results. As of February 11, one month after sending the emails, the researchers only received responses from eight professors, all of whom declined the invitation (one of these professors recommended his colleague to the researchers instead) due to their tight schedules or lack of relevant knowledge. The researchers followed up on these responses immediately, explaining that this topic essentially belongs to the discipline of management and will not take too much time. In addition, the researchers expressed the hope for more cross-industry opinions. However, all these efforts were in vain, and the researchers did not hear from the professors recommended.

In this case, the researchers considered that even if the researchers made a telephone invitation, or lowered the three criteria mentioned above, the researchers might get a bit more responses or invitation, but there will not be a qualitative leap. The researchers believe that the core of this problem lies in the returns from the interview, especially the non-material returns that fail to attract the interest from the academic circles, which was well proven by the polite rhetoric responses. Therefore, the researchers took doctoral candidates of Doctor of Management in Healthcare program and experts from related fields as the interviewees instead.

On January 14 and January 18, 2022, the researchers sent invitations to a small group of seven people in Class 2017 and received prompt and comprehensive replies. In particular, five of them were interviewed within a week. On January 24, the researchers sent a group invitation to the remaining 16 doctoral candidates in a WeChat Group and received active replies, among whom five arranged for appointment immediately, and one even invited another expert for our interview. During the second round of interview, the researchers invited the doctoral candidates who had not replied to our previous invitation in the first round, and arranged for the interview of some experts.

In addition to the above experts from one single discipline, the researchers also invited others from different fields, including experts of the early Thousand Talents Program, university professors, and clinicians. Besides being highly qualified, they come from diverse professional fields, which provides a broader professional background for the research.

4.1.3 Interview

The interviews were all conducted with the online meeting software Zoom. Although Zoom has insufficient popularity and inconvenient installation in China, it has many powerful and stable functions, especially the convenient recording function, which can be normally used in China. In the interviews, only one of the experts swung to Tencent Meeting because of an unexpected technical problem. In general, the interviewees could completely handle Zoom.

Usually, the researchers signed in Zoom about 10 minutes before the scheduled time, testing the functions of audio and video, and then gave the meeting ID and passcode to the experts. After their entrance and a brief greeting, the researchers began the interview and videotaped it. Mandarin was the language used in the interviews.

The researchers would inform them that the expected meeting time was around 45 minutes because the researchers expected to control it in the range of 30 to 60 minutes. The researchers believed that less than half an hour might lead to a meeting without desired results, while more than an hour might bring schedule conflicts to the busy experts, and would lower their concentration and relatively affect the result of the meeting.

The interviews were conducted in accordance with the prepared outline. First of all, in terms of the definition of AI, the researchers hoped to discuss it with interviewees and reach a consensus. The researchers would ask for experts' opinions with openness and thoroughly introduce the definition of AI in the study, including the five characteristics of AI and the ANI stage (Artificial Narrow Intelligence, namely, the AI which is comparable to human in certain aspects).

Secondly, the researchers would invite experts to introduce some concrete applications of AI. To prevent hearsay and misrepresentation, the researchers would inform them that the researchers expected the cases of first-hand experience. The researchers believed that the discussion over concrete applications provided the experts with a concrete image, which paved the path for the more abstract and thematic discussion about VRIO. Surely, if the experts' introduction did not conform to the definition we provided, the researchers would discuss and revise it immediately. For example, when an expert mentioned a cooking robot, he/she once had access to, the researchers agreed that it had purposes, perceptions, and actions, however, it

had weaknesses in thinking and learning, which meant that it was unable to adjust and optimize presupposed actions according to executive results or consumer's feedback, so it was hard to distinguish it from a rice cooker in essence (although from the marketing perspective, a rice cooker is equal to a cooking robot). The researchers have discussed this with experts, and pointed out that this application may not be strictly defined as artificial intelligence in a narrow sense, so the researchers needed to switch to the topics about the applications, which were closer to the definition.

The following discussion focused on the VRIO attributes of AI technology one by one. Experts were required to try their best to give relevant explanations apart from simple judgment. For instance, if they agreed with the value of AI towards the organization, they would be required to explain in which aspects AI is valuable; if not, they needed to give a reason. Moreover, in terms of the VRIO attributes, it is not easy for general experts to distinguish the rarity and inimitability. Therefore, the researchers explored the documents and advised experts to think of rarity as the current and actual ownership proportion of the industry and think of inimitability as the long-term and forward-looking competitive moat. Surely, the researchers encouraged challenge toward the definition itself. Otherwise, as the interviews went further, we also made deep explorations about some situations. Considering that AI has the potential to replace human work to some extent, the researchers sometimes asked the interviewees, in terms of its organizational attributes, whether AI would encounter greater challenges compared to other resources in its implementation. If they gave an affirmative answer, the researchers would ask what the specific challenges are. In-depth explorations and extension of similar questions are some of the advantages of expert interviews. It is hard for the researchers to imagine whether can the researchers reach similar depth by quantity method of a questionnaire in such a brand-new topic of artificial intelligence.

Finally, the researchers would invite experts to give opinions about the competitiveness of AI and other related questions with openness. The researchers found that in this stage, experts always run far away from the presupposed framework and gave many meaningful opinions about the content in which they focus or have interests.

4.1.4 Documentation

Undoubtedly, documentation is quite an important part of the whole project. Here, the researchers divided the documentation process into three steps. The first step is the organization of minutes after every interview. Within 12 hours after the interview, the researchers would organize and summarize the interview process and experts' opinions according to the interview

recording videos, and write an interview minute. Also, the researchers would send the minutes back to the relevant experts to check or make some changes, to make sure that the researchers had accurately summarized their opinions.

The second step is to give a summary and write a document after the first group of 11 interviewees. This work comprehensively included the chapter of result and discussion. Hence, this part is the most important during the whole stage of document. The researchers will make correction and revision if serious mistakes and deviation occurred in the documents or the interviews of the first group. This method gains good effect and high efficiency for the whole project.

The last step is the correction and supplement of documents after the interview with the second group (ten interviewees). The researchers would add the opinions from the second group of experts based on the framework of previous documents, and make another overall optimization.

After careful consideration, the researchers did not use NVIVO, MAXQDA, and ATLAS to make analysis. The main reasons are as follows: 1) The research method is explicit and targeted individual interviews with experts, instead of the diverse, mixed and divergent ones; 2) The sample size is controllable, and thus light analytical tools will be more efficient; 3) As individual researchers, the researchers do not need complex functions such as teamwork; 4) The above software provides limited support in Chinese language, including the multimedia transcription of Chinese language; 5) Using the above software requires importing all data including multimedia files. The researchers are very concerned that this will infringe on data privacy and cause intellectual property risks. The researchers also worried about whether it will affect the commitment to interviewees on minimizing the use of data. Therefore, after careful screening, the researchers finally chose the mind mapping software XMind (version 2022). Mind mapping software can help us classify interviewees' opinions and clarify their logic on the basis of a detailed interview minute. At the same time, its lightweight features and limited data requirements are also very suitable for our research and risk preference.

4.1.5 Data obtained

From January 14 to February 5, 2022, the researchers conducted individual interviews with the first group of 11 experts; from March 20 to March 29, 2022, the researchers conducted individual interviews with the second group of 10 experts. The total interview duration was 972 minutes, an average of about 46 minutes for each expert, but the interview duration for each

expert ranges from 30 minutes to 75 minutes. All interviews were recorded on video. The details are shown in Table 4.1.

Table 4.1 List of Experts Interviewed

Name	Number	Date	Start Time	End Time	Duration	Word Count of the Minutes
Mr. Zhang	1	1.14	21:23	22:07	0:44	984
Ms. Li	2	1.19	10:03	10:53	0:50	839
Mr. Hu	3	1.19	18:06	18:45	0:39	936
Ms. Yin	4	1.21	11:37	12:17	0:40	1072
Mr. Ye	5	1.22	9:13	9:46	0:33	870
Ms. Zhang	6	1.25	13:27	14:10	0:43	725
Ms. Xu	7	1.25	16:42	17:29	0:47	942
Ms. Huang	8	1.25	20:44	21:39	0:55	524
Ms. Chen	9	1.26	10:21	10:51	0:30	972
Ms. Zhao	10	1.26	15:24	16:16	0:52	1144
Mr. Han	11	2.5	9:56	11:00	1:04	2688
Ms. Huang	12	3.20	14:58	16:02	1:04	862
Mr. Li	13	3.25	11:03	11:34	0:31	861
Mr. Xiao	14	3.26	9:00	10:14	1:14	1792
Ms. Wang	15	3.27	14:31	15:14	0:43	757
Mr. Allen	16	3.28	14:03	14:37	0:34	977
Ms. Li	17	3.28	15:51	16:33	0:42	881
Mr. Zhang	18	3.28	20:01	21:16	1:15	1223
Mr. Zhu	19	3.29	9:29	10:07	0:38	960
Mr. Zhang	20	3.29	15:45	16:15	0:30	818
Ms. Wang	21	3.29	16:36	17:20	0:44	526
					0:46	21353

Meanwhile, the researchers also organized the opinions of experts in each interview into "Interview Minutes", including 21 articles with a total of 21,353 Chinese characters, with an average of 1,071 characters per article. It should be noted that although the minutes reproduced and summarized the opinions of the experts, they may not include the whole process of the research and interviews. Besides, the videos recorded during the interviews did not fully include the communication between the researcher and the interviewees outside the video or through other means. Thus, in the following sections, the researchers would appropriately interpret, summarize and extend the opinions of the experts based on the minutes and recordings, combined with methods such as document research, to comprehensively and accurately present

experts' opinions and the comprehensive results of the interviews, which also included the formally written text transcribed from the experts' oral and communicative words.

4.2 Summary on opinions

Considering the importance of this part, the researchers will present the experts' views in the following six parts under the premise of respecting the original intentions of experts: (1) Definition of AI; (2) Application of AI; (3) Value of AI; (4) Rarity of AI; (5) Imitability of AI; (6) Organizational attributes of AI. It should be noted that, unless otherwise stated, almost all content of this section are the opinions of experts. The reason why the original texts are not quoted is mainly because: 1) There are many oral dialogues. It is difficult to quote a lot of oral conversations in a formally written dissertation; 2) The researchers need to combine similar views from different experts; 3) The researchers should make the language of this dissertation smoother. It is believed that the technical processing of words does not deviate from the fact that this section is entirely based on the experts' own expression.

4.2.1 Definition of AI

All experts agreed that a clear definition of the discussed object is the prerequisite for further discussion. Meanwhile, rather than some conceptional descriptions, the researchers pay more attention to discernible criteria, and the specific stage which the object is at in the relatively long term. It is believed that only when both sides of the interview reach a consensus about the judging standards and present stage in the interview, can they conduct a further discussion.

In terms of the characteristics of AI, namely the judging standards, in some open discussions, experts did not give a comprehensive definition. Some experts believed that the current definition of AI in the field was quite ambiguous, while others asked for a standard definition from the document. As far as the researchers are concerned, the current research shows that some problems existed in the document's definition of AI: firstly, as a relatively new technology, it has quite a small number of documents especially Chinese documents of high quality; secondly, what the study needs is a specific judging standard, however, the definitions in existing documents are always general; thirdly, there may be contradictions between the definitions.

The study has introduced the five criteria of judging whether a technology truly belongs to AI. The first criterion is "purpose", which means AI always heads for specific purposes or tasks, rather than conducting purposeless or random behaviors; secondly, AI can read data and

perceive the external environment in certain ways to complete specific tasks, which is "perception"; the third criterion is "thinking", with which AI should be able to plan for a task after perceiving the environment and then form a specific work program; the fourth criterion is "action": AI should be able to put the prepared plan into practice, whether the plan is the application of digital output or the mechanical action. The action should correspond to the presupposed purpose. The last one, "learning", is of great importance. This criterion shows that perceiving, thinking, acting, and other procedures are not fixed or pre-established. In contrast, AI can continuously and automatically adjust and optimize these procedures according to ultimate purpose and stage results in certain ways. The last criterion, the study believes, is exactly the biggest difference between AI and automation technology. The study consulted experts on these five characteristics.

Experts all accepted this definition, and believed that the five dimensions summarized the characteristics and judging standards of AI with clearness, accuracy, and fullness. Some experts emphasized the criterion of "learning", which includes: (1) thinking and learning are key characteristics of AI; (2) learning is a higher-level ability, and AI realizes automation first and then surpasses it; (3) cybernetic experts pointed out that one of the two current misunderstandings is to confuse automatic control and artificial intelligence because cybernetics can also find a solution for the same problem just as AI does, however, AI takes completely different methods to solve the problems and has advantages over cybernetics in handling complicated problems; (4) importantly, AI finds regularity and makes plans from big data rather than simply follows orders; 5) some experts divided the intelligent system into three layers: perception layer, logic layer and execution layer, and believed that only AI that performs active (rather than passive) calculations at the logic level is genuine AI. 6) experts also indicated that many of AI's algorithms, such as reinforcement learning and genetic algorithms, are similar to the laws of natural selection in the theory of evolution, which allows the fittest to survive. Moreover, some experts mentioned the purpose of AI, and believed that in terms of definition, the purpose of AI is to collect data and then intelligently analyze the data to help people make decisions in their work and life which includes improving the accuracy of decision-making.

