

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SUMY NATIONAL AGRARIAN UNIVERSITY

ECONOMICS AND MANAGEMENT FACULTY

Accounting and Taxation Department

QUALIFICATION WORK

education degree - Master

**on: Improvement on the core competitiveness of Chinese central
management enterprises**

Zhang Rui

Completed: student of

073 «Management» (EP «Administrative Management»)

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SUMY NATIONAL AGRARIAN UNIVERSITY

Faculty Economics and Management
Department Accounting and Taxation
Education degree «Master»
Speciality 073 Management EP «Administrative management»

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_____ 2024

TASK

on thesis for student

Zhang Rui

1. Theme of Thesis: *Improvement on the core competitiveness of Chinese central management enterprises*

Supervisor Yarmila Tkai, Ph.D., Associate Professor

approved by the university from

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2. Deadline for student completed project (work)

March, 10 2025

3. Background to the project (work):

With the popularization and spread of higher education in China, private colleges and universities, as a new force in higher education, have achieved rapid development in the past two decades. The number and scale of private colleges and universities are increasing day by day, which compensates for the demand for multi-skilled, multi-disciplinary and multi-level personnel for economic development, and provides a large number of applied, technical and skilled talents for society. However, China's private colleges and universities still face great challenges. This study analyzes the problems of staffing and addresses the issues of structure optimization.

4. Contents of settlement and explanatory notes (the list of issues to develop):

This study substantiates the theoretical foundations for optimizing the structure of human resources. The current state of the human resource potential of the studied university is analyzed. Changes in the structure of the university's human resources potential are evaluated in the dynamics, a SWOT analysis of the human resources structure is carried out. The main problems existing in the personnel structure are identified, and proposals for optimization are specified

5. Date of assignment:

December, 20 2023

CALENDAR PLAN

	Name of the diploma project's stages	Dates of project stages performance	Note
1	Definition and approval of the thesis, preparation of the plan - schedule of work	<i>December, 2023</i>	done
2	Selection and analysis of literary sources, the preparation of the first theoretical chapter	<i>December, 2023</i>	done
3	Preparation and presentation of draft of the first chapter of the thesis	<i>February 2024</i>	done
4	Collection and processing of factual material, synthesis analysis of application issues in the enterprise	<i>March 2024</i>	done
5	Making the theoretical part of the thesis, summarizing the analytical part	<i>April 2024</i>	done
6	Design options improve the research problem	<i>May 2024</i>	done
7	Completion of the project part of the thesis, design chapters	<i>May 2024</i>	done
8	Previous work and its defense review	<i>December, 01-02 2024</i>	done
9	Checking the authenticity of the thesis	<i>February, 20-28 2025</i>	done
10	Deadline for student completed the thesis	<i>March, 01 2025</i>	done
11	Defense of the thesis	<i>March, 09 2025</i>	done
12	Definition and approval of the thesis, preparation of the plan - schedule of work	<i>March, 25 2025</i>	done

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ABSTRACT

Zhang Rui. Improvement on the core competitiveness of Chinese central management enterprises

**Qualification work in the specialty 073 «Management»
EP «Administrative Management», SNAU, Sumy. 2025 Manuscript.**

As a core enterprise in the field of nuclear power construction in China, China National Nuclear Corporation (CNNC) is currently at a critical stage of national strategic drive, intensified industry competition, and intertwined development bottlenecks. The support of national policies provides a solid guarantee for the sustainable development of enterprises, while technological innovation, management upgrading, and international expansion are the core paths for enterprises to break through bottlenecks and achieve high-quality development. In the future, China's nuclear construction industry needs to actively respond to industry competition, solve development problems, further enhance the technological level and international competitiveness of nuclear power plant construction under the guidance of national strategy, and make greater contributions to promoting China's energy structure transformation and global green and low-carbon development.

Keywords: competitiveness, state-owned enterprises, brand effect, enterprise production capacity.

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INTRODUCTION

Topic relevance. Against the backdrop of global energy structure transformation and accelerated progress towards carbon neutrality goals, nuclear energy, as a clean, efficient, and stable form of energy, is becoming an important development direction driven by national strategies. As a leading enterprise in the field of nuclear power construction in China, China National Nuclear Corporation (CNNC) shoulders the important mission of promoting the implementation of the national energy strategy and assisting in the achievement of the "dual carbon" goals. In recent years, with the deepening of the national strategy of "actively, safely, and orderly developing nuclear power", China National Nuclear Corporation has made significant achievements in the field of nuclear power plant construction. However, it also faces multiple challenges such as intensified industry competition, technological upgrading pressure, and bottlenecks in enterprise development.

From the perspective of national strategic drive, nuclear power has become an important pillar for China's energy structure adjustment and green low-carbon development. The national "14th Five Year Plan" and the 2035 long-term goal outline clearly state the need to "safely and steadily promote the construction of coastal nuclear power" and accelerate the construction of a new power system with new energy as the mainstay. In this strategic context, China National Nuclear Corporation (CNNC), as the main force in China's nuclear power engineering construction, undertakes the construction tasks of the vast majority of domestic nuclear power plants. Its technical strength and engineering management capabilities directly affect the implementation effect of the national nuclear power strategy. At the same time, the in-depth promotion of the "the Belt and Road" initiative also provides new opportunities for the international development of China's nuclear construction, and promotes China's nuclear power technology and standards to the world.

However, from the perspective of industry competition, the global nuclear

power construction market is showing characteristics of accelerated technological upgrading and reshaping of the competitive landscape. On the one hand, third-generation nuclear power technology (such as the "Hualong One") has become mainstream, and emerging technologies such as fourth generation nuclear power technology and small modular reactors (SMR) are also rapidly developing, which puts higher technical requirements on nuclear power construction enterprises. On the other hand, the competition in the international nuclear power construction market is becoming increasingly fierce. Developed countries in Europe and America occupy the high-end market with their first mover advantage and technological barriers, while emerging economies attempt to achieve breakthroughs in the nuclear power field through technology introduction and cooperation. Although China National Nuclear Corporation has made significant progress in technological self-reliance and engineering practice, it still faces competitive pressure in the international market in terms of technical standards and brand influence. In addition, the domestic nuclear power construction market has also shown a diversified competitive pattern, with other energy central and private enterprises gradually entering the nuclear power construction field, further intensifying industry competition.

From the perspective of the bottleneck of enterprise development, while China National Nuclear Corporation is rapidly developing, it is also facing a series of urgent problems that need to be solved. Firstly, nuclear power plants have a long construction cycle, large investment scale, and high technical complexity, which puts enormous pressure on enterprises in project management, cost control, and risk prevention. Secondly, with the continuous upgrading of nuclear power technology, the demand for high-end technical talents in enterprises is becoming increasingly urgent, but the mechanism for talent cultivation and introduction still needs to be further improved. In addition, the public's attention to nuclear safety and environmental issues such as nuclear waste disposal have also raised higher requirements for corporate social responsibility and brand image. At the same time, the rapid advancement of renewable energy technology and the deepening of electricity marketization reform have posed challenges to the competitiveness of

nuclear power in the electricity market. Enterprises need to further enhance the economy and flexibility of nuclear power plants while ensuring safety.

In summary, as a core enterprise in the field of nuclear power construction in China, China Nuclear Construction is currently in a critical stage of national strategic drive, intensified industry competition, and intertwined bottlenecks in enterprise development. The support of national policies provides a solid guarantee for the sustainable development of enterprises, while technological innovation, management upgrading, and international expansion are the core paths for enterprises to break through bottlenecks and achieve high-quality development. In the future, China's nuclear construction industry needs to actively respond to industry competition, solve development problems, further enhance the technological level and international competitiveness of nuclear power plant construction under the guidance of national strategy, and make greater contributions to promoting China's energy structure transformation and global green and low-carbon development.

The purpose and objectives of the master's work. The purpose of this study is to analyze the improvement of the core competitiveness of Chinese central management enterprises and enhance the competitiveness of China National Nuclear Corporation Limited

There are tasks for qualification work:

1. Define the main concepts and theoretical foundations.
2. Analysis of Working Mode of China Nuclear Construction Corporation Limited
3. Empirical research on the core competitiveness of nuclear power plant construction
4. Develop a model to improve the efficiency of core competitiveness
5. Propose strategies to enhance core competitiveness in centrally managed enterprises in China.
6. Evaluate the practical significance of improving the core competitiveness of enterprises.

The author's research mainly includes parts:

Theoretical Significance. This study comprehensively explores the core competitiveness and improvement path of China National Nuclear Corporation in nuclear power plant construction by defining core concepts, analyzing work modes, empirically studying core competitiveness, developing efficiency models, proposing strategic recommendations, and evaluating practical significance. The research results not only provide theoretical support and practical guidance for the sustainable development of China Nuclear Construction, but also offer valuable experience and strategies for other centrally managed enterprises to enhance their core competitiveness.

The object of the study is the enhancement of the core competitiveness of China National Nuclear Corporation Limited in China's central management enterprises.

The subject of the study is taking China National Nuclear Corporation Limited as the research object, analyze its core improvement through organization. The data collection methods include questionnaire surveys, statistical analysis, and literature reviews. China National Nuclear Corporation has formed significant core competitiveness in the field of nuclear power plant construction through technological innovation, management optimization, and resource allocation, providing successful experience for Chinese central management enterprises to learn from. In the future, enterprises need to continuously strengthen technological innovation, optimize management models, and deepen international cooperation to maintain a leading position in global competition. At the same time, central management enterprises should learn from the experience of China Nuclear Construction Corporation, combine their own characteristics, formulate scientific strategies to enhance their core competitiveness, and make greater contributions to achieving national strategic goals and high-quality development.

The information base. The information basis of the research is scientific works on the selected topic, data from major foreign experts and official reports of enterprises, as well as existing statistical information.

The significance of this research. The significance of this study lies in its

exploration of the path to enhance the core competitiveness of Chinese centrally managed enterprises, with China National Nuclear Corporation as the core. It has important theoretical value and practical significance. The research results not only provide scientific basis and practical guidance for the sustainable development of China Nuclear Construction, but also offer valuable experience and strategies for other centrally managed enterprises to enhance their core competitiveness. At the same time, research has made positive contributions to the implementation of national energy strategies and the achievement of global green and low-carbon development goals by promoting technological progress and international development in the nuclear power industry.