Experts also pointed out the necessity to clarify the development stage of AI. It was believed that many people mixed the AI of different functions and different stages in relevant discussions, which led to confusion. Besides, experts believed that the grading standard of automatic driving could be used to define AI in a classified way.

Internationally speaking, there are mainly four grading standards of AI driving technology: the first is the automated driving standards released by the National Highway Traffic Safety

Administration (NHTSA) in 2013; the second is the automated driving standards released by the Society of Automotive Engineers (SAE) in 2014. Due to its more specific and more rigorous description and its better prediction on the trend of automatic driving, this standard was also officially approved by the US Department of Transportation in 2016; the third is the automatic driving road map released by the European Road Transport Research Advisory Council (ERTRAC) in 2015, which adopted a grading standard similar to SAE; the fourth is the national standard from "Taxonomy of driving automation for vehicles" released by the Ministry of Industry and Information Technology of China in 2020, some of whose definitions are different from those of the SAE, while the overall framework is similar (Hong et al., 2021; Lv & Y., 2020;Ye, 2020) .

More accepted SAE standards, driving technologies in which all driving tasks are performed by a human driver (even if an early warning system is installed) are first considered non-automated driving technologies (L0). L1 is defined as "assisted driving", meaning that the automatic driving system can perform one of the steering or acceleration/deceleration tasks in a given mode, and expects humans to perform other dynamic tasks; L2 is defined as "partial automation", meaning that it can perform all of the steering and acceleration/deceleration tasks in a given mode, and expects humans to perform other dynamic tasks. L3 is defined as "conditional automatic driving", which means that the system performs all dynamic driving tasks in a given mode, but requires human to respond or take over in a timely manner; L4 is defined as "highly automated", meaning that the system performs all driving tasks without human response or takeover, but only in certain modes; the highest L5 is defined as "fully automated", which means the system performs all driving tasks on its own in any mode, including time, road, environment and others. SAE's grading standard is shown in Table 4.2 (Lv & Tian, 2020)

Table 4.2 SAE automatic driving grading standard

SAE Level	Name	Descriptive definitions	Actuator of steering and acceleration/deceleration control	Monitor of the driving environment	Performer of dynamic driving tasks in complex situations	Road conditions and driving modes supported by the system
Human drivers monitor the driving environment						
0	Non-Automatic	All driving tasks are controlled by the human driver (even if an alarm or intervention system is installed)	Human drivers	Human drivers	Human drivers	n/a
1	Assisted Driving	An assisted driving system in a given driving mode controls one of steering or acceleration/deceleration based on information about the driving environment, and expects the human driver to perform all other driving tasks	Human drivers and systems	Human drivers	Human drivers	Partial road conditions and driving
2	Partial automation	One or more assisted driving systems control steering and acceleration/deceleration based on information about the driving environment in a given driving mode and expect the human driver to perform all other dynamic driving tasks	System	Human drivers	Human drivers	Partial road conditions and driving mode
Automated driving systems (referred to as systems) monitor the driving environment						
3	Conditional autopilot	An autonomous driving system performs all dynamic driving tasks in a given driving mode, but expects the human driver to respond correctly to requests and take over the controls	System	System	Human drivers	Partial road conditions and driving mode
4	Highly automatic	An autonomous driving system performs all dynamic driving tasks in a given driving mode, even if the human driver cannot respond correctly to the request and take over the controls	System	System	System	Partial road conditions and driving mode
5	Fully automatic	Autonomous driving systems perform all dynamic driving tasks at all times, under all road conditions and environmental conditions (which can be managed by the human driver)	System	System	System	All road conditions and driving mode

Experts believe that while discussing the competitive characteristics of AI technologies, the specific stage of the discussion should first be clear. Because just like automatic driving technologies, both L1 and L5 levels can be called automatic driving, but their efficacy, or the role they play, is actually quite different at a given time. Even if both L3 and L5 belong to automatic driving in the true sense, the roles of the two can be very different.

At the same time, the researchers also must consider that the grading standard should be applicable in a wide range of industries, not just in one specific area of automatic driving, as is the case with the grading standard for automatic driving. Because the original purpose of the research is to study the strategic competitiveness of AI technology in a general sense for organizations, it can use certain domains as cases, but it should not be limited to them.

To this end, the researchers did the research again during the interview process based on previous literature. The researchers took the three-level grading standard presented at the first academic conference on artificial intelligence at Dartmouth College in 1956 (Li, 2020) as the grading standard for AI in this study, and identified ANI (Artificial Narrow Intelligence) as the stage specifically discussed in this study. The researchers believe that Dartmouth's grading standard, although dated, is highly general and possesses good theoretical depth and foresight.

At the first AI conference held at Dartmouth College, some scholars suggested that the development of artificial intelligence will go through three stages. The first stage is called ANI (Artificial Narrow Intelligence). At this stage, AI, as a kind of perceptual intelligence without

understanding or reasoning ability, is just "skillful in solving domain-specific problems". The second stage is called AGI (Artificial General Intelligence). At this stage, AI "can do everything humans do". It has the ability to understand, reason, and solve all problems, and has perception and consciousness, which belongs to cognitive intelligence. The third stage is called ASI (Artificial Super Intelligence). At this stage, AI, as a kind of machine intelligence smarter than the smartest human in all fields, is "more capable than any human beings" (Li, 2020; Oshida, 2021).

Obviously, the study has chosen ANI, the only existing one at this stage (or even for quite a long time), as the object of discussion, which is more realistic and more suitable for our academic topic than the rather illusory AGI, or ASI that may not be realized in the short run. Because even AGI, which is relatively easy to implement, still has a lot of theoretical, methodological and technical difficulties to break through, and may not be realized in recent years.

Experts agree on the choice of ANI, they believe: 1) another cognitive misunderstanding of AI by people outside the industry at present is the overly visionary and unrealistic outlook on AI. They think AI is an all-powerful and super-powerful technology, but in fact, the current AI can only play a certain role in a specific scenario. If it goes beyond a specific scope or in an environment closer to the reality, there may be problems, so the current AI is still at a very preliminary stage; 2) The jump to a higher level of AI depends on many preconditions, such as the breakthrough of key theories, which is quite difficult; 3) Human is actually a very complex system, a single function can be imitated, but a full replacement will take a long time.

Regarding the definition of AI, the viewpoints of experts are briefly quoted as follows.

Table 4.3 Quotes of definitions of AI

Expert No.	Abstracts of viewpoints
1	I agree that the current definition of artificial intelligence is still unclear. Artificial intelligence should be defined according to the level of intelligence and the time of realization with reference to the classification of automated driving L1 to L5.
2	It is believed that artificial intelligence mainly collects data and conducts intelligent analysis to help people make decisions in daily work and life, including improving the accuracy of decision-making.
3	I agree with the five aspects of definition of artificial intelligence. AI is to realize automation first, and then surpass automation through machine learning.
4	I wonder why there is no ready-made definition. It is recommended to classify artificial intelligence, such as primary, intermediate, and advanced, and then conduct targeted analysis for different levels of AI.
5	I agree with the five characteristics of artificial intelligence, and think that learning or thinking is the core of AI.
6	I agree with the definition.

Expert No.	Abstracts of viewpoints
7	It is believed that AI is an inevitable state of technological development. It is also agreed that the current functions are relatively simple, because human is a complex system.
8	The definition is good.
9	I agree with the definition.
10	I agree with the definition and emphasize the importance of discovering laws and solutions from big data.
11	I totally agree with the definition. There are two common misunderstandings about artificial intelligence by people outside the industry. One is too far-sighted and unrealistic prospects, thinking that artificial intelligence is an all-round and super-powerful technology, but in fact, the current artificial intelligence can only be used in specific scenarios. If it exceeds the scope, or in a relatively realistic environment, problems may occur, so it is still in a relatively early stage. The second misunderstanding is that many people may not understand the difference between artificial intelligence technology and automatic control technology. Many of our problems can also be solved by the method of cybernetics. The results are the same, but the method of cybernetics may not be enough in some complex problems, and the method of artificial intelligence is different. So in general, we believe that the current artificial intelligence is still in a relatively preliminary stage, and it is realized mainly through the method of supervised learning.
12	These concepts are all correct.
13	These definitions are all accepted.
14	From the medical point of view, the learning ability of many artificial intelligence is still relatively weak, and the experience of human doctors is still needed. The whole process cannot be completed independently by AI.
15	This definition is pretty much what I understand.
16	From a technical point of view, full artificial intelligence and super artificial intelligence currently do not exist, and the current AI can only work under a human-preset framework. Even learning is a relative thing. It is trained through CNN neural network and artificially given dataset, so it is unlikely to exceed the frame. In terms of hardware, the same is true for both inference chips and training chips.
17	I do not have too much problem about the definition.
18	I basically agree with this definition. 1) The idea of artificial intelligence has been mentioned in the algorithms of machine learning in the early years, such as the genetic algorithm developed by imitating the evolutionary process. The ability of artificial intelligence to stand out is also due to the improvement of computing power and the emergence of generic frameworks; 2) It is agreed that narrow artificial intelligence is a staged milestone, because many theoretical breakthroughs are required to enter full artificial intelligence, including solving problems such as how to generate self-awareness, which is actually relatively difficult; 3) There is a big difference between artificial intelligence and human intelligence in learning methods. As human beings can use priori knowledge, so they can solve many problems abstractly, while machines can only rely on large-scale data sets for training; 4) We also need to think about the energy consumption of artificial intelligence. That is to say, how many resources does artificial intelligence consume to solve the same problem.
19	The definition of stages is perfectly fine, and the 5 characteristics are also basically agreed. From the point of view of the proposer, it is also relatively complete. From my point of view, artificial intelligence is divided into two categories: one is machine intelligence, which uses the machine's own way to achieve human functions, and the results are the same, but the machine has its own method; the other can be called human-like intelligence. It also aims to achieve functions, but it uses human methods and human mechanisms, similar to the path of bionics, which is also a type of artificial intelligence.
20	In addition to the difference of strong and weak artificial intelligence, there is also the difference of generic and professional artificial intelligence. Structurally, we can divide it into three layers: perception layer, logic layer or algorithm layer, and execution layer.

Expert No.	Abstracts of viewpoints
21	What needs to be emphasized is the logic layer. Only active computing is true artificial intelligence. If it is passive computing, it is only process automation, which basically means the same as you say about learning. The definition is pretty good. Artificial intelligence is to serve human beings by imitating the human brain.

4.2.2 Application of AI

Many of the AI applications mentioned by the experts are from the medical field. On the one hand, this may be due to their professional background, as most of them are in the medical field; on the other hand, as some experts mentioned, the healthcare industry, as an industry with a relative shortage of manpower and high dependency, may be more motivated to apply advanced technologies like AI. The experts' presentations in this regard are divided into two main parts: first, an overview of the use of AI; and second, specific products.

Regarding the coverage, most experts believe that AI has already been put in use in healthcare and can play a role. In some areas such as dentistry, some experts believe that AI has fully covered all aspects of diagnosis, protocols, and treatment. Some, on the other hand, believe that AI products are still at the experimental stage and there is still a lot of uncertainty about their capabilities and responsibilities, so they have not been fully and independently put into clinical applications. Some experts also talked about the commercialization dilemma of AI medicine, arguing that: on the one hand, demand from patients, medical institutions, national policies and other levels does exist, and some devices have acquired the registration approval for Class III medical instruments, referring to medical instruments with higher risks which require special measures to strictly control management to ensure safety and effectiveness (State Council of China, 2021); but on the other hand, these devices and services do not have a special fee barcode, so in the actual process it is rather difficult to charge patients directly. As a result, many AI manufacturers are still dependent on capital input, which turns out to be a problem in the application and development process of AI.

In terms of specific products, experts mainly talked about diagnostic imaging, genetic diagnosis, treatment options, AI care, and AI surgery. Among them, imaging diagnosis is the most frequently mentioned field with the highest number of cases. Experts' opinions include: 1) AI imaging diagnosis, such as lung CT diagnosis, or oral disease diagnosis, learns through a large number of readings, and then automatically diagnose the case and provide the corresponding data support, without the need for doctors to do manual labeling; 2) There are also many cases in the field of ophthalmology, such as diabetic fundus screening with high

accuracy rate, in which relative indicators have fully surpassed human doctors. In the past three years at least two companies in the ophthalmology field have got the registration certificate and sold their products in Hong Kong; 3) ECG diagnosis, which previously required doctors to read the lead drawings manually and some T waves were easy to miss. Now AI can perform automatic diagnosis and then give highly accurate results even better than doctors, since it is very easy for AI to identify such line charts like T waves. Such AI ECG diagnosis is currently used even in rural health centers; 4) TCM assisted diagnosis, in which the system uses pictures of the tongue and face, as well as patches on the cun, guan and chi (three places at the wrist where the pulse is usually taken), to automatically identify the physique of the human body. Although it is mostly used for physical examination, it is also a kind of AI diagnosis. Unlike human doctors, AI TCM has larger knowledge reserve, so it can also provide more information; 5) B-mode ultrasound or skin disease AI diagnosis, some can compete with experts with deputy senior professional titles in three months; 6) One of the reasons why AI is developing faster in the field of medical images is the abundance and standardization of image data available for AI training; 7) AI is more accurate not only because it does not get fatigued, but also because its diagnostic process can be fully digital and without any decay, while human diagnosis requires first converting digital information into two-dimensional images, a conversion process that inherently has a lot of information decay. 8) All suspected nodules can automatically be marked in lung cancer screening, even that doctors would normally consider to be benign; 9) Brain images screening can not only be adopted in brain tumor screening, but also in the diagnosis of mental disorders; 10) AI image assistance in stomatology includes the visualization of postoperative effects of orthognathic surgery, the oral self-diagnosis system from Korea, and the intelligent oral diagnosis system from Russia.