Approbation of the results. The scientific provisions of the main research results, conclusions and recommendations were reported and received a positive evaluation at the Scientific and practical conference of teachers, graduate students and students of the Sumy NAU.

Publications. The main provisions of the qualification work were published in 2 theses of scientific conferences.

Structure and scope of work. The qualification work consists of an 15 introduction, three sections, conclusions and proposals, a list of used sources from 79 titles, appendices. The main text is laid out on 60 pages of computer text, the work contains 7 tables, 7 figures, 36 appendices.

CHAPTER 1

SUMMARIZE RELEVANT CORPORATE STRATEGIC CONCEPTS

1.1 The history of China National Nuclear Corporation

The history of China National Nuclear Corporation can be traced back to the early days of the founding of the People's Republic of China, when a group of construction teams related to the nuclear industry were gradually formed to meet the needs of national defense construction and nuclear energy development. In 1955, China made a strategic decision to develop its nuclear industry. Subsequently, the nuclear industry construction team devoted themselves to the construction of nuclear military bases, making immortal contributions to China's "Two Bombs and One Satellite" cause. Under difficult conditions, the builders, with their tenacious will and professional skills, successfully built multiple important nuclear facilities. These early construction practices accumulated valuable technical and management experience for China's nuclear construction and laid the foundation for its position in the field of nuclear industry construction.

In July 1999, based on some enterprises and institutions under the former China National Nuclear Corporation, China Nuclear Industry Construction Group Corporation was officially established, becoming a large state-owned important backbone enterprise under central management and a nationally authorized investment institution. It is also one of the top ten military industrial groups in the defense science and technology industry. Afterwards, China Nuclear Engineering Corporation opened a new chapter of development and continued to make efforts in the field of nuclear power engineering construction. In 2005, China National Nuclear Corporation (CNNC) undertook the construction task of Sanmen Nuclear Power Plant, the first third-generation nuclear power technology AP1000 project in China. This project was a major technological leap in China's nuclear power construction field, and CNNC overcame multiple technical difficulties during the project

construction process, laying a solid foundation for the localization and independent development of China's third-generation nuclear power technology.

On December 21, 2010, China National Nuclear Corporation, together with China Cinda Asset Management Co., Ltd., Aerospace Investment Holdings Co., Ltd., and China Guoxin Holdings Co., Ltd., jointly initiated the establishment of China National Nuclear Corporation Limited to promote the restructuring and listing of its main business. On June 6, 2016, China National Nuclear Corporation successfully listed on the A-share market (stock code: 601611), marking the rise of China National Nuclear Corporation in the capital market and providing a broader source of funding and capital operation space for the company's further development.

On January 31, 2018, with the approval of the State Council, China National Nuclear Corporation (CNNC) and China National Nuclear Construction Corporation (CNNC) underwent a restructuring, and CNNC as a whole was transferred to CNNC without compensation, no longer directly supervised by the State owned Assets Supervision and Administration Commission (SASAC). This restructuring has further optimized the layout of China's nuclear industry, achieving effective integration and coordinated development of resources. In the process of development after restructuring, China Nuclear Construction fully leverages its professional advantages in the field of nuclear power engineering construction, continuously expands its business scope, and actively participates in major nuclear power projects and industrial and civil engineering construction projects at home and abroad.

In the nuclear construction industry, China Nuclear Construction is undoubtedly a leading enterprise. In terms of market share, as of the end of 2017, there were 58 nuclear power units under construction worldwide, of which China National Nuclear Corporation was responsible for the construction of 21 units, accounting for 36% of the world's under construction nuclear power units. In China, both completed nuclear power units and under construction nuclear power units have undertaken important construction tasks. At present, the total installed capacity of nuclear power generation in China accounts for a certain proportion of the country's total installed capacity of nuclear power generation, and the annual power generation

of nuclear power also accounts for a certain share of the country's total power generation. The leading position of China National Nuclear Corporation in nuclear power engineering construction plays a key role in promoting the development of China's nuclear power industry.

The industry position can also be seen from the newly signed contract amount and revenue growth data. From 2019 to 2023, the company's newly signed contract amounts were 97.08 billion yuan, 109.945 billion yuan, 124.167 billion yuan, 139.047 billion yuan, and 150.637 billion yuan, respectively, with year-on-year growth of 10.4%, 13.25%, 12.94%, 12%, and 8.34%, showing a sustained growth trend. In the first nine months of 2024, the company achieved a total of 106.732 billion yuan in newly signed contracts, an increase of approximately 10.777 billion yuan compared to 95.955 billion yuan in the same period of 2023, with a year-on-year growth rate of approximately 11%. In terms of operating income, from 2017 to 2023, the company achieved operating income of 45.33 billion yuan, 51.36 billion yuan, 63.59 billion yuan, 72.8 billion yuan, 83.72 billion yuan, 99.14 billion yuan, and 109.4 billion yuan respectively, an increase of 9.49%, 13.28%, 23.83%, 14.48%, 15.00%, 18.42%, and 10.34% year-on-year. In the first nine months of 2024, the company achieved a cumulative operating revenue of 78.611 billion yuan, which is basically the same as the 78.59 billion yuan in the same period last year. The continuously increasing amount of newly signed contracts and steady revenue growth indicate that China Nuclear Construction has strong ability to attract orders and expand its business in the market, maintaining a leading position in the nuclear construction industry. The specific data is shown in Figures 1.1 and 1.2 below:

In the entire construction industry, China Nuclear Construction also holds an important position. As a large state-owned listed enterprise, relying on its advanced technology, rich experience, and strong engineering management capabilities accumulated in the field of nuclear power engineering construction, it has expanded its industrial and civil engineering construction business and achieved good performance in multiple fields.

Year	Percentage
2023	21%
2022	19%
2021	17%
2020	15%
2024 (First 9 months)	15%
2019	13%

Figure 1.1 – Data Analysis of Newly Signed Contracts by China National Nuclear Corporation limited

Source.created by author based on [14,15]

Year	Percentage
2023	18%
2022	16%
2021	14%
2024 (First 9 months)	13%
2020	12%
2019	11%
2018	9%
2017	8%

Figure 1.2 – Data Analysis: Annual Operating Revenue of China National Nuclear Corporation Limited

Source.created by author based on [14,15]

The professional strength and market share in the construction and installation industry make it an important participant in the industry, and its development strategy and business dynamics have a certain influence on the overall development trend of the construction industry. China National Nuclear Corporation's position in the industry is not only reflected in its business scale and market share, but also in its important role in industry standard setting, technological innovation leadership, and other aspects.

The origin of the theory of core competitiveness can be traced back to the profound theoretical soil of economics and management. From an economic perspective, its origins can be traced back to the classical economist Adam Smith's theory of division of labor. In 1776, Adam Smith proposed in "The Wealth of Nations" that the nature and degree of division of labor within a company are the main factors limiting the benefits of economies of scale, which in turn determine the limits of the company's growth. This theory laid the foundation for the later views on the accumulation of internal resources and capabilities in the theory of core competitiveness of companies.

In the development process of enterprise strategic management theory, the theory of core competitiveness gradually emerged. From the 1960s to the 1990s, strategic management theory evolved from a positioning school primarily focused on environmental analysis to a resource-based and dynamic capability view primarily focused on analyzing internal resources and capabilities within the enterprise. In 1990, American scholars C.K. Prahalad and G. Hamel published an article titled "The Core Competence of Enterprises" in the Harvard Business Review, marking the formal birth of the theory of core competence. They defined core competence as "the shared knowledge within an organization, particularly on how to coordinate different production skills and organically integrate multiple technological flows". Subsequently, numerous scholars have conducted research on core competitiveness from different perspectives, forming various theoretical viewpoints.

Based on the theory of core competitiveness based on the knowledge perspective, represented by Dorothy Leonard Barton, it is believed that core

competitiveness refers to the proprietary knowledge and information of a company that has unique characteristics and is not easily leaked; The core competitiveness theory based on the resource-based perspective, represented by Christine Oliver, emphasizes the role of resources and capabilities in enabling enterprises to achieve high profit returns and sustained competitive advantages; The theory of core competitiveness based on organizational and systems perspectives, represented by Coombs, advocates that core competitiveness is the organic combination of different management systems, goal and value systems, structural systems, and social psychological systems of an enterprise; Based on the theory of core competitiveness from a cultural perspective, represented by Raffa and Zollo, it is pointed out that the accumulation of a company's core competitiveness is hidden in its culture and permeates the entire organization. It is an organic combination of technological core capabilities, organizational core capabilities, and cultural core capabilities.

With the passage of time, the theory of core competitiveness has continuously developed and improved, and its application scope has gradually expanded from the initial field of enterprise strategic management to various industries and fields, becoming an important theoretical basis for enterprises to seek survival and development in fierce market competition.

Core competitiveness is composed of multiple key elements that interact with each other to jointly support a company's competitive advantage in the market.

Technical elements are a key component of core competitiveness. It covers the research and development capabilities, technological innovation capabilities, and technological application capabilities of enterprises. Strong research and development capabilities enable enterprises to continuously introduce new products and technologies to meet the diverse needs of the market. For example, Huawei continues to invest in research and development in the field of communication technology, with a large number of patented technologies. Its 5G technology is at the world's leading level, which has given Huawei a huge competitive advantage in the global communication market. Technological innovation capability drives enterprises to continuously improve existing technologies, enhance production efficiency, and

improve product quality. Apple has continuously launched innovative electronic products with its innovative design and technology, leading the trend of the global consumer electronics market.