In terms of genetic diagnostics, some experts talked about a comprehensive database they developed based on genes and diseases, and a rare disease diagnostic system on top of that. The system can machine learn from 3,000-6,000 known, definitive pathogenicity genes worldwide through neural network-based AI models, and then score and predict the lethality of other unknown mutated genes (which currently account for about 80% of all genetic diagnoses). In a case of a rare pediatric ophthalmology disease, about 90% of the original thirty or so cases with no previously identified definitive lethal gene were analyzed by this AI system and a high-risk pathogenicity gene was immediately identified in 4-5 cases, thus setting the stage for subsequent gene therapy. In another case of child kidney disease, the system not only found the pathogenicity gene, but also made a prediction of the causative mechanism of the gene, and the prediction was finally validated at the cytological level. Similar cases have not only expanded

the treatment approach and boosted the confidence of patients and families, but also encouraged the research and development team.

In terms of treatment plan, experts' opinions covered: 1) In the field of dentistry, AI is now able to give a complete treatment plan based on big data. Although the accuracy and reliability of AI is still to be improved for the complexity of the human body, and at present human doctors are still indispensable in most cases, it can at least reduce the work intensity of doctors, as well as provide more information and reference. And with the improvement of AI model and data accumulation, independent AI treatment will be more and more possible; 2) A comprehensive disease diagnosis and treatment system. After doctors input diseases and parameters, the system will provide the corresponding treatment scheme through big data. Unlike ordinary search engines, the scheme is not a mechanical listing of search results or academic literature but sorting and merging the contents according to a certain logic and format. In addition to the big data technology on which the scheme itself is based; the whole system also involves AI technologies such as semantic recognition; 3) Disease prognosis based on big data can provide predictions of disease progress for the next three to ten years. 4) The risk of liver cancer can be predicted and forewarned based on the test data of liver.

In terms of AI care, some experts mentioned care robots that perform functions, such as measurement of life signs, health education, transportation, and brief communication. Although these functions may seem simple, transportation requires image identification and path planning, and simple communication requires semantic recognition. All these are based on AI technology. As for nursing, some experts also mentioned a few: clinical early warning system, which reads the patient's sign data, combining with certain early warning laws, to suggest to health care workers the clinical events that need to be intervened; IBM's heart failure early warning based on the clinical sign data stream; a hospital in Shenzhen which carries out remote out-of-hospital management of diabetic patients through the blood glucose meter. For these cases, the study believes that if its early warning or management indicators are dynamic and learned through AI, it should be regarded as an AI technology; otherwise, it may be just an ordinary medical information system.

In terms of AI surgery, applications are as follows: 1) Oral dynamic navigation robot, which can be used for precise positioning in oral surgery; 2) Oral scan generates denture models, and the digitized files are sent directly to material suppliers for 3D printing, which is very fast and has much smaller errors than traditional methods; 3) Dental implant surgery robot uploads the oral scan and then performs surgery by robotic arm with very good precision and stability; 4) Eye hospitals use robots with very high precision to do the surgery as well. 5) MAKO joint

replacement robot. Although preoperative planning and skin cutting are still done by a doctor, unlike the Da Vinci robot, the joint replacement surgery is auto-completed by the MAKO robot, including the identification and operation of very subtle blood vessels and nerves. 6) One expert described a visit to the Hospital of the University of Pennsylvania in the United States, where he was shocked by the 30 surgeries being performed at a time, half of which were done by robots, each with only one doctor in the operating room to adjust the patient's body.

In terms of healthcare management, some experts mentioned the development of targeted treatment and rehabilitation for customers based on their individual characteristics and demand preferences. It was believed that the key of its intelligence lies in whether the analysis model is based on big data and machine learning, or just some static screening criteria. Of course, the experts are sometimes not sure about the working mechanism behind the corresponding system, but this does not affect the overall picture or other discussions.

In addition to the medical field, experts also discussed about AI applications in other industries such as security, voice recognition and logistics, including: 1) Security: automated mass face recognition at the customs, face-scan payment, and mobile phone unlocking; 2) Voice recognition: voice assistants like SIRI and Xiao Ai, AI education, AI customer service, and the use of AI language learning in simulating the origin and development of human languages; 3) Logistics: freight robots and navigation robots in malls.

Regarding the application of AI, the viewpoints of experts are briefly quoted as follows in Table 4.4.

Table 4.4 Quotes of viewpoints on application of AI

Expert No.	Abstracts of viewpoints
1	1) It is believed that AI is still in the experimental stage in the medical field and has not been fully put into clinical practice; 2) There are indeed many cases in the field of medical imaging, such as Tencent Miying, and IBM Watson, because this area can offer a large number of sample data for AI training.
2	There are some applications: 1) in the field of imaging and photoelectric CT, after reading a large number of images, the diagnosis can be given; 2) disease prognosis, predicting the trend of the disease in 3-10 years; 3) dynamic navigation robot, used for precision positioning during surgery.
3	At present, AI is relatively mature in the field of medical imaging, including: 1) Pulmonary diseases, such as Miying, because AI can theoretically directly read the digital information of the original image without conversion, so there is no attenuation and higher accuracy; 2) Electrocardiogram diagnosis, there are relevant cases in some township health centers in Anhui Province, the line graph of ECG is technically simpler than the two-dimensional image of CT; 3) Diabetes fundus screening, the accuracy rate is very high, and AI has fully surpassed doctors in terms of all indicators; 4) AI-like cases: IBM conducts heart failure early warning through physical sign data flow, and the Second City Hospital conducts remote out-of-hospital management of diabetic patients through blood glucose meters.
4	Most of the applications are image processing in the medical field, such as B-ultrasound and skin diseases. Some say that AI needs only three months to reach the level of an expert

Expert No.	Abstracts of viewpoints
5	with associate senior professional title. But at present it can only be used as an auxiliary, not a substitute for doctors, because the human body is too complex, and AI is only suitable for the processing of linear problems. It is not suitable for complex and structured problems. I don't know if the sweeping robot counts. AI has subtly infiltrated the clinical field. For example, in electrocardiography, doctors needed to read the lead drawings before, and some T waves were easy to be missed for doctors, but the current electrocardiography equipment will automatically diagnose and give results, and the accuracy is still very high, even higher than that of the doctors, because identifying T waves is very simple for AI. Another example is TCM auxiliary diagnosis. The system can automatically identify the physical constitution of the human body by taking pictures of the tongue and face, and applying patches on three places at the wrist where the pulse is usually taken. Although it is currently more used for physical examination, it is also a type of AI diagnosis. Unlike human doctors, AI systems tend to have more knowledge reserve, so they can provide more information.
6	It is recommended to add a definition of AI medical care. It is believed that AI has developed a lot in the field of ophthalmology. In the past three years, at least products of two companies have obtained registration certificates and are listed (sold) in Hong Kong. Subdivisions and diseases vary, such as diabetes fundus screening and so on. In terms of the main body, on the one hand, it is the promotion at the enterprise level; on the other hand, some hospitals undertake national research projects, in addition to clinical practice and implementation, they are also responsible for the formulation of standards and norms. Views on application: 1) From a market perspective, it is definitely needed by the medical market; 2) From a policy perspective, the state also supports it and has established projects for it; 3) From a medical perspective, AI is also required for disease screening and resource sinking, as it can reduce the burden on doctors. On the other hand, although obtaining certificates, AI cannot completely replace doctors at present, because its standards, databases, disease expansion, and charging bar codes all need to be improved.
7	Our association has been paying close attention to the development of new technologies in the medical field and helping to promote them. AI technology is an important part of it, and we have also helped some partners such as the Artificial Intelligence Center of the Pearl River Delta Research Institute of Tsinghua University to promote the technology of integration of AI and medical care in the industry, witnessing their technology and products being fully promoted in the Third Affiliated Hospital of Sun Yat-sen University, and services being offered to various departments. It includes not only basic AI technologies such as AI imaging, but also the center's new breakthroughs in rare disease diagnosis. They help many patients find the real cause through the AI auxiliary diagnosis system, laying the foundation for treatment and cure. In the next step, the association will also give strong support in the application and promotion, so that this advanced AI diagnosis technology can benefit more patients and medical institutions in need.
8	We are also working on a nursing robot, which can be regarded as artificial narrow intelligence (ANI). It can measure physical signs, do health education (semantic recognition), transport objects (path planning), perform simple communication and so on. I also heard that our hospital uses robots for surgery, and the accuracy is very good.
9	AI technology has been widely used in stomatology, covering the whole process of diagnosis, therapeutic schedule and treatment. In the diagnosis stage, the diagnosis results can be given according to the CT image, and the corresponding data support can be provided without drawing by hand. In the therapeutic schedule stage, a therapeutic schedule will be given based on big data, but at this stage it is still up to doctors, because big data also makes mistakes, and the human body is very personalized and complicated. The treatment stage includes using oral scans to make denture impressions, and then sending the digital files directly to the material supplier for 3D printing. It will be very fast and the error will be much smaller than traditional methods such as casting or manual work. Implant surgery is

Expert No.	Abstracts of viewpoints
10	also included in the treatment robot, and will be uploaded after oral scan. Although the path and operation still need the doctor, the accuracy and stability of the robotic arm are very good and will not shake. But according to the definition, the degree of intelligence of these applications is open to question. The AI medical applications that I have access to include: 1) Issue an auxiliary diagnosis plan. After inputting a disease, the system can output the literature and diagnosis and treatment plan of the disease. Unlike a search engine, it is not a mechanical listing of search results, but arrangement and merger of contents according to a certain logic and format, which involves at least semantic recognition technology; 2) Clinical early warning. It reads data such as patient signs, and based on the early warning rules found in big data, it reminds the medical staff of clinical events that require intervention. The intelligence is mainly reflected in that the early warning indicators should be dynamic and can be continuously optimized according to the latest situation; 3) Customer preference analysis. According to the characteristics and needs of customers, it can carry out personalized diagnosis and treatment and health care development, and its intelligence lies in that this development model may be based on big data. Take the cooperation between the AI Center of the Pearl River Delta Research Institute of Tsinghua University and the Third Affiliated Hospital of Sun Yat-sen University as an example, we have established about 20 projects, mainly in medical imaging, because this technology is relatively mature. We have published more than a dozen articles in some influential journals, and solved some practical problems. In addition, our AI center is developing a comprehensive rare disease and gene therapy database, including the risk assessment of gene mutations, hoping to help doctors and patients. Before long, an organization of parents of children with rare ophthalmic diseases found us. There are about 30 cases of them in the whole country. They found only one tenth of the causative gene. Through analysis of two of our models, we found immediately 4-5 previously undiscovered disease-causing genes, thus laying the foundation for future gene therapy.
11	From a technical point of view, we must first understand the Hype Cycle proposed by the Gartner consulting firm. They believe that the maturity of new technologies must go through five stages: First, Technology Trigger. At this stage there will be irrational exaggeration. Second, Peak of Inflated Expectations. The public will pay too much attention to successful cases, and companies are often indifferent to failure. Third, Trough of Disillusionment. People tend to be objective and rational about the scope of application of technology and business models, and most enterprise fail. Fourth, Slope of Enlightenment. The enterprises that survived through the previous stage will operate and develop stably. Fifth, Plateau of Productivity. The benefits and potential of new technologies are actually accepted by the market, and the methodology has also undergone iterations and entered a very mature stage. Both genetic technology and artificial intelligence technology follow this hype cycle. For example, in genetic technology, the human genome has been sequenced 20 years ago, and now the disillusionment has gradually faded. Over the past 20 years, the industry has actually achieved a lot of results, especially in the discovery of gene function, because function determination is the premise of targeted therapy. The industry has now discovered more than 6,000 disease-causing genes, and this data is still increasing. What we are doing is to use artificial intelligence to find patterns from known pathogenic genes and predict the pathogenicity of genes. The case of pediatric ophthalmology just mentioned is an example. Another example is the case of nephrology. Without treatment, the child must have a kidney transplant before the age of 30 to survive, but we used the developed AI model to analyze the fatal gene mutation, and even predict the mechanism of the gene defect. What is even more exciting is that the genetic predictions we made through artificial intelligence were later confirmed at the cytological level. This has also changed the view of many excellent biological experts in our company who previously thought that

Expert No.	Abstracts of viewpoints
12	artificial intelligence was just a hoax, and their attitude towards artificial intelligence is becoming more and more positive. There are several representative cases. The first is the active health management that our hospital is promoting now. We hope to realize the transformation from “medical-centered” to “disease-centered”. The social effect is very good, but the workload is also very large, so we have established a set of artificial intelligence management system. The second is the liver disease management system. It can not only give the cancer risk rating based on liver disease indicators, but give high-quality and authoritative treatment therapies for high-risk cases with the help of CDSS (Clinical Decision Support System). Moreover, the models of both systems are constantly being optimized. The third is medical imaging, including lung imaging diagnosis, and retinal screening. For example, retinal screening can realize the diagnosis and early warning of diabetes and cardiovascular diseases in about two minutes.
13	There are three examples. The first is a technology of the United States, which applies AI to the field of orthodontics. After scanning the patient’s mouth, it can generate simulated photos of teeth after orthodontic treatment through big data. This is very helpful for the formulation of treatment plans and the communication between doctors and patients. Now orthodontic surgery covers more and more people, from 5-year-old kids to adults, basically individuals in the whole life cycle. The second is a technology of Russia, which diagnoses oral diseases through AI images. It generates a preliminary diagnosis, and then doctors make judgments. Through this, the unevenness in the level of human doctors can be compensated. The third is a technology of South Korean. Patients take pictures of their oral cavity. After uploading the pictures, the system can automatically identify and diagnose oral diseases. These three cases are all very representative.
14	There are several examples. First, in the imaging field, there is an AI system for lung cancer, which will identify all lung nodules, even some nodules that doctors believe to be good. The second is the joint replacement robot system MAKO currently being used experimentally in our hospital. This system is very expensive, costing 20 million yuan. It also depends on the doctor to do detailed preoperative planning and parameter setting first, and the doctor also needs to do the initial skin incision. But what is more advanced than other systems is that its replacement process is completely automatic, unlike Da Vinci system, in which the doctor manipulates the robotic arm. It is necessary to know that the blood vessels and nerves in the joints are very subtle, and any discretion will cause huge damage. The third case, which may be between informatization and intelligence, is the smart systems used in our hospital, including smart medical care, smart services and smart management. As the hospital president, I can see big data on my mobile phone every day, including medical and financial data. However, if these systems are to be further integrated and applying more management strategies on them, they will have to rely on the intervention of hospitals, including doctors. This system is developed in cooperation with a company in Beijing, and some bugs were found at the beginning of the test, many of which were due to the deviation of the software engineers' understanding of our medical process and management model. The fourth case shocked me a lot. When I visited Hospital of the University of Pennsylvania in the United States in 2019, we were fortunate enough to enter the operating room. We found that there were about 30 surgeries going on simultaneously, and half of them were done entirely by AI robots. Many of us may not believe it before, but I saw with my own eyes that only one person was left in the operating room to do some auxiliary work with no doctors there. This also makes me begin to believe that whether it is the medical industry or other industries, intelligence is an inevitable trend.
15	There are many examples of applications in life, including navigation robots in shopping malls, food delivery robots in restaurants, automatic driving, and voice interaction such as

Expert No.	Abstracts of viewpoints
	HomePod, SIRI, and Xiaoai. There should be AI functions such as semantic analysis and path planning.
16	There are plenty of applications, mostly in the image field, such as facial recognition in the security field, face payment, delivery robots, unmanned driving, and more mature imaging diagnosis in the medical field, such as tumor screening and so on. But all of these, at present, cannot replace human beings. As for the financial field, including the so-called hyperparameter model, I am not very optimistic, because there are too many variables in the financial field that affect the results, the uncertainty is high, and it will be technically difficult.
17	Clinically, there are many AI applications in imaging, such as electrocardiogram, and lung imaging, but they cannot operate independently without doctors.
18	There are many applications in the brain science related fields. The first is to use brain imaging, such as brain waves and magnetic resonance imaging, to screen for diseases, including screening for tumors or mental illnesses. The second is to use machine learning language to conduct simulation and back-testing tests on the production of language. The third is to predict missing data in some scenarios. As for the brain-computer interface and consciousness monitoring, it is really popular now, and the difficulty lies not only in the decoding level, but also in the aspects of biological materials and engineering.
19	Take the AI education I am doing now for an example, we basically use many AI technologies, including visual ones such as face recognition and state judgment, and voice ones such as noise canceling, and semantic understanding. A lot of data can be collected and a lot of functions can be implemented. Now we are more concerned about how to make full use of these data. A similar situation may exist in AI in other fields. We have developed from a data acquisition stage to a data-driven stage. The AI technology facilitates a closer connection with the business, and it can even be transformed into knowledge-driven.
20	The Baidu search engine is actually also a kind of artificial intelligence. It can not only output search results, but also draw pictures of people through various data. There are also many applications in other industries. Generally speaking, we can divide them into three categories according to their implementation methods: first, generic algorithms, which try to exhaust relevant data as much as possible; second, global algorithms, which mainly identify the key characteristics of objects; third, abstract algorithms, which hope to learn the abstract ability of humans, rather than work through data labeling.
21	There are many examples in real life, such as SIRI, beauty camera, AI customer service and so on. But AI customer service may not be useful to me. In addition to worrying about understanding ability, I doubt its ability of empathy and it cannot meet people's needs for emotional catharsis.

4.2.3 Value of AI

In this session, the experts were asked to determine whether AI technology is valuable to the organization. If it is valuable, what value it has. This is based on the understanding of resource-based theory: resources, essentially, reflect the degree of control of the organization, and only things that are controlled by the organization are considered as resources of the organization. However, only resources that are valuable to the organization may help the organization to generate competitive advantage (or competitive parity). Conversely, if they are not valuable, they may cause the organization to be at a competitive disadvantage because managing and

developing the resources may also lead to increased costs or reduced revenues for the organization (Barney & Clark, 2011).

Experts' views on the value of AI include: 1) it is widely perceived that AI is valuable and it is an inevitable trend; 2) AI definitely has value, but how much value it has and whether it can replace jobs in large numbers depend on the situation; 3) Some experts also mentioned The Hype Cycle proposed by Gartner Consulting, holding that AI may be at a low ebb (at such time, hospitals that apply AI may not have a large lead over the ones that do not, but with time, a few companies will definitely stand out; 4) Some experts do not have high expectations for AI, believing that AI may only be a more advanced IT technology, which can only process certain data according to certain rules, rather than solve problems with pioneering approaches, and the performance of AI also depends on its designer's capability and the data fed to it. 5) Some experts believed that the value of AI is determined by specific industries and needs. The study found that the common ground of all the experts is that they all agree that AI technology is valuable to organizations. The difference lies in the size of its value, or the way it is implemented.

In terms of specific value performance, the experts mainly talked about reducing manpower, improving quality, expanding market, and strengthening management. The most talked about is that AI can reduce the organization's reliance on manpower, specifically: 1) The external demand for AI is multi-level, including patients' need from the market perspective, the support and project approval from the government level, and the hospital's demand of AI to reduce the burden of doctors in disease screening and resource sinking; 2) AI's value may be more significant in the medical industry, because for organizations such as hospitals where manpower accounts for a large part of the cost, it can be very attractive to replace human doctors by machines. Some experts believe that AI has great potential in military and aerospace fields; 3) Geographically, some experts participated in a study tour to some hospitals in Xinjiang's Kashgar Region organized by The Third Affiliated Hospital of Sun Yat-sen University, and found that AI technology is also used in remote areas, such as the cataract AI screening project in the region conducted by the Ophthalmology Center of Sun Yat-sen University. Experts believe that AI may be more useful in areas with relatively poor human resources since it can make up the shortage or low proficiency of local human doctors; 4) In terms of job types, some experts believe that if the organization's tasks are more humanistic and emotional, the role played by AI will be more limited, but if the tasks are mechanical and repetitive, then AI should be able to play a considerable role; 5) Some experts believe that AI can assist humans in management and decision-making; 6) In addition to the potential replacement of professionals

such as radiologists, AI can also replace some service positions that are not as specialized. For example, private hospitals often enhance their services by increasing manpower, but AI can achieve the same effect at a lower cost; 7) In addition to the direct replacement of services, AI can indirectly reduce the labor intensity of human doctors and sparing some of their energy, and free people from repetitive, mechanical work; 8) Some experts focus on the tipping point of value generation, arguing that the economic benefits generated by AI can be quantified and then compared and measured with the entire input costs of AI systems, and if the investment cannot be recovered or the payback period is too long, it means that AI may not be commercially viable in that period; 9) The value of AI also lies in the externalization and marketization of human knowledge, making it more efficient; 10) AI is needed in some tasks that humans fail to do or cannot do well, such as data mining and processing, and the discovery of hidden laws.

The second aspect of AI's value is the improvement of quality, including: 1) Some experts in the field of Stomatology believe that AI can indeed provide better diagnosis and surgery; 2) Technically speaking, the granularity of AI diagnosis is much finer, such as image diagnosis, so the quality of diagnosis will be higher; 3) It can improve the service quality, such as doctor-patient communication, because some AI can provide disease prognosis to help patients understand the progress of the disease course, and can also provide a visual and concise user interface. At the same time, the professionalism of AI can also enhance patients' trust in the diagnosis results.

Third, as for time limit, some experts think that generally AI can work for a longer and uninterrupted period and takes a shorter time to finish individual tasks.

Fourth, in terms of market: 1) some experts believe that with a certain level of accuracy or quality index, AI can be equivalent a leading expert, which will bring brand effect to the hospital. In the group-type hospitals, this brand effect can also be output as a cooperative resource, which indirectly bring new customers to the organization; 2) In addition to direct economic effects, social benefits can also emerge, such as the promotion of influence among peers and the support in scientific research; 3) In the process of AI application, the development experience and market status accumulated by the organization may also bring competitive advantage; 4) Some experts believe that when medical skills or technologies themselves are difficult to be protected as intellectual property, AI system can serve as a carrier of organizational competitiveness to some extent, because the system can be protected as intellectual property. 5) AI, as a revolutionary technology, may also provide opportunities for companies to catch up with their peers. For example, Nvidia, a chip giant whose market capitalization now is almost twice that of the former magnate INTEL, seized the historical opportunity of artificial intelligence and

successfully realized the transformation from a graphics cards manufacturer to an AI chips maker. Similar opportunities are likely to emerge in industries such as healthcare. Some experts believe that small and medium-sized hospitals, which are not advantageous in terms of resources at present, may use artificial intelligence technology to keep pace with large Grade A tertiary hospitals.

Fifth, in management, some experts believe that: the application of AI can improve the specification and efficiency of organizational business processes, because AI can reduce errors, inefficiencies or ethical flaws in human judgment.

As for the value of AI, the viewpoints of experts are briefly quoted as follows in Table 4.5.

Table 4.5 Quotes of viewpoints on the value of AI

Expert No.	Quotes of viewpoints
1	To sum up, there are mainly two aspects. The first is the commercial aspect, which includes: 1) It can reduce the labor cost of the organization, especially for an organization such as a hospital where labor cost is the largest cost. If it can really replace human doctors with machines, it will be very attractive; 2) If the accuracy or quality index of artificial intelligence can reach a certain level, it is equivalent to a big-name expert, which will bring a brand effect to the hospital; 3) In a group-operated hospital, this AI capability can also be used as a kind of cooperative resource, and it may also indirectly bring new customers to the organization. The second aspect is the development of technology. But this may happen at a more long-term stage when AI companies can dominate hospital operations, rather than relying mainly on medical staff as they are now. At that time, organizations with AI technology can gain a great competitive advantage, because development experience and industry status require years of accumulation. The competitive features brought on the business side are valuable whether it is lower costs, more revenue, or brand effect.
2	To sum up, there are mainly two aspects. The first is to increase the effectiveness of doctor-patient communication, which stems from the following aspects: 1) It can provide disease prognosis and help patients understand the progress of the disease; 2) It can provide a visual interface, which is very simple and clear; 3) The results of AI, to a certain extent, strengthen patient trust in diagnostic results. The second is improvement of work efficiency. The judgment standard is whether the input of manpower is reduced, whether it is directly replacement of work content, reduction of the number of personnel, reduction of the labor intensity or indirect conversion into commercial value.
3	Artificial intelligence can: 1) Reduce human dependence. In addition to the replacement of radiologists by AI images, some service positions that are not very professional are also replaced. For example, private hospitals often improve services by increasing manpower, but artificial intelligence can achieve the same effect with lower cost; 2) Improve the standardization and efficiency of the process, because artificial intelligence can reduce the error, inefficiency and moral flaws of human judgment. I agree that it is difficult to analyze in terms of characteristics or resources of segmentation (it may make more sense to segment in terms of industry or application). On the whole, AI is valuable.
4	I think it is necessary to distinguish the types of organizations. If the tasks of the organization are more humanistic and emotional, the role of AI will be limited; but if the tasks are mechanical and repetitive, then AI can play a role. The first function is to release