Quantitative comparison of risks and opportunities			
No.	Dimension	Risk Indicators	Opportunity Indicators
1	Policy Dependence	Nuclear power approval cycle extension (2024 new approval fleet ↓15%)	"Dual Carbon" target to boost nuclear power installed capacity (2035 target 200 million kW)
2	Cost Control	Steel price fluctuations impact gross margin (sensitivity coefficient 0.8)	Modular construction techniques reduce labor costs by 30%
3	Internationalization	Geopolitical risk (overseas project ↓2.3%)	"Belt and Road" nuclear power project reserves exceed 50 billion
4	Summary Calculation and Analysis	Sustainability of growth: 5-year CAGR for nuclear power engineering revenue is 14.45%, CAGR for new energy business is 41.2%, with significant dual engine drive Reasonability of valuation: The current dynamic PE is 13.35 (industry average 18.2), PB is 1.29 (industry average 1.8), and there is room for valuation repair Debt safety margin: current ratio of 1.28 (Q3 2024), interest coverage ratio of 3.5X, stable debt paying ability	

Figure1.3 – Quantitative comparison of risks and opportunities

Source.created by author based on [14,15]

Management elements play a crucial role in enhancing the core competitiveness of enterprises. Effective management can optimize the allocation of resources in enterprises and improve operational efficiency. Including strategic management capabilities, enterprises provide strategic guidance for the construction

of core competitiveness by formulating scientific and reasonable strategic plans, clarifying development directions and goals. For example, Alibaba has developed a diversified development strategy, starting from e-commerce and gradually expanding into multiple fields such as finance, logistics, and cloud computing, creating a strong business ecosystem and enhancing the company's core competitiveness. Organizational management capability ensures a reasonable organizational structure, clear division of labor, and efficient collaboration among departments within the enterprise. The lean production management model adopted by Toyota Motor Corporation has become a management model in the automotive industry by optimizing production processes, reducing waste, and improving production efficiency and product quality.

1.2 The fundamental element of a company's core competitiveness

Talent is the fundamental element of a company's core competitiveness. Excellent talents possess professional knowledge, skills, and innovative thinking, which can provide intellectual support for the development of enterprises. Enterprises need to attract, cultivate, and retain high-quality talents, and establish a competitive talent pool. For example, Google has attracted a large number of outstanding technology talents from around the world with its good corporate culture, generous welfare benefits, and broad development space. These talents have made important contributions to Google's development in search engines, artificial intelligence, and other fields. The innovative ability of talents can drive enterprises to constantly break through tradition, develop new products and services, and enhance their market competitiveness.

Brand elements are the external manifestation of a company's core competitiveness. A good brand image can enhance a company's visibility and reputation, and strengthen consumers' trust and loyalty to its products or services. For example, as a globally renowned brand, Coca Cola has extremely high brand value, and consumers have a strong sense of identification and loyalty to Coca Cola's

products. Even in fierce market competition, Coca Cola can still maintain a high market share with its brand advantage. Brands can also bring premium effects to businesses, enabling them to gain higher profits in the market.

The application of core competitiveness theory in the construction industry has unique features. Compared with other industries, products in the construction industry have characteristics such as singularity, long production cycle, and high investment, which make the composition and manifestation of core competitiveness different.

In terms of technology, the technological innovation in the construction industry is not only reflected in building materials, construction processes, etc., but also includes the application of emerging technologies such as Building Information Modeling (BIM) technology and prefabricated building technology. BIM technology can achieve digital design, construction, and management of construction projects, improving project collaboration efficiency and quality; Prefabricated building technology can improve the efficiency and quality of construction, and reduce environmental pollution during on-site construction. For example, some large-scale construction projects in Shanghai have adopted BIM technology to establish 3D models for visual design and simulation analysis of building structures, equipment pipelines, etc., in order to detect and solve problems in advance, greatly improving the construction efficiency and quality of the project.

In terms of management, project management in the construction industry is crucial. Due to the involvement of multiple parties and professional fields in construction projects, project management capabilities directly affect the progress, quality, and cost of the project. Construction companies need to have excellent project management teams that can effectively coordinate resources from all parties to ensure the smooth implementation of projects. For example, China State Construction Engineering Corporation has established a sound project management system and adopted advanced project management methods and tools in numerous large-scale engineering projects, achieving effective control over project progress,

quality, and cost, and enhancing the competitiveness of the enterprise in the construction market.

In terms of talent, the construction industry requires various professional talents, including architects, structural engineers, cost engineers, project managers, etc. These talents not only need to possess solid professional knowledge and skills, but also need to have good communication skills, teamwork skills, and the ability to solve practical problems. For example, in some large-scale construction projects, the project manager needs to have rich project management experience and coordination skills, be able to lead the team to overcome various difficulties, and ensure that the project is completed on time and with quality.

Core Business Structure Analysis (2023-2024)					
Serial Number	Business sector	2023 Revenue Proportion	Proportion of revenue in the first three quarters of 2024	Growth contribution rate	Key driving factors
1	Nuclear power engineering	0.2187	0.235	0.082	22 units under construction worldwide (43%)
2	New energy (wind power/photovoltaic)	0.153	0.181	0.93	Double the year-on-year increase in installed capacity
3	municipal engineering	0.147	0.168	0.22	The release of infrastructure policy dividends
4	other business	0.4813	0.416	-0.054	Strategic focus on core areas

Figure 1.4 – Core Business Structure Analysis (2023-2024)
Source.created by author based on [11]

In terms of brand, the brand image of construction enterprises is often closely related to the quality and reputation of the project. A successful construction project can establish a good brand image for the enterprise, attract more customers and projects. For example, the Beijing Bird's Nest, as the main stadium of the 2008 Beijing Olympics, was constructed by China State Construction Engineering Corporation and other units. Its unique design and high-quality construction have won widespread praise at home and abroad, and have also established a good brand image for China State Construction Engineering Corporation, enhancing its competitiveness in the international construction market.

China National Nuclear Corporation has significant advantages in nuclear power construction technology and has mastered a series of advanced technologies. In the technology of pouring large volume concrete, with the upgrading and iteration of nuclear power reactor types, the volume of the bottom plate of nuclear power plants continues to increase, such as from over 4000 cubic meters of M310 reactor type bottom plate to 15000 cubic meters of CAP1400 reactor type. China National Nuclear Corporation has innovated on the basis of the original layered and segmented pouring process for the bottom plate. Through simulation calculations, dynamic maintenance monitoring, and other technological applications, it has solved the difficulties of temperature control, crack control, and compactness inspection in pouring. It has created multiple records in China, including the longest and widest bottom plate pouring of nearly 15000 cubic meters at once, ensuring that no temperature cracks occur and meeting the high standard requirements of third-generation nuclear power for large volume concrete construction in terms of technology, safety, reliability, construction period, and economy.

In the field of large-scale modular construction technology, China Nuclear Construction closely follows international advanced concepts, completing module production for some of the construction work of nuclear power plants in a factory environment, and then transporting them to the construction site for assembly. This technology not only improves construction efficiency, reduces the impact of on-site construction time and uncertainty factors, but also enhances construction quality, as

production conditions in factory environments are easier to control and manage. Compared with other international nuclear power construction companies, China National Nuclear Corporation's large-scale modular construction technology is in a leading position in terms of application scope and maturity, and can efficiently complete various complex module construction tasks, providing strong guarantees for the smooth progress of nuclear power projects.

In terms of advanced automated welding technology, China National Nuclear Engineering Corporation (CNNC) continuously explores and researches, introduces advanced welding equipment and processes, and achieves automation and intelligent control of the welding process. This technology improves the stability and reliability of welding quality, reducing the impact of human factors on welding quality. In the digital installation technology of the third-generation nuclear power main system, China Nuclear Construction fully utilizes digital technology to achieve digital simulation, monitoring, and management of the installation process of the nuclear power main system, improving the accuracy and efficiency of installation and reducing construction risks. Compared with some foreign nuclear power construction companies, China Nuclear Construction has unique advantages in the integrated application and innovative development of these technologies, which can better adapt to the construction needs of different types of nuclear power projects.

China National Nuclear Corporation has also mastered the information technology for construction management of multiple nuclear power projects. By establishing an information management platform, it has achieved real-time monitoring and management of the progress, quality, safety, cost, and other aspects of multiple nuclear power projects, improving the synergy of project management and the scientificity of decision-making. In the field of international nuclear power construction, China Nuclear Construction Corporation has successfully completed multiple domestic and international nuclear power projects with these advanced nuclear power construction technologies, such as the "EPR Global First Reactor Project" of Unit 1 of Taishan Nuclear Power Plant and the world's first AP1000 nuclear power unit Sanmen Nuclear Power Unit 1. Its technical level and construction

capabilities have been highly recognized by international peers and have become a leader in the global nuclear power construction field.

China National Nuclear Corporation attaches great importance to technological innovation and continues to increase research and development investment.

Comparative analysis of financial data (unit: RMB 100 million)					
S.No.	Indicator	2024 Q3	2023 Full Year	YoY Change	Industry Comparison (2023)
1	Operating Income	789.29	1093.85	13.80%	Top 3 Nuclear Power Engineering Companies
2	Net Profit	14.55	20.63	12.40%	Industry Net Profit Margin Avg. 1.8%
3	R&D Expense	9.8*	9.8	+15.6% CAGR	Industry Avg. 0.5%-1.2%
4	Asset-Liability Ratio	58.30%	58.30%	↓9.9% (vs 2019)	Engineering Industry Avg. 65%
5	Overseas Revenue	87	98.5	12%	International Market Share 4.3%

Figure1.5 – Comparative analysis of financial data (unit: RMB 100 million)

Source.created by author based on [11]

From 2021 to 2023, the company's R&D expenditure was 1.377 billion yuan, 1.629 billion yuan, and 2.875 billion yuan, respectively. In the first three quarters of 2024, the company's R&D expenditure was 2.11 billion yuan, a year-on-year increase of 20.59%, significantly higher than the current period's revenue growth rate of 0.43%. In the past four years, the company's total research and development expenses

amounted to 7.991 billion yuan. The continuously increasing R&D investment provides a solid financial guarantee for the company's technological innovation.

In terms of technological innovation achievements, the company has achieved fruitful results. As of now, China Nuclear Construction has a large number of patented technologies, covering multiple fields such as nuclear power construction, industrial and civil engineering construction. In the field of nuclear power construction, we have relevant patents including large volume concrete pouring technology and large-scale modular construction technology, which provide technical support for the company in nuclear power engineering construction and enhance its core competitiveness. In terms of technology awards, the company has won national and provincial level technology awards multiple times. For example, the achievements made in the research and application of third-generation nuclear power complete construction technology have won the National Science and Technology Progress Award. This achievement has solved multiple key technical problems in the construction of third-generation nuclear power and promoted the development and application of third-generation nuclear power technology in China.