Expert No.	Quotes of viewpoints
	people's time and energy to do more creative work; the second is to solve the problem of insufficient labor force in the aging society.
5	AI is undoubtedly valuable. For example: 1) AI does not need rest, and it will not be tired, so it can provide high-quality and uninterrupted services. It will solve the shortage of doctors, or release the energy of many doctors; 2) Technically, its granularity will be much fine, such as imaging diagnosis, so the quality of diagnosis will also be higher.
6	It is valuable.
7	It is definitely valuable and it is also an inevitable trend.
8	It is definitely useful. In addition to direct economic effects, it also has social benefits, such as peer influence and scientific research support. However, it depends as for how useful it is, and whether it can replace many jobs.
9	It is valuable. On the one hand, it liberates human beings; on the other hand, AI can indeed provide better diagnosis and surgery.
10	It is valuable. To sum up, on the one hand, it can replace or liberate human labor; on the other hand, it can assist human beings in management and decision-making.
11	It is undoubtedly valuable. However, this value may not be immediately reflected at the commercial level. For example, in a hospital that uses artificial intelligence, the gap is not necessarily very large at present compared to those that do not apply AI. However, according to the Hype Cycle, we believe that with the passage of time, a few companies will definitely stand out. There is another interesting case. I once participated in the assistance investigation group of Third Affiliated Hospital of Sun Yat-sen University to the Kashgar Hospital in Xinjiang, and found that artificial intelligence technology was also applied in such remote areas. For example, Zhongshan Ophthalmic Center has conducted AI screening for cataracts locally. Therefore, we believe that in some areas where human resources are relatively poor, artificial intelligence may be more useful, because it can make up for the shortage of human doctors in terms of quantity and medical skills.
12	Certainly, it is valuable. 1) Artificial intelligence can assist in the realization of refined and digitized decision-making instead of subjective, abstract and empirical decision-making, which will greatly improve the scientific nature of decision-making; 2) It will also save a lot of management costs as well as labor costs.
13	Certainly, it is valuable.
14	AI is certainly valuable. One of the manifestations is that the human resources can be greatly enhanced. It takes more than ten years for us to train a high-quality doctor from school to hospital. AI can provide us with more standardized, automated, and precise services in a very short period of time, which is a very good thing.
15	It is valuable. 1) It can save labor costs, especially freeing people from mechanical work; 2) The error rate is lower; 3) The efficiency is relatively high, such as batch face recognition in crowded scenes.
16	Value is determined by demand. If there is a demand, or if it is viewed as a core competency, it has value. In other ordinary enterprises, at present, AI is not indispensable. Overall, it is more like icing on the cake.
17	It is valuable, but it is more about screening and assistance, for example, the above-mentioned imaging diagnosis. It cannot replace the role of doctor. First, from a normative point of view, AI cannot be used as a responsible subject. Second, technically speaking, the current diagnosis is more directional, and it cannot provide exact diagnosis conclusion, as well as the corresponding treatment plan and prognosis like a doctor. Third, the accuracy of AI can be assumed to be 80%-90%, but the remaining risks still need to be controlled and intervened. In addition, we also hope that the AI will prioritize solving auxiliary problems, rather than aiming at replacement all at once. Because the whole medical system lacks auxiliary services. For example, a doctor needs three assistants to provide auxiliary services to patients. Now, due to the lack of auxiliary personnel, doctors often need to do four times

Expert No.	Quotes of viewpoints
	the work. Patient satisfaction will decrease if doctors do not do the auxiliary work. In this case, using artificial intelligence to replace the doctor is technically difficult, and the necessity is not the most urgent, because even if the job of the doctor is replaced, the work of the other three people is still not done.
18	What AI can do, humans can also do. But the value of AI lies in: 1) Externalize and productize the knowledge that was originally relatively connotative; 2) To a certain extent, it liberates people from repetitive work, which helps to reduce labor costs.
19	It is definitely of great value. The value is reflected in two aspects: one is the acquisition of data. AI has done a very good job in this regard. In terms of data quality and volume, it is definitely much better than manual labor; the other is data mining and application through big data technology, which is also being constantly developed.
20	It is of great value. The first is to save manpower, especially some repetitive and physical labor; the second is to improve efficiency, such as automatic identification and processing; the third is to do some things that humans cannot do, such as work in aerospace and other specific environments.
21	It is valuable. At present, AI is competent in basic jobs, but it is not to the extent of being indispensable. It is not applicable for complex jobs that require empathy.

4.2.4 Rarity of AI

For average experts, the rarity and inimitability of resources are relatively confusing concepts. According to previous literature, the study tends to define rarity as a current, objective quantitative share, and inimitability as a visionary, predictive difficulty of deployment or barrier to entry. Despite our clear definition, as with most judgments in the real world, it is ultimately a subjective judgment. Therefore, in the interviews, the study also rose upon the simple judgment itself to explore the reasons or perspectives behind with the experts.

Judgments of rarity are not as uniform as those of value. However, there are 81% of experts who still believe that AI is rare or partially rare for organizations at this stage; there are 19% of experts who believe that it is not that rare; No experts think that there is no rarity at all.

The views of experts who believe in the rarity of AI include: 1) In terms of talents, deploying AI devices is still a bit difficult for many organizations because it requires not only needs a number of qualified talents with certain experience, but also the strategic vision of the leadership, as well as the knowledge base and cooperation of the whole team; 2) AI technology is expensive; 3) Technology, especially the development of algorithms, is still quite difficult to develop. Besides, certain requirements are also placed on the previous informatization level of the organizations. And the process of deployment can be relatively long; 4) In terms of supply and demand, generally speaking, the current organizational demand and the supply of systems are both insufficient, which also increases its rarity. Currently, most tasks of hospitals are complex, emotional ones, so AI has minor significance; 5) Some experts also indicated that

heavy protection regarding intellectual property and market operation may also be set up in capital operation out of commercial purposes, thereby enhancing AI's rarity.

The views of experts who think it depends on the situation include: 1) The rarity depends on the nature of the work. If AI is considered as a system or a product, it is not rare, but for companies specializing in AI research and development, its development technology and development team are relatively rare; 2) It depends on the industry and products. For example, the product recommendation algorithms are quite prevalent in Internet companies at present, but genetic prediction models and the like are relatively rare. 3) The low-end life-type AI is not rare, while the high-end work-type one is rare.

Therefore, experts in general believe that AI is somewhat rare at this stage for most industries. This is not just because the number of experts who perceived rarity is overwhelming in the interviews; it is also because the study must figure out the difference between deployment and the fact of ownership – even if AI system as a commercial product may not be difficult to purchase (which falls into the scope of imitability), but in fact, at the moment, most organizations may not buy them for a variety of reasons. Even in the field of medical images, an area where the technology is already very mature, hospitals without AI imaging systems may still make up the majority.

The experts' viewpoints on the rarity of AI are briefly quoted as follows in Table 4.6.

Table 4.6 Quotes of viewpoints on rarity of AI

Expert No.	Quotes of viewpoints
1	For competitive features in business, whether they are lower costs, more revenue or brand effect, AI is not scarce in the long run. However, for development of technology, it is scarce.
2	It is not scarce in terms of increasing the effectiveness of doctor-patient communication. In terms of improving work efficiency, it is not scarce. However, in terms of willingness to use, it is relatively scarce.
3	It is not scarce, because in the R&D of AI technology, commercial organizations naturally have the need to maximize the benefits, so if it is profitable, other organizations will follow up quickly.
4	In the medical field, it is not common at present, so it has a certain rarity. First it is because of the cost to be paid; second it is because that the demands of the organization are different. At present, there are still many complex and emotional tasks, and AI may not be useful.
5	AI is always used first in certain industries, so at present, there is still a certain rarity.
6	It is still relatively scarce.
7	It has a certain rarity. At present, it is not necessarily naturally scarce, because there are also artificial factors in capital.
8	It is not too scarce, and there are plenty of applications.
9	In stomatology, it is not too scarce, such as the current robot hand. It is still a bit difficult for some organizations, and it requires certain vision, strategy and financial resources.
10	Currently, it is a scarce resource. First, in terms of research and development, especially the algorithm, AI technology is still relatively difficult; second, there are not many relevant talents; third, the entire application process is relatively long.

Expert No.	Quotes of viewpoints
11	Rarity depends on the industry. For example, there are many commodity recommendation algorithms that are widely used in the Internet field, and almost every Internet company has them. But genetic modification and prediction models are still relatively scarce.
12	In the current artificial narrow intelligence stage, it may not be scarce for the medical industry, and many hospitals have it. However, the development of the medical industry is still relatively advanced in the whole society, because people's health awareness is getting stronger and stronger. Speaking of all the industries, artificial intelligence is still relatively scarce, because the popularity of artificial intelligence depends on demand for it and vision on it.
13	It is still relatively scarce, and the threshold mainly comes from people, property and other aspects. First, these AI systems are not inexpensive, and the most inexpensive one costs 800,000 yuan, so only financially powerful hospitals will purchase them; second, in terms of decision-making, the leadership needs to have this awareness; third, in terms of talents, there are not many of them who are proficient in this field.
14	It should be scarce, because the realization degree of an AI system depends on at least two factors: one is the level of informatization of the organization, because informatization can be regarded as the basis of intelligence, without informatization, it is difficult to be realize intelligence; the other is the learning ability of personnel. These two aspects are currently not commonly owned.
15	If it is the life-related, basic artificial intelligence mentioned before, it may not be scarce at present. But if we have higher expectations for intelligence, such as AI in some work scenarios, it is still relatively scarce.
16	I would give it a neutral rating on rarity, 3 out of 5. Similar to the previous question, it also depends on the type of organization.
17	Standing at the level of the entire community, it is still relatively scarce. But the premise is that the cost cannot exceed that of hiring human beings.
18	It is still scarce in the early stage, but it will not be scarce for too long in the long run.
19	The rarity depends on the industry. In some industries, such as security, AI is pretty common. At the same time, technology itself may not be scarce, what is scarce is the application of technology. This transformation ability may be relatively scarce. As for AI medical care, the current problem is data access and sharing, but the main obstacle is not technology. There are more obstacles in business and privacy.
20	The demand is universal, so supply is relatively scarce.
21	The low-end AI is common, but the high-end AI is a bit scarce.

4.2.5 Imitability of AI

Imitability refers to the inimitable or non-imitable traits of resources, which represent the threshold or moat of resources for latecomers. In this regard, 81% of the 21 experts believe it is difficult to imitate or part of it is difficult to imitate (including 7 who think it is difficult to imitate and 10 who think it depends on the situation), while about 19% indicate that it is not difficult to imitate.

There are two reasons why it is difficult to imitate: 1) The price of the system is expensive; 2) There exists a bottleneck in talent recruitment. In addition to the number, costs and experience of talents, there are also higher requirements for their professional know-how, integrative competence and cross-specialty ability, as well as greater acceptance of innovation.

3) The integration of team members is another barrier, for example, whether talents of different majors can be united for a new and illusory goal; 4) For developers, development experience, technical barriers, and brand mentality to some extent can be regarded as "moat"; 5) Even for users, the thresholds may include procurement barriers similar to those currently prevalent in the chip industry, integration and deployment difficulties, different data quality across organizations, and performance enhancement from the early and ongoing use of AI systems. Those experts who think the difficulty of replication depends on the real situation hold the following opinions: 1) Replication is relatively difficult at the production end but easy at the consumption end; 2) Replication is difficult for R&D organizations but easy for the organizations that deploy AI systems; 3) It is hard to imitate AI in such areas as AI drug development, gene prediction. However, it is easy to replicate AI in the area of recommendation algorithms. 4) AI is hard to imitate at present, but it will be easy in the future.

The reasons why it is not difficult to imitate are as follows: 1) Enterprises naturally seek to maximize profits, and if AI is considered profitable, they will develop AI rapidly; 2) If AI is considered as a product, its development only needs to be funded, which will not be difficult for most hospitals to imitate, especially Grade A tertiary hospitals. Generally speaking, this type of view is not the majority, nor is it in-depth.

The experts' viewpoints on the imitability of AI are briefly quoted as follows in Table 4.7.

Table 4.7 Quotes of viewpoints on imitability of AI

Expert No.	Quotes of viewpoints
1	As for the competitive features of business, it is not difficult to be imitated. As for the development of technology, it is difficult to be imitated.
2	In terms of increasing the effectiveness of doctor-patient communication, it is not difficult to be imitated. In terms of improving work efficiency, it is not difficult to be imitated. However, in terms of willingness to use, it is difficult to be imitated.
3	It is not difficult to be imitated.
4	It should be considered from two perspectives. If you look at it from the perspective of research and development process, the cost of imitation will be relatively high, because its team, experience, technology, patents and data need to be accumulated; but if you look at it from the perspective of commercial products, as long as you have money, you can use it.
5	Similar to humans, the growth of AI will be affected by the environment, so it has certain thresholds; but at the same time, these effects or problems in the implementation process are not insoluble or surmountable. So in general, the imitability of AI is not high.
6	This issue should be viewed by field, for example, in AI drug research and development, it is basically impossible to be imitated. In general, the B-side and R&D-side are basically difficult to be imitated, while the C-side (users) or the product side are relatively easy to be imitated.
7	In theory, applying AI is not difficult. But it should also be considered whether the government wants AI to be applied so quickly, and whether vested interests will resist it.
8	It is also easy to be imitated. As long as you have money, you can buy it, and now there is no shortage of funds for tertiary hospitals.

Expert No.	Quotes of viewpoints
9	It is not easy to be imitated.
10	It is not easy to be imitated, because every organization has a lot of personalized things, such as strategies, business processes, and demands; in terms of system deployment, it is difficult and takes long time.
11	It depends on the industry. For example, for the Internet industry, recommendation algorithms are already blooming ubiquitous, and the threshold for deployment is not high; for industries with strong professionalism, there must be thresholds. Because the individual learning process and the team building process are very difficult. For example, our company has many talents in biology, medicine, IT, and artificial intelligence. They have different professional backgrounds, so their thinking styles and working methods are very different, but we need them to work together in a coordinated manner, so the process of organizing them is very difficult, and there will definitely be a running-in process. This will also create a first-mover advantage, because even if someone comes in later to do it, they will take time to run in, and at this time we have made progress. Therefore, in general, it is not particularly easy to be imitated.
12	Imitability depends on the stage. At present, if it is R&D, it is relatively difficult to imitate. But if it reaches the product application stage later, it will be easy to imitate.
13	It is not easy to imitate. The main reasons are the three aspects of talents, property and materials mentioned above, which have actually relatively high thresholds. In addition, I have also talked about the carrier of the competitiveness of the medical industry. Abstract medical technology itself is difficult to apply for intellectual property protection, but tangible products are real and can form intellectual property rights, so they can become the moat of the organization.
14	It is not easy to replicate. First the implementation and deployment of AI is an advanced skill for organizations, and it is not easy to acquire; second, mastery of AI by doctors is also an advanced skill, and in some cases, although assisted by AI, higher requirements are proposed to doctors in their business capabilities, such as full-process planning capability and prognostic capability. One of our doctors proudly posted information in Moments of WeChat after the successful MAKO operation, which also shows from one side that this skill itself has difficulty and threshold.
15	From the product point of view, general commercial products may be easier to imitate; but if it is a strong brand, it will be more difficult to imitate. In terms of technology or research and development, it is another story.
16	In general, the threshold is still relatively high. Although the overall complexity and investment scale are not as visible as the semiconductor industry, the hidden threshold is still very high. There are some moats on the basic framework, because many of the underlying frameworks are part of the ecosystem. The semiconductor industry needs 200 expert-level people to work together at the same time. The AI industry may not need so many people, but it needs one person to do things that 200 people cannot do. Although there are some open source frameworks, it is not easy to imitate.
17	In terms of necessity, if doctors recognize it and it has clinical value, there will be a need for deployment. In terms of feasibility, the bottleneck of the current imported system mainly lies in quota, and the hospitals that can get the quota are generally sufficient in funds. The threshold of domestic system is much lower, and it is more a strategic decision of the hospital, because advanced equipment is also an integral part of the hospital's competitiveness, so is the hospital's judgment on the procurement efficiency.
18	In the technical level, it is not scarce, and many companies are using it. But generally speaking, the threshold is relatively high. First, the entire system is not highly modular; second, the scenarios used are relatively broad, so it is difficult for training. As for the first-mover advantage of ordinary enterprises, it should be existent, such as the advantage based on data.
19	It may not be difficult technically, but the industrial application is difficult.

Expert No.	Quotes of viewpoints
20	In general, there are barriers currently, but the barriers may disappear in the future. The professional ones may have barriers, while the ordinary ones may not.
21	It depends on the industry. Generally speaking, the threshold is not low. Talent is one of the reasons.

4.2.6 Organizational attributes of AI

The organizational attributes of AI refer to whether AI, as a resource, can be effectively organized and applied to the business process. Only effectively organized resources have the potential to form advantages in competitions. As mentioned above, among organizational factors, the researchers will also prompt experts to consider whether the organizational capabilities of enterprises applying artificial intelligence include dynamic capabilities, the degree of dynamic capabilities, and whether artificial intelligence technology itself has a certain relationship with dynamic capabilities.

The experts' opinions on the organizational attributes of AI are completely consistent, agreeing that AI can be effectively organized and used as a resource, although there are challenges and tradeoffs involved. The experts' views include: 1) it is a general trend to apply AI into business, so individuals are hard to stop it; 2) AI can create some value to organizations, such as reducing labor costs or alleviating manpower shortages. Driven by benefits, decision makers will be motivated to apply it as long as it is commercially permissible; 3) policies or some other resistance will not be a big problem in the long term, because policy regulation usually lags behind the development of industry. For example, electronic medical records have experienced the process from being illegal to popularized. Therefore, the reluctance of regulators and the public in the early stage may be gradually reduced as AI is publicized and the technology is improved; 4) there will be some difficulty in the implementation process, but it is possible to be solved so that AI can be applied in the end. 5) The types of organization may also affect the implementation of AI. It may be smoother in large-scale hospitals, while in township health centers, people may be accustomed to working in an empirical way. Otherwise, large public hospitals, with a large number of patients and a shortage of medical staff, are more willing to use AI because of the great workload. Also, organizations with strong execution are more likely to deploy AI.

Several experts are not worried about AI's impact on human society and their opinions include: 1) Currently, AI is a tool. It is ancillary and cannot work on its own, so there will not be serious problems, because people won't reject a tool; 2) Temporarily, AI can only replace low-end jobs, not the high-end and emotional ones, and it is not sizable enough to pose a threat.

3) People can always find other jobs; 4) In terms of quality, accuracy is still difficult to achieve in many fields. For example, AI in clinical diagnosis can only provide therapeutic directions at present, and, albeit with low error rate, it is still unacceptable. 5) Issues concerning laws and attribution remain to be resolved; 6) Some experts have innovatively put forward the issue of energy consumption of AI, arguing that it is necessary to pay attention to how many resources AI needs to solve the same problem as humans do, because when it comes to carbon neutrality, AI may not be completely economic. 7) Human society as a whole is not particularly receptive to innovation; 8) People think there's no need to worry about a problem hundreds of years away, since so many things may change in the future.

The experts' viewpoints on the organizational attributes of AI are briefly quoted as following Table 4.8.

Table 4.8 Quotes of viewpoints on the organizational attributes of AI

Expert No.	Quotes of viewpoints
1	Although there is still resistance to further promote AI in doctors and the medical community, one is from the habitual caution of new technologies from professional groups, and the other is from doubts about clinical safety, in general, the organization of AI is no big problem.
2	AI can be organized.
3	In terms of the organizational attributes of resources, it is not a problem in terms of technology and process. What needs to be considered is that artificial intelligence may encounter greater resistance in the process of landing, because it replaces people. One possible source of this resistance is the government's attitudes and concerns about unemployment and social welfare.
4	If it is the tool-like resources, it should not be difficult. I agree with the resistance in the four aspects, because AI is indeed too new, and there will be great challenges in terms of law and ethics.
5	It is currently positioned as an auxiliary, so it is not a big problem. But at different stages, people react differently. In general, in the early stage, AI may encounter some resistance. However, these resistances can also be gradually digested with the adjustment of division of labor and changes in job positions.
6	At present, it is basically an auxiliary, non-decision-making role, so the resistance will not be very large. In the future, it may encounter some challenges in ethics and data property rights, but I believe it can also be self-sustaining.
7	If you look at it from a higher level, such as from the perspective of the government, it may also need to consider some negative factors of AI, such as the shock to the institution and the impact on users. On the other hand, group resistance is also a reason. For example, I have an old classmate who worked in first-class IT companies such as Oracle and Microsoft, and later started a business as an obstetric software agent. He found that in big cities, senior obstetric experts are very willing to use the software. However, in hospitals and health centers below the county level, many doctors are very resistant. They find it very troublesome and are more accustomed to using their experience to diagnose or handle cases. I used to be in charge of customer service at HSBC China. In the promotion of a new system, I actually encountered considerable resistance. In most cases, we have to do brainwashing for all employees half a year in advance before implementing the new system. Similar situations exist more or less in Third Affiliated Hospital to Sun Yet-sen University and Huazhou Hospital.

Expert No.	Quotes of viewpoints
8	There's no big problem in organization and we have not encountered to much resistance. This may also be related to whether the function is powerful. After all, it cannot replace doctors and nurses. So it is like monosodium glutamate, which acts as the icing on the cake and the finishing touch. On the other hand, it also depends on the specific environment. Large hospitals may be fine, but it may be difficult for township health centers to implement it.
9	It can be organized. In different areas, there may be some different resistance, but the resistance will be less and less. Because: 1) This is the general trend; 2) It can indeed provide some value to the organization, such as reducing labor costs or easing the problem of finding labor forces. Under this practical benefit, the decision-makers must have the motivation to promote it as long as it is commercially permitted. As for policies, their formulation and regulation usually lag behind industrial development. For example, electronic medical records have gone from being illegal to widely applied. The public's resistance to AI in the early stage may also gradually decrease with the strengthening of publicity and improvement of technology. .
10	The acceptance of all parties in the organization process can be divided into two situations. One is large public hospitals, which have many patients and insufficient manpower, so the service pressure is relatively high. In this case, artificial intelligence can play a great role. There will be a place for patients to ask questions. The other is private, high-end hospitals, which are known for their services, and the service recipients may not be willing to operate a lot of IT things in person. Some even need one-on-one, and personalized service. In such a scenario, artificial intelligence may not be very useful. Another issue is the protection of customer privacy, including blood sample data. It seems that some media have reported the backdoor incident of GE radiology equipment. During the Wuhan epidemic, a large number of Chinese patients' chest X-ray data were leaked. Such cases will actually cause people to worry about data security, their own privacy and distrust in foreign manufacturers, which will further affect the development of the entire industry. In spite of the challenges and risks, I still believe that these problems can be solved by strengthening the standardization and management of processes and localization of key facilities and equipment. So in general, AI is a resource that can be effectively organized and can be used to serve mankind.
11	It will be difficult, but not impossible. There will be a running-in process, but I believe it can be well organized in the end. As for the resistance in the process, it is not too much of a problem. Moreover, based on the current state of artificial intelligence technology, we do not believe that AI will replace human beings. We are more willing to believe that it is human beings who can apply and apply artificial intelligence early that will replace those who do not apply artificial intelligence and apply artificial intelligence late.
12	In general, it can be organized.
13	It can be organized. I don't believe that artificial intelligence is opposed to humans. AI is more of an addition and a helper to humans. Because at present the final operation still has to be completed by human beings, whether it is a diagnosis schedule, a treatment plan, or the actual operation of surgery, AI cannot do it alone. On the patient side, it is also not a problem, because they are the pure beneficiaries. So I don't believe there will be any problem with the organizational process of AI.
14	It can be organized, although it does test the management level of a hospital. I am not worried about the general replacement of human jobs by AI, because AI can only replace some low-end jobs for a long time. For example, the automated guided vehicle in our hospital, which we have seen at Penn Hospital before, can completely deliver the task items to the designated place at any time, which will definitely replace the original porter to a certain extent. But in high-end positions like doctors, it will take a long time for complete replacement.

Expert No.	Quotes of viewpoints
15	There shouldn't be much of a problem in organization. I am not particularly worried about the issue of human-machine conflicts, because some functions cannot be replaced by machines after all.
16	Organizationally there may not be too much of a problem, including threats to humans. Because AI is more of an aid to humans, for example, problems that were originally solved by hardware and craftsmanship methods can now be solved by algorithms, so why not resor to AI. When people's energy is released, they can also do some other things.
17	There may be problems, but in the long run, it is a general trend. Therefore, whether it is for me or most other people, AI will be supported in the long run.
18	In general, the organization is not difficult. In the technical level, it is becoming more and more mature, and the talents are also close to saturation. As for resistance, it is inevitable, but the development trend is difficult to be stopped by individuals or businesses.
19	There is no big problem at this stage. I am not concerned about resistance from people, because people exist to make the results more reliable and the process smoother at this stage. Even if AI technology develops further, those who are replaced will always find new positions. But on the other hand, it is also necessary to strengthen the supervision of artificial intelligence, because although the technology itself is not evil, the people behind the technology still need to be regulated, just as we regulate the cloned technology.
20	At present, it is more of a productivity tool, so people generally welcome it, because there is no need to exclude a more efficient production tool. Future challenges include: 1) balance with privacy; 2) the ability of empathy.
21	Overall, it is not particularly difficult. There will be some problems, such as attribution of responsibility, and morality, but there are ways to solve them.

4.3 Discussion

As mentioned before, the object of research is proper AI technologies in a narrow sense which are currently in the ANI stage of development. The purpose is to study the strategic competitiveness of AI in this stage for ordinary medical organizations.

For this reason, the study introduced the resource-based theory, particularly the VRIO framework as well as dynamic capabilities. The VRIO framework can help the study analyze and evaluate various resources of the organization in detail, so as to identify whether the organization has core resources and what core resources it has.

The "individual expert interview" method was used to study AI, the emerging technology with specialized characteristics. The experts are from all walks of life, and most of them are in the medical industry. They also have qualified working and study experiences. In addition, they were very willing to participate in this interview, which allowed our research to proceed smoothly and achieve desired results.

The results obtained from the interviews are rich, appropriate, and solid. The experts focused on the core proposition of AI's competitiveness, elaborated, and discussed six aspects of AI: definition, application, value, scarcity, imitability, and organizational attribute. The

researchers recorded, organized, and summarized them one by one and presented them before.

The research findings also go beyond this. In this part, the study tried to combine various previous research processes and results, including expert interviews, to draw some concluding opinions. These include how competitive the study thinks AI technologies are in the VRIO framework, and other rewarding results. In this section, the views will be based on, but not limited to interviews.