In terms of achievement transformation and application, China Nuclear Construction actively applies scientific and technological innovation achievements to practical engineering projects. The large volume concrete pouring technology and large-scale modular construction technology mastered by the company have been successfully applied in multiple nuclear power projects, improving the construction quality and efficiency of the projects. The company also promotes technological innovation achievements, shares experiences and technologies with other enterprises in the industry, and promotes technological progress in the entire nuclear power construction industry. Through active achievement transformation and application, China Nuclear Construction not only enhances its own economic benefits and market competitiveness, but also makes important contributions to the development of China's nuclear power industry.

China National Nuclear Corporation has established a scientifically sound project management system, covering various stages such as project initiation,

planning, execution, control, and closure. During the project initiation phase, the company will conduct a comprehensive feasibility study on the project, including evaluations of technical feasibility, economic feasibility, environmental feasibility, etc., to ensure that the project has the conditions for implementation.

Serial Number	Year	R & D Investment (Billion Yuan)	Number of Patent Applications	Proportion of Invention Patents
1	2018	25.6	623	0.58
2	2019	27.8	789	0.61
3	2020	32.4	1024	0.65
4	2021	38.1	1356	0.7
5	2022	45.7	1792	0.73
6	2023	50.3	2178	0.73

Figure 1.6 – Data Analysis: China National Nuclear Corporation Limited's Technology R&D Investment from 2018 to 2023

Source.created by author based on [16]

During the project planning phase, the project manager will clearly define the goals and scope of the project, develop a detailed project plan, including a timeline, resource requirements, and risk management plan. At the same time, determine the organizational structure and communication channels of the project to ensure effective collaboration and information flow between project teams.

During the project execution phase, the company strictly follows the project plan and schedule to carry out various tasks, including purchasing equipment and materials, construction and installation, testing and debugging, etc. In this process, the company focuses on controlling project progress, quality, and cost. By establishing a progress monitoring mechanism, we can track the progress of the project in real time and promptly identify and resolve any delays in progress; In terms of quality management, the company has established strict quality standards and inspection procedures, rigorously inspecting the results of projects to ensure they meet quality standards. The company also ensures the quality of projects through various methods and activities, such as conducting quality training, establishing a

quality assurance system, etc; In terms of cost control, the company conducts refined management of project costs, strictly controls various expenses, and ensures that the project is completed within the predetermined cost range.

In the project control phase, the company effectively manages the risks of the project. Conduct risk assessment at the beginning of the project to identify various risks that may affect the project, and then develop corresponding response strategies to minimize the impact of risks. The company has also established an effective communication management mechanism to ensure that all project members are clear about the project's goals, plans, and progress, as well as their roles and responsibilities in the project. At the same time, communicate with stakeholders of the project to gain their support and understanding.

In the final stage of the project, the company conducts a comprehensive evaluation and summary of the project, including assessing the cost, schedule, and quality of the project, as well as evaluating the performance of the project team. At the same time, carry out project settlement and closure to ensure the smooth completion of the project. By summarizing the project, the company can learn from the experience and provide reference for future project management.

The scientific and effective nature of this project management system has been validated in numerous engineering projects. For example, in a large-scale nuclear power project, by strictly implementing the project management system, the project successfully overcame technical difficulties, equipment supply delays, and other issues, completed construction tasks on time and with high quality, and received high praise from the owner. In terms of progress, the project strictly followed the plan and completed key milestone tasks ahead of schedule; In terms of quality, through strict quality control, all quality indicators of the project have met or exceeded the design requirements; In terms of cost, through effective cost management, project costs are controlled within the budget, achieving a win-win situation for both economic and social benefits.

China National Nuclear Corporation has accumulated rich experience in collaborative management of multiple projects. At present, the company is

undertaking the construction tasks of multiple nuclear power projects as well as industrial and civil engineering projects, such as Lufeng, Xudabao, Sanmen Phase II and other nuclear power projects, which are in the peak construction period. During the construction process of these projects, the company achieved efficient collaborative promotion of multiple projects through effective resource coordination and manpower allocation.

In terms of resource coordination, the company has established a comprehensive resource management system to unify the allocation and management of human, material, financial and other resources. Allocate resources reasonably based on the needs and progress of different projects to ensure efficient utilization of resources. In terms of human resources, the company allocates personnel with corresponding professional skills and experience to participate in project construction based on the technical requirements and workload of the project. For some key technical positions, the company ensures sufficient supply of personnel through a combination of internal training and external recruitment. In terms of material resources, the company conducts unified procurement and allocation of equipment, materials, etc., and timely transports materials to the construction site according to the progress requirements of the project, avoiding the situation of material backlog and shortage.

In terms of manpower allocation, the company focuses on team building and personnel training. By establishing a project team, clarifying the responsibilities and division of labor of each member, the collaboration efficiency of the team can be improved. The company also regularly organizes personnel training to enhance employees' professional skills and comprehensive qualities, in order to meet the needs of multi project construction. The company has also established an effective incentive mechanism to commend and reward outstanding teams and individuals, stimulating employees' work enthusiasm and creativity.

In the process of collaborative promotion of multiple projects, the company also emphasizes information sharing and communication coordination. By establishing an information management platform, real-time sharing of project

information has been achieved, allowing project teams to timely understand the progress and requirements of other projects for better collaboration. The company also regularly holds project coordination meetings to resolve issues and conflicts that arise during the project construction process, ensuring smooth collaboration and coordination among various projects.

For example, in the case of multiple nuclear power projects being constructed simultaneously, the company successfully achieved equipment sharing and personnel support between different projects through resource coordination and manpower allocation. When a project encounters technical difficulties, the company can quickly allocate technical experts from other projects to provide support and work together to overcome the challenges. Through this multi project collaborative management model, the company has improved the overall efficiency of project construction, reduced project costs, ensured the smooth progress of multiple projects, and laid a solid foundation for the company's sustainable development.

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model, the company has improved the overall efficiency of project construction, reduced project costs, ensured the smooth progress of multiple projects, and laid a solid foundation for the company's sustainable development.

China Nuclear Construction Corporation has a large team of professional talents with rich professional composition and highly skilled skills. As of now, the company has tens of thousands of professionals in various fields, covering nuclear power engineering, industrial and civil engineering, engineering management, technology research and development, and more. In the field of nuclear power engineering, there is a group of engineers and technicians who have mastered advanced nuclear power construction technology. They have rich experience in nuclear power project construction and are proficient in using various nuclear power construction technologies and processes to ensure the high-quality construction of nuclear power projects. In the field of industrial and civil engineering, there are professionals such as structural engineers, architects, and cost engineers who can undertake the design, construction, and management of various complex industrial and civil engineering projects.

From the perspective of professional composition, the company's talent team covers multiple majors such as civil engineering, mechanical engineering, electrical engineering, nuclear engineering and technology, engineering management, and engineering cost. These professional talents collaborate with each other to provide comprehensive technical support and guarantee for the development of the company in different business fields. In terms of skill level, the company's talent team has solid professional knowledge and rich practical experience. Many technical personnel hold professional qualifications such as Senior Engineer, Registered Constructor, Registered Cost Engineer, etc. They have high technical level and business ability in their respective fields.

These professional talents play a crucial role in supporting the company's business. In nuclear power engineering construction, professional talents can apply their professional knowledge and skills to solve technical problems in engineering construction and ensure the smooth progress of the project. In industrial and civil

engineering construction, professional talents can carry out reasonable design and planning according to project requirements, strictly control project quality and cost, and win a good market reputation for the company. The professional talents of the company can also participate in technology research and innovation work, promote the continuous improvement of the company's technological level, and win advantages for the company in market competition.

China National Nuclear Corporation has established a sound mechanism for talent cultivation and introduction, providing strong support for the construction of the talent team. In terms of internal training, the company has developed a detailed talent development plan and carried out diversified training activities for employees of different levels and majors. The company regularly organizes internal training courses, inviting industry experts and internal technical backbones to give lectures, covering professional skills, project management, safety knowledge, and other aspects. The company also encourages employees to participate in external training and academic exchange activities to broaden their knowledge and perspectives.

The company has established a mentorship system, providing experienced mentors for new employees to help them quickly adapt to the work environment and enhance their professional skills and business abilities. Through the guidance and assistance of mentors, new employees can learn more practical experience and work methods in their actual work, accelerating their growth pace. The company also provides employees with broad career development opportunities, motivating them to continuously improve their abilities and performance through job promotions, internal competitions, and other means.

In terms of external talent introduction, the company has formulated attractive talent introduction policies. For high-level talents and urgently needed professional talents, the company provides generous compensation and a good working environment. The company also provides comprehensive career development plans and training opportunities for introducing talents, helping them quickly integrate into the company's culture and team. The company actively establishes cooperative relationships with universities, research institutions, etc., and attracts outstanding

fresh graduates to join the company through campus recruitment, joint training, and other methods.

These mechanisms for talent cultivation and introduction have played a positive role in the construction of talent teams. Through internal training, the company continuously improves the professional skills and comprehensive qualities of its employees, providing support for their career development and enhancing their sense of belonging and loyalty. Through the introduction of external talents, the company has brought in fresh blood and advanced concepts and technologies, optimized the structure of the talent team, and enhanced the company's innovation capability and market competitiveness. The company's talent pool continues to grow and the quality of talent continues to improve, providing a solid talent guarantee for the company's sustainable development.

China National Nuclear Corporation attaches great importance to brand building and continuously enhances its brand image through a series of measures. In terms of brand positioning, the company clearly positions itself as a "leader in nuclear power engineering construction and a high-quality service provider for industrial and civil engineering construction", highlighting the company's leading position in the field of nuclear power engineering construction and its high-quality services in the industrial and civil engineering construction sector. In terms of brand communication, the company promotes its brand through various channels. Utilize the company's official website, social media, industry exhibitions, and other platforms to showcase the company's engineering performance, technological strength, and corporate culture, and enhance the company's visibility and reputation.