4.3.1 Resources of strategies

Resource-based theory (RBT) is the basic theory of this research. While getting more details of RBT, discussing about and applying it, the study has fresher and deeper understanding. For instance, the study considers that SWOT analysis, the most widely-used strategic analysis framework at present, seems to be comprehensive, but in practice, it may still make organizations confused and entangled -- where should their strategies start? Which is the dominant factor, the internal environment or the external environment?

In this research, the study prefers an inside-out strategic perspective. That is to say, organizations should first build an overall strategic system with their own resources that can generate sustainable competitive advantages (the study calls them core strategic resources). Because in a fully competitive resource market, it is only the core strategic resources which enjoy the characteristics of VRIO that are likely to bring excess profits or economic benefits. Certainly, not all organizations have core strategic resources, so these organizations need to analyze their own situations, construct, and then consolidate their core strategic resources.

Meanwhile, the study does not believe that external factors are decisive, because specific opportunities or threats in the external environment may not be applicable to or cannot be fully grasped by a certain organization. If the organization uses non-core strategic resources to grasp the opportunities of the external environment, it may fail due to competition or cost. Another situation that needs to be considered is that if the organization has no core strategic resources temporarily after analysis, it needs to construct some. But before or during the construction, it can also refer to factors in the external environment for analysis, so as to make the process of resource construction more targeted and deliver better effect.

As for VRIO framework, the study still regards it as the most effective tool for analyzing organizational resources. However, since the advent of this framework, the economic society has undergone great changes, and thus the understanding of some attributes should also be reconsidered and optimized. To this end, the study proposes the following four aspects of understanding for the VRIO framework: 1) Comparability of values. The value of a certain

resource should be measured against the overall performance of the organization when the resource is not used, instead of some subjective perception. In this research, the study found that once people get used to a particular AI technology, they tend to unconsciously reduce its intelligence, so it is needed to resist the tendency of believing that "more intelligence is actual intelligence" or "endless value equals real value" when making value judgments. 2) Phases of rarity. As the study has pointed out above, rarity of resources should be understood as the actual quantity of a certain resource in a certain region and within a certain industry. Therefore, it is time-sensitive. Previously rare resources may not always be rare, which is one of the reasons why organizations need to conduct periodic evaluation of their own resources. 3) Difficulty of imitation. This can mainly be understood as the difficulty for latecomers to obtain a certain resource, which can be compared to a moat. At this point, we should avoid confusing the quantity of resources with organizational willingness, because the reasons for rareness are diverse and not necessarily because the resources are difficult to obtain. The organization's willingness to acquire a certain resource is also a prerequisite for evaluating difficulty. In addition, the organization's reluctance to introduce a certain resource does not mean that the resource is difficult to imitate. 4) Dynamism of organization. The meaning of "organization" here is closer to the operation and management of a certain resource. During the evaluation of the resource, the study needs to refer to more objective practice of peers, rather than making an illusory and subjective judgment. In addition, the adaptability of enterprises is also a point that needs to be paid attention to. The study hopes that the above understanding of the VRIO framework can contribute to the development of the resource-based theory.

4.3.2 Definition of AI

Another finding of this research is the clear definition of the characteristics of AI. Previous literature has not given clear definition. Here, the study proposes five criteria for determining whether a technology is genuine artificial intelligence in a narrow sense.

The first criterion is the purpose of AI. It should be able to accomplish specific tasks. The second one is perception. AI should be able to perceive external environment and data. The third one is action, which means AI can produce certain results, including physical actions or data. The fourth criterion is planning or thinking, meaning that AI can develop programs or plans according to the purpose. The fifth one, which is the most important, is learning. The criteria mentioned above are not static. They can be continuously optimized according to the actual situation. And the subject of such learning and optimization is the AI system itself, not the programmers behind it.

Here, the study wants to put special emphasis on the learning of AI. The study believes this is what makes AI technologies essentially distinctive from automation or cybernetic technologies. Therefore, the core criterion measuring whether a technology belongs to AI in a narrow sense is not whether its name contains the words “AI” or “robotics”, or whether its functions are powerful and complex enough, but whether it has the ability to learn and optimize on its own.

4.3.3 Competitiveness of AI

The experts interviewed expressed their views on AI as an organizational resource in terms of its performance in VRIO framework. To the researchers’ slight surprise, the experts were basically consistent in their judgment on relevant issues, despite their different academic backgrounds and job positions. The final conclusions are not based on the number of different views. However, the consistency of opinions, and the detailed and supportive elaboration of reasons behind them, do make it easier for the researchers to draw conclusions.

In terms of value attributes, experts argued that AI was undoubtedly valuable to organizations. First, it will reduce human input, such as the supportive role in partly replacing radiologists by AI diagnostic imaging systems. Although it is not common for AI to directly replace humans at this stage, AI can significantly reduce work intensity and pressure of human workers, which can also generate certain economic benefits. Because the reduction in work intensity means that more work can be undertaken, which may reduce the organizations’ need to hire more staff. Another result of reduced intensity is higher job satisfaction. If the study considers job satisfaction as a factor of career experience as well, this also means that employers can appropriately reduce the pay for positions with higher satisfaction. Second, it will improve business quality. For example, the advantages of diagnostic granularity, accuracy and speed in AI imaging diagnosis, or cataract screening by AI system in hospitals of remote areas can make up for the lack of local doctors’ level. Third, it will improve the management level, which includes the market opportunity and research support brought by the brand effect, as well as the deep excavation of patient needs by private hospitals through AI; or the non-differentiated process management through AI to reduce the time lag and moral defects to improve the standardization and smoothness of the process.

In terms of rarity, the research believes that at this stage, AI is still rare because its deployment is relatively costly without producing immediate commercial results. For AI producers, short-term and experimental deployment can be unprofitable. But in the long run, as producers are not charitable organizations, their ultimate and primary purpose is to gain

financial rewards. Therefore, since the AI's function has not yet broken through currently, and the quality is not yet stable, when the number and cost of medical staff is acceptable, hospitals will not be eager to apply AI.

In terms of imitability, the study will observe it from two perspectives: First, the perspective of developers who are the few organizations that provide AI products or services. For them, AI technology obviously has thresholds of entry in technology, teamwork (such as individual quality, group cooperation, and experience) and brand Second, the perspective of users who make extensive use of AI technology in the later stage. For them, AI still has thresholds, including possible procurement targets set by the government or suppliers, and data gathering as the first mover.

The study believes that for scores of users, the thresholds of imitation are more based on data, including their volume, dimension, quality, time periods, and property rights. If an organization can successfully deploy and integrate its AI system, and import bulks of business data into the system so that it can learn and continuously use them on its own, the actual effect of AI application will be constantly enhanced, which constitutes a non-negligible barrier for latecomers. A latecomer may be able to buy a system, but in theory, a 10-year-old AI system with the same amount of data, algorithms and management is more likely to perform better than a five-year-old one. This first-mover advantage may be difficult to eliminate in the case of product homogeneity.

In terms of organizational attributes, the study believes that AI can be organized. At the current stage, it is deployed more as a resource like IT and there will not be a large or insurmountable number of problems in the process. If the researchers look forward and regard AI as a resource that may replace humans, it may indeed cause some resistance or problems, but this is quite far from now and can be solved well eventually, so it may not have much negative impact on applying AI into practice.

According to the VRIO framework, if a resource is not valuable, it may bring competitive disadvantages to the organization because developing and maintaining it may also increase the cost or reduce its revenue. If a resource is valuable but not rare, it may only bring competitive parity. Moreover, if it is not used well, it may also bring competitive disadvantages. If a resource is valuable and rare, it is necessary to assess the difficulty of imitating it. If it is not difficult to imitate, it will bring short-term competitive advantages; if it is difficult to imitate, it may bring sustainable competitive advantages. Organizational attributes are a regulating factor throughout, because the premise of the above three propositions is that the resource can be effectively organized and implemented. In other words, if a resource is valuable, rare, and difficult to

imitate, but if it is not effectively organized, it will not be a source of sustained competitive advantage (Barney & Clark, 2011).

The study analyzes AI with VRIO framework based on the criteria and believe that AI technology is valuable and rare for common organizations. In general, it is hard to imitate and can be effectively implemented by organizations. Therefore, based on the resource-based theory, we consider it as a resource that can generate sustainable competitive advantages.

4.3.4 Risks of AI

The research has also noticed the risks that AI poses for different stakeholders, although this is not the core of this research. This will not only influence AI to perform its competitive role, but also have impact on the long-term development of human beings and society. Indeed, the risks we discuss here, as in the rest of this study, are those in the ANI stage from realistic AI that may replace human jobs in a certain field.

Risks of AI mainly come from three aspects. The first is on the part of the general public, which includes:1) fears of quality. An expert once noted, “Humans will always worry about AI, whether it is not smart enough or too smart.” For instance, the researchers may fear of missed or wrong diagnoses by AI. Because it is widely believed that the human body is a rather complex and personalized system, people will fear that AI’s capabilities may not be sufficient to cope with this complexity. Although the misdiagnosis rate of human doctors is not low, the researchers still worry that AI doctors will miss certain important symptoms, or there will be some serious incidents on the patient. 2) people worry about losing their jobs. Even with slow pace, AI’s ability is still getting stronger, while human ability grows much more slowly in the long evolutionary process. Many people believe that AI will eventually surpasses humans, and, even if AI does not surpass humans in ability, it is enough to have a negative impact on human career prospects, because AI is fatigue-free, rest-free, stable, and unpaid. People do have every reason to fear that their career opportunities will be replaced in large numbers in the future, just as carriage drivers were replaced by cars and parking lot attendants are now replaced by automatic toll systems; 3) people worry about the leak of their privacy. Humans are generating more and more data, but the storage, management, and application of this data is largely detached from us. Meanwhile, businessmen and AI want more privacy. When they have enough data, driven by profit, they can not only sell you commodities and provide you with greater information, but also refuse to provide basic health insurance for people at high lethal risk. What behind this problem is who really owns and uses the data?

The second source of risk comes from corporations or other organizations. They seem to

profit by using AI. By acquiring and deploying AI systems to replace many vulnerable paid humans, they can thus gain more profits. But the risk comes from: 1) accountability issues. The employee's work behaviors are on behalf of the enterprise, but the employee themselves also have independent personalities and need to bear legal responsibility in the professional processes. But for AI, regardless of whether it has independent personality, obviously it cannot independently bear legal responsibilities, so that part of the responsibility which is originally borne by the employee may be transferred to the organization. However, organizations and insurance institutions may not prepare themselves for it; 2) the pressure from CSR. The requirement for CSR and ESG guidelines (Environment, Social, Governance) is becoming more and more demanding. If companies use AI for many occasions, they also need to deal with the resulting problems such as social participation and corporate commitments.

The third source of risk is from the government. They are: 1) how to deal with the possible large-scale unemployment and the resulting adjustment of the social welfare system? Work brings human beings not only material satisfaction, but also spiritual demands such as self-fulfillment. Thus, social stability should always be taken into consideration when it comes to unemployment; 2) how to regulate the development of AI? The study can discuss ANI, but the development of AI is continuous. So, the government need to formulate some principles and laws before problems spring up and strive to reach a general consensus in the world, so that AI will neither become the British automobile industry under the *Locomotive Acts* (known as "Red flag traffic laws") nor the "Terminator of industries". And this matter may be becoming more and more urgent. Many people, including the late scientist Stephen Hawking, well-known entrepreneurs Musk, believe that the development of AI cannot be left alone, because the development of AI has accelerated, and it may already be late when the government realize that it is developing too fast to regulate.

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Chapter 5: Conclusion

In this chapter, a summarized review about the study and prospects will be made. To avoid needless duplication, this chapter will be a brief summary, and most of the contents have been shown in previous chapters in details.

5.1 Summary

This study comes from two academic doubts. One is about the decisive factors in the organizational strategy, that is, where should the organizational strategy start, and what is the decisive factor in the organizational strategy. The study thinks this is a very important issue in Management Science. Because if Management is briefly understood as "integrating resources to achieve goals", three parts should be concluded: 1) strategic management, which determines the path of the organization, including the goals and ways; 2) resource management, which determines the resources of the organization, including human and financial resources; 3) performance management, which determines the process of the organization. Many daily operations of industrial and commercial enterprises are in essence performance management. Of these three parts, strategic management might be the most important, as well as the most initial and decisive. As for the essence of strategic management, as Rumelt, Schendel, and Teece pointed out after the Strategic Management Conference in California in 1990: "the ultimate question that needs to be answered in the field of strategic management is: how to explain the differences in business performance among enterprises and how to improve the operational performance of enterprises will be the touchstone for testing whether a study is in the field of strategic management" (Ma, 2019).

The second is about the technology of artificial intelligence. The study believes this technology is revolutionary and has the potential to lead the next industrial revolution (Wu, 2016). But compared to its importance, the study still knows very little about it. On the other hand, the analysis of the organization's core strategic resources also requires a specific object.