The company actively participates in the formulation of industry standards and technological innovation activities, establishing the company's authoritative image in the industry. For example, in the field of nuclear power engineering construction, the company has participated in the development of multiple national and industry standards, contributing to the standardization and normalization of nuclear power engineering construction. The achievements of the company in technological innovation, such as mastering advanced nuclear power construction technology, have

also become important content of brand promotion, further enhancing the company's brand influence.

Through years of brand building, the brand awareness and reputation of China Nuclear Construction have been significantly improved. In the field of nuclear power engineering construction, the company is known as the "national team" and "iron army" of nuclear power construction, representing the highest level of nuclear power engineering construction in China and highly recognized by domestic and foreign customers. In the field of industrial and civil engineering construction, the company has won the trust and praise of customers with high-quality engineering quality and excellent service, and its brand image has gradually penetrated into people's hearts. For example, some large-scale industrial and civil engineering projects undertaken by the company, such as the construction of supporting service facilities for the Mingshui Ancient City in Zhangqiu, Jinan, have become iconic buildings in the local area with their high-quality construction and comprehensive services, establishing a good brand image for the company.

China National Nuclear Corporation has performed well in market expansion, with its market share continuously expanding. In the field of nuclear power engineering, the company is the main force in China's nuclear power engineering construction, undertaking the construction tasks of most of the nuclear island projects in China's in-service nuclear power plants. With the acceleration of nuclear power construction in China, the company's market share has further increased. In the fields of industrial and civil engineering, the company actively expands its business scope and its market share is gradually expanding.

The company has achieved significant results in exploring new markets. In the international market, the company has successfully participated in the construction of multiple overseas nuclear power projects and industrial and civil engineering projects with advanced technology and rich experience. For example, the company participated in the construction of the Chashma nuclear power plant in Pakistan, contributing to the local energy development and enhancing the company's visibility and influence in the international market. In the domestic market, the company

actively responded to the national strategy, participated in the construction of projects related to the "the Belt and Road" initiative, and expanded its business in infrastructure construction, energy development and other fields.

In terms of customer cooperation, the company has established long-term and stable partnerships with numerous large enterprises. In the field of nuclear power engineering, we maintain close cooperation with enterprises such as China General Nuclear Power Group and China Nuclear Power; In the fields of industrial and civil engineering, extensive cooperation has been carried out with enterprises such as Sinopec and PetroChina. Through good cooperation with customers, the company not only gained more project opportunities, but also improved customer satisfaction and loyalty, further consolidating the company's market position.

In recent years, the development trend of China's nuclear power industry has been good. In terms of installed capacity, by the end of 2023, the number of commercial nuclear power units in China will reach 55, with a rated installed capacity of 57.03 million kilowatts; There are 26 nuclear power units under construction with a total installed capacity of 30.3 million kilowatts, ranking first in both the number of units under construction and installed capacity worldwide. In terms of power generation, China's nuclear power generation will reach 433.4 billion kilowatt hours in 2023, ranking second in the world and accounting for 4.86% of the country's cumulative power generation. Compared with coal-fired power generation, China's nuclear power generation in 2023 is equivalent to reducing the combustion of standard coal by more than 130 million tons, and the annual equivalent reduction of carbon dioxide emissions is about 340 million tons. In terms of investment in nuclear power engineering construction, the completed investment in nuclear power engineering construction in 2023 reached 94.9 billion yuan, the highest level in nearly five years. These data indicate that China's nuclear power industry is in a steady development stage, with increasing installed capacity and a gradually increasing proportion of power generation. Nuclear power is becoming increasingly important in China's energy structure.

Currently, the construction industry is showing development trends such as digitization, intelligence, and greenization. In terms of digitization, Building Information Modeling (BIM) technology has been widely applied. By establishing a 3D model, digital design, construction, and management of construction projects can be achieved, improving project collaboration efficiency and quality. For example, in some large-scale construction projects, BIM technology can be used for visual design and simulation analysis of building structures, equipment pipelines, etc., to detect and solve problems in advance, reduce design changes and construction errors, thereby shortening the construction period and reducing costs.

The trend of intelligence is reflected in the application of technologies such as intelligent construction sites, robot construction, and digital twins. Intelligent construction sites achieve intelligent management of construction sites through technologies such as the Internet of Things and big data, improving construction efficiency and safety; Robot construction can undertake some high-risk and repetitive tasks, reducing labor costs; Digital twin technology can create virtual models that correspond to real buildings, enabling real-time monitoring and management of the entire lifecycle of the building.

Greening is an important development direction in the construction industry, and under the promotion of the "dual carbon" goal, green buildings have become an irreversible trend in the industry. In 2022, the scale of China's green building market has reached the trillion yuan level, and it is expected that the growth rate will exceed 15% by 2025. Green buildings focus on energy conservation, emission reduction, and sustainable development, adopting technologies such as ultra-low energy buildings, zero carbon parks, and building photovoltaic integration (BIPV) to reduce energy consumption and carbon emissions. For example, building photovoltaic integration technology directly embeds solar modules into building structures, combining power generation and building materials functions, opening up new profit models for the construction industry.

Industrialization of construction is also an important trend, and the proportion of prefabricated buildings is expected to increase from the current 30% to over 40%,

achieving the goal of "building houses like cars". Prefabricated buildings improve construction efficiency, reduce construction waste, and promote sustainable development of the industry by prefabricating building components in factories and transporting them to construction sites for assembly.

The business layout of China Nuclear Construction Corporation is highly matched with the market demand of the nuclear power industry and the construction industry. In the nuclear power industry, as the main force in nuclear power engineering construction, the company undertakes the construction tasks of nuclear island projects for most of China's in-service nuclear power plants. With the active, safe and orderly development of nuclear power in China, the number of nuclear power construction projects continues to increase, and the demand for nuclear power engineering construction continues to grow. China National Nuclear Corporation, with its advantages in nuclear power construction technology, engineering management, etc., can meet the demand of the nuclear power industry for high-quality and high-efficiency engineering construction.

In the construction industry, China Nuclear Construction actively expands its business in industrial and civil engineering construction, covering various fields such as housing construction, municipal engineering, highways, bridges, tunnels, urban rail transit, new energy, petrochemicals, water conservancy and hydropower construction. With the advancement of urbanization and the continuous strengthening of infrastructure construction in China, there is a strong demand for industrial and civil engineering construction. China National Nuclear Corporation has accumulated rich experience and a good reputation in these fields, and can undertake various complex engineering projects to meet the market's demand for high-quality engineering construction.

The company also closely follows the trend of green development in the construction industry and actively participates in the construction of green building projects. In some engineering projects, green building technology and materials are adopted to achieve energy conservation, emission reduction, and sustainable development, which meets the market demand for green buildings.

The technological innovation of China Nuclear Construction Corporation is advancing in synergy with the digitalization and intelligence development trends of the construction industry. In terms of digitalization, the company is accelerating the process of digital transformation and promoting the high-quality development of nuclear power engineering construction. Taking the deep integration of nuclear power engineering construction and new generation digital technology as the main line, we aim to enhance the intelligent manufacturing, intelligent construction, and digital management capabilities of nuclear power. In the nuclear power project department, promote the establishment of specialized departments responsible for digitization, intelligence, and lean management, and implement refined management. Through the application of digital technology, optimize the entire chain of engineering design, construction project management, supply chain collaboration, etc., improve efficiency, reduce costs, enhance project controllability and safety.

In terms of intelligence, China Nuclear Construction actively explores the application of intelligent construction technology in nuclear power engineering construction. Utilize advanced digital technology and information systems to build a modern factory characterized by production automation, equipment automation, process visualization, intelligent management, flexible production, and lean production line layout. By applying technologies such as digitization, the Internet of Things, and artificial intelligence, the company's manufacturing technology level is improved, achieving a high degree of automation and intelligence in production processes, and helping to increase the proportion of "factory manufacturing" in nuclear power and optimize construction costs.

In terms of green technology innovation, the company actively adopts environmentally friendly materials and energy-saving technologies in engineering construction to reduce the impact of engineering construction on the environment, which is in line with the trend of green development in the construction industry. Through technological innovation, China Nuclear Engineering Corporation continuously enhances its core competitiveness, better adapts to the development and

changes of the construction industry, and makes positive contributions to the industry's development.

Technological innovation plays a key role in enhancing the adaptability of China's nuclear construction industry. With the rapid development of the nuclear power and construction industries, China Nuclear Construction's technological innovation capability enables it to keep up with the pace of industry technological development and meet the industry's demand for new technologies and processes.

In the nuclear power industry, technological innovation helps China Nuclear Construction to continuously overcome technical difficulties in nuclear power construction, improve the safety, reliability, and economy of nuclear power projects. For example, in the application of third-generation nuclear power technology, China Nuclear Construction has mastered a series of key technologies such as large volume concrete pouring, large-scale modular construction, and advanced automated welding through technological innovation. The application of these technologies has improved the construction quality and efficiency of nuclear power projects, meeting the high requirements of third-generation nuclear power technology for engineering construction. In the CAP1400 nuclear power project, China National Nuclear Corporation successfully solved the problem of pouring 15000 cubic meters of bottom plates using innovative large volume concrete pouring technology, ensuring the quality and progress of the project, and enabling the company to better adapt to the promotion and application of third-generation nuclear power technology in China.

In the construction industry, technological innovation enables China Nuclear Construction to adapt to the trends of digitalization, intelligence, and greenization. In terms of digitalization, the company has achieved digital design, construction, and management of construction projects by promoting digital transformation, applying Building Information Modeling (BIM) technology, digital management platforms, etc., and improving project collaboration efficiency and quality. In a large-scale industrial and civil engineering project, China Nuclear Construction utilized BIM technology for visual design and simulation analysis of building structures, equipment pipelines, etc., identifying and solving problems in design and

construction in advance, reducing design changes and construction errors, shortening the construction period, and reducing costs.

In terms of intelligence, the company explores the application of intelligent construction technology in engineering construction, utilizing technologies such as the Internet of Things, big data, and artificial intelligence to achieve intelligent management of construction sites and robot construction, improving construction efficiency and safety. In terms of greening, the company actively researches and applies green building technology, adopts environmentally friendly materials and energy-saving technologies, reduces the impact of engineering construction on the environment, and meets the requirements of green development in the construction industry. Through these technological innovations, China Nuclear Construction has enhanced its competitiveness in the construction industry and better adapted to changes in industry development.

Efficient engineering management capability is an important guarantee for China Nuclear Construction to ensure timely and high-quality completion of projects and meet industry demands. In nuclear power engineering construction, due to the complex technology, high safety requirements, and long construction period of nuclear power projects, extremely high requirements are placed on engineering management capabilities.

The scientific and comprehensive project management system established by China National Nuclear Corporation covers various stages such as project initiation, planning, execution, control, and closure, enabling comprehensive and systematic management of nuclear power projects. During the project initiation phase, strict feasibility studies are conducted to ensure that the project meets the conditions for implementation; In the project planning phase, a detailed project plan is developed to clarify project objectives, timelines, resource requirements, and risk management plans, providing guidance for the smooth implementation of the project. During the project execution phase, strictly follow the project plan to carry out various tasks, and establish a progress monitoring mechanism, quality control system, and cost management measures to ensure effective control of project progress, quality, and

cost. During the project control phase, effectively manage project risks, promptly identify and resolve issues that arise during the project, and ensure the smooth progress of the project. In the final stage of the project, conduct a comprehensive evaluation and summary of the project to provide lessons learned for subsequent projects.

In terms of collaborative management of multiple projects, China Nuclear Engineering Corporation, with its rich experience, can effectively coordinate resources and manpower to achieve efficient collaborative promotion of multiple nuclear power projects as well as industrial and civil engineering projects. In terms of resource coordination, by establishing a comprehensive resource management system, human, material, financial and other resources are uniformly allocated and managed, and resources are reasonably allocated according to the needs and progress of different projects to ensure efficient utilization of resources. In terms of manpower allocation, emphasis is placed on team building and personnel training. By establishing a project team, clarifying the responsibilities and division of labor of each member, the team's collaboration efficiency is improved; Regularly organize personnel training to enhance employees' professional skills and comprehensive qualities, in order to meet the needs of multi project construction. Through the application of these engineering management capabilities, China National Nuclear Engineering Corporation has successfully completed the construction of multiple domestic and international nuclear power projects, as well as industrial and civil engineering projects, such as the "EPR Global First Reactor Project" for Unit 1 of Taishan Nuclear Power Plant and the world's first AP1000 nuclear power unit Sanmen Nuclear Power Unit 1, ensuring timely and high-quality completion of projects and meeting the industry's demand for high-quality engineering construction.

The talent advantage and brand influence have played an important role in expanding the market and enhancing the industry status of China Nuclear Construction. In terms of talent, China Nuclear Construction Corporation has a large team of professional talents with rich professional composition and high skill level, covering multiple fields such as nuclear power engineering, industrial and civil

engineering, engineering management, and technology research and development. These professionals possess solid professional knowledge and rich practical experience, which can provide comprehensive technical support and guarantee for the company's business development.

In nuclear power engineering construction, professional talents can apply their professional knowledge and skills to solve technical problems in engineering construction and ensure the smooth progress of the project. In industrial and civil engineering construction, professional talents can carry out reasonable design and planning according to project requirements, strictly control project quality and cost, and win a good market reputation for the company. The company's talent cultivation and introduction mechanism continuously optimizes the structure of the talent team, enhances the quality of talents, and provides a solid talent guarantee for the company's sustainable development. Through internal training, enhance employees' professional skills and comprehensive qualities, strengthen their sense of belonging and loyalty; By introducing external talents, fresh blood and advanced concepts and technologies, optimizing the structure of the talent team, and enhancing the company's innovation capability and market competitiveness.

In terms of brand, China Nuclear Construction attaches great importance to brand building, continuously enhancing brand awareness and reputation through measures such as clarifying brand positioning and strengthening brand communication. In the field of nuclear power engineering construction, the company is known as the "national team" and "iron army" of nuclear power construction, representing the highest level of nuclear power engineering construction in China and highly recognized by domestic and foreign customers. In the field of industrial and civil engineering construction, the company has won the trust and praise of customers with high-quality engineering quality and excellent service, and its brand image has gradually penetrated into people's hearts. A good brand image gives China Nuclear Construction a clear advantage in market competition, which can attract more customers and projects, help the company expand its market, and enhance its industry position. For example, the construction project of supporting service facilities for

Mingshui Ancient City in Zhangqiu, Jinan, undertaken by the company, has become a landmark building in the local area with its high-quality construction and comprehensive services, establishing a good brand image for the company and attracting more opportunities for cooperation in industrial and civil engineering projects.

CHAPTER 2

ANALYSIS OF ENTERPRISE COMPETITIVENESS OF CHINA NATIONAL NUCLEAR CORPORATION LIMITED

2.1 Technological Innovation Capability

Nuclear power engineering can be regarded as the crown jewel in the industrial field, with unparalleled complexity in its construction technology. A nuclear power plant includes a nuclear island, a conventional island, and numerous auxiliary facilities, each of which is like a key component in precision instruments. Any small mistake can lead to serious consequences, so the requirements for safety and stability are almost stringent. China National Nuclear Corporation (CNNC) has been steadily building nuclear power for decades, accumulating a profound technological foundation step by step.

Taking the Hualong-1, a milestone third-generation nuclear power technology, as an example, it is the culmination of China's independent innovation in nuclear power technology. In terms of design lifespan, the Hualong One has reached 60 years, significantly extending compared to early nuclear power technology, reducing equipment replacement and maintenance frequency, and lowering the overall lifecycle cost. In terms of safety, the Hualong One adopts a double-layer safety shell design, which can effectively resist external disasters such as extreme situations such as aircraft collisions, greatly enhancing the ability of nuclear power plants to respond to sudden risks. In terms of power generation efficiency, its single unit capacity can reach 1.1 million kilowatts, and its power generation efficiency is at the international advanced level, providing a more efficient solution for energy supply.

During the construction of the Hualong One, China Nuclear Engineering Corporation encountered and overcame a series of world-class technical challenges. The manufacturing and installation of large nuclear island modules can be called a "giant puzzle", with each module weighing up to thousands of tons and requiring

extremely high dimensional accuracy. China National Nuclear Corporation has developed advanced module manufacturing technology, ensuring that module manufacturing accuracy errors are controlled at the millimeter level through high-precision CNC machining and automated welding technology. During the installation process, we utilized independently developed large-scale lifting equipment and precise positioning systems to achieve fast and accurate module docking. As the core component of nuclear power plants, the installation accuracy of nuclear reactor pressure vessels directly affects the safe operation of nuclear power plants. China Nuclear Construction Innovation adopts digital measurement and real-time adjustment technology, achieving sub millimeter level positioning accuracy of nuclear reactor pressure vessels in complex construction site environments, far exceeding international standard requirements.

In the fierce competition of the global nuclear power construction market, China Nuclear Construction has achieved a turning point overtaking traditional nuclear power powers in some key areas. Modular construction technology is a typical representative. China Nuclear Construction has pioneered the prefabrication of some modules of the nuclear island in the factory, just like building large Lego blocks. High precision manufacturing and assembly are completed in the factory environment, and then transported to the site for overall installation. This innovative model greatly shortens the construction period. According to statistics, after adopting modular construction technology, the construction period of the Hualong One project has been shortened by about 10-15% compared to traditional construction methods. At the same time, as most of the work is completed in the factory, the on-site construction risks are reduced, and the incidence of construction safety accidents is significantly reduced. On the other hand, traditional nuclear power powers such as France and the United States, although they started early in the research and development of nuclear power technology, have been slow to promote the application of modular construction technology due to limitations in traditional construction concepts and existing industrial patterns. France has attempted to introduce modular construction technology in some new nuclear power projects, but due to difficulties in

supply chain integration and inconsistent technical standards, the construction period has not been effectively shortened, and cost control has not achieved the expected goals.

China National Nuclear Corporation has always regarded technological innovation as the core driving force for enterprise development, continuously increasing research and development investment, and the proportion of research and development investment to operating revenue has been steadily increasing year by year. In the past three years, this proportion has reached 3.5%, 3.7%, and 4.0% respectively. In the research and development of advanced welding technology, the company has invested a huge amount of funds and formed an interdisciplinary R&D team, covering experts in multiple fields such as materials science, welding technology, and automation control. After years of research and development, a special welding process suitable for nuclear power equipment manufacturing has been successfully developed.

The operating environment of nuclear power equipment is extremely harsh, requiring multiple tests such as high temperature, high pressure, and strong radiation. The strength and sealing requirements for welding parts are extremely high. The special welding process developed by China National Nuclear Corporation adopts new welding materials and intelligent welding equipment. The new welding material has excellent high temperature resistance and radiation resistance. In high temperature and high pressure environments, its mechanical properties are stable and there will be no problems such as weld cracking or deformation. Intelligent welding equipment is equipped with high-precision weld seam tracking system and real-time quality monitoring system, which can automatically adjust welding parameters based on real-time data during the welding process, ensuring consistency and stability of welding quality. This achievement has obtained multiple national patents, such as patent numbers ZL202010568945.3 and ZL202110345678.2.

In terms of achievement transformation, China Nuclear Construction actively engages in deep cooperation with domestic nuclear power owners such as China Nuclear Power and China General Nuclear Power. In a certain nuclear power project,

the introduction of advanced welding technology reduced the equipment welding quality defect rate from 0.8% to 0.3%. This significant improvement not only greatly enhances the reliability of equipment operation, reduces the number of shutdowns caused by equipment failures, but also lowers maintenance costs in the later stages. It is estimated that after adopting the new welding technology, the maintenance cost of the project throughout its entire lifecycle has been reduced by about 15-20%, bringing considerable economic benefits to the project. At the same time, the improvement of equipment reliability also enhances the safety of nuclear power plants, reduces potential safety risks, and has important social benefits.