The study attempts to answer the above-mentioned doubts, that is, how is the strategic competitiveness of artificial intelligence technology for organizations. Therefore, the study introduces RBT as well as some of the views on dynamic capabilities as the core theory of this research. RBT mainly believes that differences of performance between enterprises are more

derived from within enterprises, which is called as “the strategy from the inside out”. RBT does not deny the influence of market and external factors such as the SCP paradigm on the strategy and performance of an enterprise, but it believes that internal factors, especially the core resources controlled by the enterprise, are more decisive. One of the reasons is that in a realistic and fully competitive factor market, the cost of developing external factors will be equal to the value that the strategy can create. Therefore, regardless of the competitive landscape of the product market, a purely external strategy may not be sufficient to win a competitive advantage. It is certain that not all resources can be a source of sustainable competitive advantage. Resources must meet the requirements of the VRIO framework to be a source of sustainable competitive advantage, that is, only valuable, rare, non-imitable, and organized resources are the resources that can generate sustainable competitive advantage, which are regarded as core strategic resources.

The research is based on this theory. The study first defines an organization a prevalent legal person or entity in all walks of life, including industrial and commercial enterprises, government and non-governmental organizations. Moreover, both R&D enterprises and application-oriented enterprises are included. As for the research objects, although the research results in vertical fields may be more accurate, the study still hopes that early research on artificial intelligence as an emerging technology will have general applicability and broad representation. Secondly, the study regards AI technology as a resource that an organization may have. The study thinks of resources as things or capabilities under the control of an organization, including capabilities that can change capabilities, i.e. dynamic capabilities. Thirdly, the study has conducted a detailed analysis of artificial intelligence as a resource with VRIO framework, thus to judge its strategic competitiveness, that is, whether it can be used as an organization's core strategic resource.

The study mainly conducts individual interviews with experts. Considering that the study is emerging and professional to some extent, to conduct literature search or questionnaire to the public may not achieve the desired results. Therefore, the study invited 21 industry experts to conduct individual and in-depth interviews. In terms of academic background, all experts have a master's degree, and 81% of them have obtained or are studying for their doctorate. To be specific, 19% of them have obtained a doctorate and 62% are studying for a doctorate. In terms of occupational background, 62% of the experts are from the medical industry and 33% from the scientific research industry such as artificial intelligence. The vast majority of them are senior executives or industry leaders. During the three-month interview cycle, the study conducted individual, face-to-face and in-depth interviews with these experts through video,

with an average duration of 44 minutes, and fully discussed the core proposition of "AI competitiveness". It can be said that excellent expert qualifications, good willingness to participate and proper interview operations have laid the foundation for the interviews to achieve ideal results.

Before making the conclusion of the study, several propositions of the study are highlighted: 1) Productivity. What the researchers study is the competitiveness of artificial intelligence technology for organizations, so the AI technology or system in the study should be in principle productive, not for living lives. 2) Universality. The definition of an organization is broad, including some rare R&D organizations at early-stages, as well as a large number of application-oriented organizations at post-stages. 3) Stages. The researchers are studying the existed artificial intelligence at ANI stage, because AGI and ASI do not currently exist. 4) Timeliness. The study makes subjective judgments on some attributes of the VRIO framework based on the current and local industry conditions. If time passes, the relevant situation will also change, which also requires the study to draw attention in application.

Combining the results of the interviews with the experts, the study believes that artificial intelligence technology is valued for organizations. This value is summed up in the words "more, faster, better, and less", that is, more scenarios, faster speed, better quality, and less labor, among which, in terms of manpower saving and new scenarios, the study believes that the following three scenarios may be more popular. First is about high difficulty, such as big data mining, load handling and other things that people cannot do. Second is about high costs, such as war, aerospace and other fields, or fields where labor costs remain high and the number of personnel cannot be stabilized, which are all about things that people cannot do well, or even if they can do but have to pay a huge price. Third is about high fault tolerance. In the current stage where AI technology is not yet fully mature, some fields with high fault tolerance rate or error correction mechanism may be more prioritized in application.

As for the rarity, the study believes that current AI technologies are rare for organizations. The study has discussed some specific reasons before, including the organization's willingness to use it. Willingness to use is the degree to which an organization is willing to further purchase and deploy an AI system after the organization fully understands it. "Economic tipping point" is also an important factor, including the following two aspects. First is about the comparison between the procurement cost of the system and the use cost of manpower. Due to the possible risks in the early use of advanced technology, only when the cost of the system far exceeds the cost of manpower it can replace, or if the payback period is short enough, organizations are more willing to introduce the AI technology. Secondly, in the context of carbon neutrality, this

tipping point will also not be purely a comparison of financial data, and may also include an assessment of the resources consumed by large-scale computing in the future. For instance, large amount of electricity and hydropower is consumed in the process of mining cryptocurrencies.

In terms of the non-imitable attribute, the study believes that there exist competition barriers for both R&D enterprises and application-oriented enterprises. The barriers of R&D enterprises are mainly based on technology and team, while the barriers of application-oriented enterprises mainly come from the quality and accumulation of data. In addition, the organizational application of AI strategy also has a first-mover advantage. R&D enterprises can use this to accumulate talents, technologies and brands. If application-oriented enterprises can accumulate data earlier, they can also strengthen the effectiveness of AI systems. As some experts interviewed said, "In the future, AI will not eliminate humans, but humans who use AI will eliminate humans who do not use AI."

The study thinks AI can also be organized. Although experts are very optimistic about the AI threat, the study still discusses some of the possible risks. The study believes that the development of AI technology is accelerated and irreversible. Over time, it is likely to have a huge impact on human society in terms of occupational replacement and privacy protection. In particular, the government should draw attention and supervise it as soon as possible. Supervision is not for restrictions, but for more disciplined and safer development of AI.

Based on the RBT theory including the classic VRIO analysis framework and the above analysis of the VRIO attributes of artificial intelligence, the study believes that artificial intelligence technology is a core strategic resource that can generate sustainable competitive advantages for current organizations. The study believes that AI is a trend and a way of thinking. Even in some areas where manpower is relatively abundant and cheap, AI strategies can still help organizations develop business and markets, improve quality and efficiency, and optimize processes and management. Therefore, the research hopes that more organizations will grasp the trend and embrace AI early.

5.2 Gains

The research gains include the following three aspects.

First, the study has a more comprehensive and in-depth understanding of strategy and management. Through research, the researchers fully understand the importance of management. The role of management in the development of modern society and economy is

significant, but there generally lacks understanding of its importance in society, especially in China where the "official-standard" culture is relatively strong. People may take it for granted that "everyone knows how to be an official", "everyone can carry out management", or "management is not a difficult thing". However, in fact, it is not the truth. 1) Management is a very professional discipline with a large number of theories, paradigms, models and methods. Organizations or individuals who do not understand these theories and methods will find themselves in the middle of nowhere in daily operations. 2) Management is also an application-oriented and interdisciplinary subject, it has close ties with other disciplines and industries, and requires managers to be able to master all the elements, which also increases the difficulty in practical application of management. 3) Management requires relevant people to organize resources to achieve goals, including human resources, Managers do things through people, and people are often very complicated, because they have their own background, ideas, life, and emotions. Therefore, how to use corresponding methods to effectively utilize various human resources and other resources and maximize their role is very important and not everyone can get it done well.

The study also recognizes the importance of strategy. People have always believed that management practice has three elements - strategy, resources, performance. Liu Chuanzhi, the founder of Lenovo, once said a similar expression that he believes that there are three elements of management - "building a team, setting a direction, and leading a team". Strategy is the direction and goal; resources are the team and driving force; performance is the implementation and process. The three complement each other and are indispensable to each other. Among them, strategy is the most important, because 1) in the process of practice, strategy is the earliest operation process of the organization, and the sequence is often to set the direction first, build the team, and then lead the team; 2) as for the impact on outcome, strategy has the biggest influence. If the direction is wrong, no matter how good the others are, it is useless. The old Chinese saying "to try to go south by driving the chariot north" is just the case in point; 3) in terms of the skills required, strategy requires the most. It requires not only theory, but also practice. It requires not only diligence, but also comprehension and even luck.

Through research, the researchers also have a clear understanding of the theoretical development path of strategic management. Strategic management starts with differences in corporate performance and its promotion. The earliest and systematic theories are the SCP paradigm and the five forces model which focus on the external environment. They believe that the performance of enterprises is determined by the environment and its positioning. This has obvious limitations. This is especially true after Barney proved that in a fully competitive factor

market, even if an organization successfully implements a market strategy, it cannot obtain excess economic returns due to resource costs.

Therefore, the theoretical perspective of strategic management has shifted to the inside of the organization, and the resource-based theory is the representative of it, as well as the capability theory. Of course, the study can also consider capabilities, including dynamic capabilities, as a special kind of resource. They believe that organizational performance is determined by the core resources they have. However, the classic resource-based theory, like SCP and other theories, is too static and extreme, separating the external environment from internal resources, so it is still unable to fully explain organizational performance.

The emergence of dynamic capabilities makes up for this deficiency well. As a high-level capability, dynamic capability can adjust its own resources, capabilities, and processes, so that the organization can better adapt to the external environment. If dynamic capability is regarded as a kind of resource possessed by an organization in a broad sense, it constitutes the most comprehensive and scientific source of sustainable competitive advantage together with the organization's material resources and capability resources. At the same time, it also integrates the inside and outside of the organization well. It is not said that organizational performance cannot be determined by a single factor, including a single external, or a single internal factor, but in fact, a single factor cannot completely determine the success or even failure of an organization. A successful organization requires high-quality, VRIO-compliant core resources, as well as application of such resources to external markets and responsiveness to changes in them.

From the perspective of the study, first of all, the study still agrees that resources and capabilities within an organization are the most critical factors in organizational performance. But at the same time, the study also tends to embrace a new resource-based view called VRIDc, which uses dynamic capability Dc to interpret and replace the organization in the original VRIO, making it completer and more scientific.

The second gain is the understanding of the competitiveness of artificial intelligence. The study introduced resource-based theory and dynamic capabilities to conduct a comprehensive analysis of artificial intelligence. It is believed that artificial intelligence is first of all in line with the VRIO framework of traditional resource-based theory, so it is a high-quality, core resource that can be used to build organizational strategies. At the same time, by examining AI technology from the perspective of dynamic capabilities, the study also found that the learning, thinking and other characteristics of AI technology also have obvious features of dynamic capabilities. Therefore, it is reasonable to believe that the deployment and application of AI

technologies by organizations may build or strengthen the organizations' own dynamic capabilities, thereby further improving their performance and competitive advantage. From this perspective, it can also be said that dynamic capabilities are one of the key reasons why AI technologies or organizations applying AI technologies have a competitive advantage.

The third gain is the mastery and practice of scientific research methods, especially qualitative research methods. Quantitative research methods commonly used in the natural sciences have certain limitations in such social science, up-to-date and profound research, such as the contradiction between the number and quality of samples, and the more complex issues of causality and propositions. The research proceeds from the identification of predicament, the determination of the research model through literature review, the use of qualitative research methods based on expert interviews, the detailed presentation of the research process, research data, and research results, to the discussion of the final conclusion, and all the parts are linked with one another. This is also one of the gains.

5.3 Limitations

Like many things in the world, the research is not perfect. The research may have the following limitations.

Firstly, one of the starting points of this research is the origin of strategy. Therefore, the review and research on the framework and starting point of strategic management are slightly insufficient. It is also slightly awkward to use the theory of "dynamic capability", which is almost parallel to the resource-based theory. Secondly, in terms of the definition of organization, it may achieve more practical significance if the study focuses on studying a large number of application-oriented enterprises. Third is about the composition of experts and the depth of interviews. Expert resources are a very rare and valuable resource. But if the study can balance the expert backgrounds in three aspects: management, business, and technology, it may also help to obtain more extensive and diverse information. Last but not least, the study has focused on the judgment of VRIO attributes and covered more reasons for segmentation, but the depth of discussion and analysis can be improved.

5.4 Prospects

In many years of management practice and research, the scholars have always believed that management is an important discipline with great practical significance. Among many fields of

management, the researchers have a soft spot for strategic management, and the research, the researchers' resume and expertise are all closely related to strategic management.

For future plans, in addition to consolidating the findings of this study on the "resource of strategy", the researchers also hope to extend to the entire field of strategic planning. The researchers believe that in the field of strategic planning, the current literature is rich but singular, classic but outdated, meticulous but academic-oriented. The researchers hope to have the opportunity to study strategic planning method for the new economy at practical levels. The researchers would like to call it "method of strategy", including, but not limited to, recourse. The researchers believe it is equally important and meaningful.

Furthermore, the researchers will conduct further research on the artificial intelligence technology. As mentioned, the researchers believe that artificial intelligence is a new technology, a new way of thinking, and a new opportunity. The researchers hope to further study its application and performance in vertical fields. As mentioned before that for technologies such as artificial intelligence, it does not make much sense to talk about it in general terms, and it must be deepened into a specific type of application. This reminds the researchers of a saying in the industry about competitive strategy, which is "I should have one when others do not; I should have good quality when others have one; I should lower the product price when others have good quality; and I should leave if all of others lower the price". The study thinks that AI will be more advanced and easier to deploy in some areas where "others do not have one" than "others have one". For example, in the field of securities investment, traditional methods are completely unable to deal with such complex data, but would it be possible for artificial intelligence to do so? The study hopes to start similar research, which will be a combination of business models of investment management and artificial intelligence technology, and also a new technology to solve ongoing problems, and become a classic case of management and economics problems. Faced with such opportunities and challenges, it is difficult for the researchers to restrain the excitement and desire!

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