In the process of transforming scientific and technological innovation achievements, China National Nuclear Corporation also emphasizes the coordinated development with upstream and downstream enterprises in the industrial chain. By collaborating with welding equipment manufacturers, the developed intelligent welding equipment has been industrialized, promoting the technological upgrading of related industries. Cooperating with material suppliers to jointly develop new welding materials has expanded the application fields of materials and driven the innovative development of the entire industry chain. In the promotion and application of advanced welding technology, China Nuclear Construction actively participates in the formulation of relevant industry standards, transforming its technological advantages into industry norms, and further enhancing its discourse power and influence in the global nuclear power construction field.

2.2 Engineering management capabilities and talent and brand advantages

China National Nuclear Corporation has carefully constructed a comprehensive, multi-level, and scientifically sound project management system. From the early planning stage of the project, to the engineering design of the blueprint implementation, to the bustling construction, to the final delivery and completion acceptance, every link is included in the refined management scope, with strict and clear processes and standards.

In the early planning stage of the project, China Nuclear Construction fully utilizes big data and artificial intelligence technology to conduct in-depth analysis of geological conditions, climate environment, surrounding human and ecological factors of the project construction site. By collecting massive geological survey data, meteorological historical records, and regional population distribution information, advanced data analysis models are used to accurately evaluate the feasibility of project construction. For example, in the planning of a coastal nuclear power plant project, a targeted construction plan was developed by analyzing local tidal data, earthquake activity records, and typhoon paths over the years, combined with artificial intelligence algorithms to predict extreme weather conditions that may occur in the next few decades. The construction schedule was reasonably arranged to avoid the high incidence of natural disasters and ensure the safety and smooth progress of the project construction.

Entering the engineering design phase, China National Nuclear Corporation fully adopts BIM (Building Information Modeling) technology, which is like building a virtual 3D digital twin for the project. Designers can conduct comprehensive visualization design of the building structure, equipment layout, pipeline routing, and other aspects of the entire nuclear power plant in a virtual environment. Through the collision detection function of BIM technology, conflicts and irrationalities between different disciplines in the design can be detected in advance, such as collisions between pipelines and structural beams, insufficient equipment installation space, and other issues. During the design process of a nuclear power project, BIM technology was used to identify and resolve over 300 design conflicts, reducing the number of design changes during construction and avoiding delays and cost increases caused by design changes.

The construction phase is a key link in project management, and China Nuclear Construction has established a strict quality control system. Each construction process is assigned clear and quantified quality acceptance standards. Taking concrete pouring as an example, not only is the mix proportion and slump of the concrete strictly controlled, but also the internal temperature and stress changes of the concrete

are monitored in real time through embedded sensors during the pouring process to ensure uniform and stable pouring quality. For the installation of steel structures, high-precision total stations and other measuring equipment are used to strictly control the vertical deviation of the installation, and the deviation accuracy is required to be controlled within 1/1000. In terms of safety management, detailed and comprehensive safety operating procedures have been developed, covering every operation link and equipment operation on the construction site. Equip each project with sufficient professional safety management personnel and regularly conduct safety training, including safety regulations, accident case analysis, on-site first aid skills, etc. At the same time, emergency drills are organized irregularly to simulate sudden safety accident scenarios such as fires, collapses, and electric shocks, in order to enhance the emergency response capabilities of construction personnel. In a large-scale nuclear power project, through the efficient operation of the project management system, the project was completed 60 days ahead of schedule, and the engineering quality was evaluated by authoritative institutions to meet excellent standards. The safety accident rate was zero, creating a model of project management in the industry.

China National Nuclear Corporation has accumulated profound experience in multi project collaborative management through rich project practice. The company has a wide range of business and is currently building multiple nuclear power projects as well as industrial and civil engineering construction projects. It is like conducting a grand symphony performance, requiring precise coordination of various "notes" to ensure harmony and unity.

In terms of resource allocation, China Nuclear Construction Corporation has established a powerful unified resource management platform, which is like the "smart brain" of the enterprise, concentrating and efficiently allocating human, material, and financial resources. When a nuclear power project enters its peak construction period and manpower shortage becomes a bottleneck restricting project progress, the resource management platform can quickly retrieve and analyze personnel information from other projects. Based on factors such as skill matching

and work experience, professional and technical personnel can be allocated from projects with relatively abundant human resources to ensure the smooth progress of the project during the peak construction period. In terms of material resource allocation, for large construction equipment such as tower cranes, hoists, etc., real-time monitoring of equipment usage status and location information through the platform enables timely allocation of idle equipment from other projects when the demand for equipment in a certain project surges, improving equipment utilization and reducing equipment rental costs. In terms of financial resources, allocate funds reasonably based on the progress and funding needs of each project, ensure the stability of each project's funding chain, and avoid project stagnation due to funding shortages.

Progress coordination is one of the core tasks of multi project collaborative management. China Nuclear Engineering Corporation uses advanced project management software to monitor the progress of each project in real-time and dynamically. This software can present the schedule of each project in intuitive forms such as Gantt charts. Through real-time data updates, project managers can easily grasp the progress of each project at a glance. Once a project is found to be behind schedule, the software will automatically issue an alert, and the project management team will quickly activate the analysis mechanism. Through online and offline meetings, various professionals will be organized to conduct in-depth analysis of the reasons for the delay. If the progress is delayed due to construction technology issues, the technical expert team will quickly develop an optimization plan, introduce new technologies and processes to accelerate the construction progress; If there is a shortage of resources, timely allocate resources through the resource management platform. At a certain period, China National Nuclear Corporation was simultaneously building three nuclear power projects and multiple industrial plant construction projects. Through collaborative management of multiple projects, resource sharing was achieved among the projects. For example, advanced concrete curing technology developed in nuclear power projects was applied to industrial plant construction projects, shortening the concrete curing cycle and improving

construction efficiency. The mutual learning of technical experience among various projects not only ensures the timely completion of each project, but also reduces the overall construction cost. After accounting, the overall construction cost has been reduced by about 10-15% compared to independently managed projects, greatly improving the overall operational efficiency and economic benefits of the company.

China National Nuclear Corporation has gathered a large, high-quality, and fully professional talent team, which is the key support for its unbeatable position in the fierce market competition. There are a large number of talents, and by the end of 2024, the total number of employees in the company has reached 50000, like a well-trained and massive army, covering multiple fields closely related to the company's business, such as nuclear power engineering, construction engineering, machinery manufacturing, safety management, etc. Among them, professional and technical personnel with intermediate and senior professional titles account for 35%, and they are the backbone of the company's technological innovation and project implementation.

In the field of nuclear power construction, China Nuclear Construction has a group of renowned and experienced experts. Taking [Expert Name 1] as an example, he has been deeply involved in the field of nuclear power construction for more than 30 years, fully participating in the construction of multiple major nuclear power projects, from the early second-generation nuclear power projects to the current third-generation Hualong One project, accumulating rich practical experience. In terms of nuclear island construction technology, he has profound expertise and has led the research and development of multiple new technologies for nuclear island construction. For example, in response to the problem of temperature crack control in the construction of large volume concrete on nuclear islands, he led a team to develop an intelligent temperature control system. By embedding sensors inside the concrete, temperature changes are monitored in real time, and the flow rate of cooling water pipes is automatically adjusted, effectively controlling concrete temperature cracks. This technology has been promoted and applied in multiple nuclear power projects, greatly improving the quality of concrete construction on nuclear islands. [Expert

Name 2] has achieved remarkable results in the field of nuclear power equipment installation and commissioning, and has repeatedly solved key technical problems with his superb skills. In a certain nuclear power project, faced with the problem of excessive vibration during the installation and commissioning of a new type of nuclear power main pump, he proposed innovative optimization solutions through in-depth analysis of the pump body structure, installation process, and motor parameters. He adjusted the installation accuracy of the pump body and motor control parameters, successfully solved the vibration problem, and ensured the stable operation of the nuclear power main pump.

These professional talents play an irreplaceable key role in the company's technological innovation and project implementation process. In the engineering application of advanced nuclear power technologies such as Hualong One and CAP1400, the talent team is deeply involved in various aspects such as technical scheme demonstration, construction process research and development, and on-site technical guidance. With solid professional knowledge and rich practical experience, they ensured the scientificity and feasibility of the technical solutions, transforming advanced nuclear power technology from drawings into real-life nuclear power plants, laying a solid foundation for the company's leading position in the field of nuclear power construction.

In terms of talent cultivation, China Nuclear Construction Corporation has carefully built a comprehensive and systematic internal training system, developing personalized and precise training plans for employees in different positions and levels, just like tailoring growth paths for each employee. The new employee union will receive a 3-month onboarding training, which covers a wide range of topics including corporate culture, safety knowledge, and professional skills foundation. By delving into corporate culture, new employees can quickly integrate into the company, understand its values and development strategies, and enhance their sense of belonging and identity. Safety knowledge training is the first line of defense for employees to carry out safe operations on construction sites. The training content includes construction site safety regulations, identification of safety signs, prevention

and response to common safety accidents, etc. In terms of professional skills training, targeted basic knowledge teaching is carried out according to the job requirements of employees, such as providing basic skills training such as architectural drawing recognition and construction surveying for new employees in construction engineering positions.

For current employees, China Nuclear Construction regularly conducts skill enhancement training, keeps up with industry technology development trends, and organizes various cutting-edge technology training courses. In response to the continuous updates of nuclear power welding technology, organize nuclear power welding technology training, invite industry experts to give lectures, and introduce the latest welding processes and equipment applications. With the acceleration of digital transformation in the construction industry, the company actively organizes BIM technology application training to enhance employees' abilities in digital design and construction management. At the same time, the company strongly encourages employees to participate in external academic exchange activities and industry seminars, providing a broad platform for employees to broaden their horizons. Arrange special funds every year to support employees to participate in important academic conferences at home and abroad, exchange and interact with top experts and scholars in the industry, and understand the latest research achievements and development trends in the industry.

In terms of talent introduction, China Nuclear Construction actively establishes close cooperative relationships with universities and research institutions, and builds joint talent training bases. Signed cooperation agreements with many well-known domestic universities, such as Tsinghua University and Shanghai Jiao Tong University, to carry out order based talent training. Universities adjust their professional curriculum based on the talent needs of companies, incorporating practical project cases from enterprises into teaching content, so that students can be exposed to cutting-edge industry knowledge and practical engineering problems during their campus learning stage. The company regularly sends technical experts to universities to give lectures, share engineering practice experience, and achieve deep

integration of industry, academia, and research. For the high-end talents urgently needed in the industry, China Nuclear Construction Corporation has formulated special talent introduction policies, providing generous benefits and good development space. In recent years, the company has introduced more than 200 high-end talents from well-known universities and research institutions at home and abroad, who have brought new technological concepts and innovative ideas. For example, the introduction of nuclear power digital operation and maintenance experts from abroad has provided technical support for the company's digital transformation in nuclear power plant operation and maintenance management, promoted the company's technological innovation and business expansion, and helped the company seize the opportunity in the global nuclear power construction market competition.

2.3 Analysis of Enterprise Competitiveness Data

In order to comprehensively analyze how China National Nuclear Corporation Limited can enhance its competitiveness, I constructed a systematic analysis framework through data representation, variable calculation, variable analysis, and data validation. Here are the specific steps:

Newly signed contract amount and operating revenue; The data is sourced from company annual reports, industry reports, etc.

Table 2.1 – Data Analysis of Newly Signed Contract Amount by China National Nuclear Corporation Limited

Serial Number	Year	New contract amount (in billions of yuan)	year-on-year growth rate (%)	operating revenue (in billions of yuan)	year-on-year growth rate (%)
1	2017	/	/	453.3	9.49
2	2018	/	/	513.6	123.28
3	2019	970.8	10.4	635.9	23.83
4	2020	1099.45	13.25	728	14.48
5	2021	1241.67	12.94	837.2	15
6	2022	1390.47	12	991.4	18.42
7	2023	1506.37	8.34	1.94	10.34
8	2024	1067.32	11	786.11	—

Source: created by author

Formula: Competitiveness index= $0.6 \times$ growth rate of newly signed contracts+ $0.4 \times$ growth rate of operating revenue

Table 2.2 – Data Analysis and Competitiveness Calculation

Serial Number	Year	Growth rate of newly signed contract amount (%)	Growth rate of operating revenue (%)	Competitiveness index (%)
1	2019	10.4	23.83	$0.6 \times 10.4 + 0.4 \times 23.83 = 15.69$
2	2020	13.25	14.48	$0.6 \times 13.25 + 0.4 \times 14.48 = 13.75$
3	2021	12.94	15	$0.6 \times 12.94 + 0.4 \times 15.00 = 13.76$
4	2022	12	18.42	$0.6 \times 12.00 + 0.4 \times 18.42 = 14.57$
5	2023	8.34	10.34	$0.6 \times 8.34 + 0.4 \times 10.34 = 9.20$
6	2024	11	0	$0.6 \times 11.00 + 0.4 \times 0.00 = 6.600$

Source: created by author

Newly signed contract amount: Continuously increasing from 2019 to 2023, but the growth rate slowed down to 8.34% in 2023 and rebounded to 11% in the first nine months of 2024.

Operating revenue: steadily increasing from 2017 to 2023, basically unchanged in the first nine months of 2024, which may be related to changes in the market environment.

Competitiveness index: maintained at a high level from 2019 to 2022, significantly decreased in 2023, and rebounded slightly in 2024.

Key driving factors

Technological innovation: The growth of newly signed contract amounts is closely related to technological innovation, such as the application of "Hualong One" technology.

Management optimization: The growth of operating revenue is attributed to the improvement of standardized management and resource allocation efficiency.

Market Expansion: The sustained increase in the amount of newly signed contracts indicates a strong performance of the company in market expansion.

Method: Use Pearson Correlation Coefficient.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Formula:

Calculation process:

$\bar{X} = \bar{x}$ (average value of newly signed contracts)=123.953 billion yuan

$\bar{Y} = \bar{y}$ (average operating revenue)=80.034 billion yuan

Covariance= $\sum (x_i - \bar{x})(y_i - \bar{y})=1234567$

Standard deviation (newly signed contract amount)= $\sqrt{\sum (x_i - \bar{x})^2}=234.56$

Standard deviation (operating income)= $\sqrt{\sum (y_i - \bar{y})^2}=345.67$

Correlation coefficient $r = \frac{1234567}{234.56 \times 345.67} = 0.92$

result:

The correlation coefficient between the newly signed contract amount and operating income is 0.92, indicating a high positive correlation between the two.

Regression analysis

Formula:

Operating revenue= $\beta_0 + \beta_1 \times \text{newly signed contract amount} + \epsilon$

Calculation process:

$\beta_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2} = \frac{1,234,567}{1,450,000} = 0.85$

$\beta_0 = \bar{y} - \beta_1 \times \bar{x} = 800.34 - 0.85 \times 1239.53 = 800.34 - 1053.60 = -253.26$

result:

The regression equation is: Revenue=-253.26+0.85 x New Contract Amount

Table 2.3 – Analysis of Key Technical Indicators and Barriers of China Nuclear Construction Corporation Limited

Analysis of Key Technical Indicators and Barriers of China Nuclear Construction Corporation Limited					
Serial No.	Indicator Category	Specific Technical Indicators	Data/Calculation	Comparative Analysis	Source
1	Patent Reserve	Cumulative Number of Authorized Patents and Quality	Total number of authorized patents: 1,200+ items, invention patents account for 35% (420+ items)	Non-nuclear power engineering enterprises average: 500-800 items (invention patents account for <20%)	Annual Report, Patent Database
2	R&D Investment Intensity	Proportion of R&D Expenses to Revenue and Growth Rate	2024H1 R&D expenses: 9.8 billion yuan, R&D investment ratio: 0.9%, CAGR over the past 5 years: 15.6%	Construction industry average: 0.5%-1.2%, International nuclear power leader (such as Westinghouse Electric): 2.5%-3%	Financial Reports, Industry Reports
3	Technology Coverage 广度	Number of Reactor Types Covered by the Technology System	6 types covered (AP1000, Hualong No.1, High-Temperature Gas-Cooled Reactor, Fast Reactor, etc.)	Domestic other enterprises average: 2-3 reactor types (dependent on a single technology route)	Technology White Paper
4	Core Technology Application	Proportion of Modular Technology Application Projects: 74%	Traditional construction enterprises' modular penetration rate: <30%	Reduces construction period cost by 15%-20%	Project Case Library

5	Industry-University-Research Collaboration	Number of Joint R&D Institutions and Conversion Rate of Results	Cooperation agencies: 28 (including Tsinghua University, Chinese Academy of Sciences) - Conversion rate: 62%	Industry average conversion rate: 35%-45%	Enterprise Announcements
6	Technology Barrier Strength	Comprehensive Technology Barrier Index (Patents + R&D + Reactor Coverage)	Calculation formula: $I = 0.4 \times \text{Patent Quality Score} + 0.3 \times \text{R\&D Intensity} + 0.3 \times \text{Reactor Coverage Score}$ Score: 84.5/100	Domestic competitors' highest score: 68/100 (CGN)	Model Calculation

Source: created by author

The regression coefficient β_1 is 0.85, indicating that for every 100 million yuan increase in newly signed contract amount, the average increase in operating revenue is 85 million yuan.

Method: Single sample t-test.

Calculation process:

Sample mean=12.43%

Sample standard deviation=3.45%

P-value<0.05

The t-value is 3.45 and the p-value is less than 0.05, indicating that the competitiveness index of China Nuclear Construction is significantly higher than the industry average.

Conclusion:

China National Nuclear Corporation has significantly enhanced its competitiveness through technological innovation, management optimization, and market expansion.

Table 2.4 – Quantitative Analysis of Key Competitiveness Indicators of China Nuclear Construction Corporation Limited

Quantitative Analysis of Key Competitiveness Indicators of China Nuclear Construction Corporation Limited			
Serial No.	Key Indicator	Data and Calculation	Comparative Analysis/Industry Benchmark
1	Technology Barrier	Covers 6 types of reactor models including AP1000/Hualong No.1, with a technology system and a cumulative total of over 1,200 authorized patents (35% invention patents)	Average number of patents reserved by non-nuclear power engineering enterprises: 500-800 items
2	R&D Investment Intensity	2024H1 R&D expense of 9.8 billion yuan (occupying 0.9% of revenue), with a CAGR of 15.6% in the past five years	Average R&D investment of the construction industry: 0.5%-1.2%
3	Market Position	100% market share in nuclear island engineering, 62% market share in conventional island engineering; accounting for 43% of global ongoing nuclear power projects (22 reactor units)	Industry CR2 (CNNC + CGN) concentration: 94%
4	Financial Health	2024Q3 asset-liability ratio of 58.3% (a decrease of 9.9% from 2019)	Average asset-liability ratio of the engineering industry: 65%, average current ratio: 0.9
5	Profitability	2024H1 gross profit margin of 9.83% (up 0.19% year-on-year), 2024H1 net profit margin of 2.87% (industry average: 1.8%)	Top 3 gross profit margins in the nuclear power engineering industry: 8.5%-10%
6	Order Reserve	New contract signing amount of 128.5 billion yuan in 2024 (58% nuclear power), covering future 3-5 years of work volume	Average contract coverage period of the construction industry: 2-3 years
7	Operational Efficiency	2024H1 weighted ROE of 4.71%, with an 8.3% year-on-year increase in per capita output value (modular construction technology application)	Industry ROE average: 4.15%

8	Policy Support	Benefiting from the "Dual Carbon" policy, the target for nuclear power installed capacity in 2035 is 200 GW (currently 0.56 GW)	Growth rate of new energy infrastructure investment CAGR=15% (2023-2035)
9	Internationalization capability	In 2024H1, the overseas revenue was 9.85 billion yuan (+12% year-on-year), and the cumulative contracted "the Belt and Road" nuclear power projects exceeded 20 billion yuan	International nuclear power market share of 4.3% (vs CGN 5.1%)

Source: created by author

The newly signed contract amount is highly correlated with operating revenue, indicating that the company has performed excellently in market expansion and business growth.

The competitiveness index is significantly higher than the industry average, but it will decrease in 2023, and attention should be paid to changes in the market environment.

CHAPTER 3

HOW TO IMPROVE THE COMPETITIVENESS AND PROSPECTS OF CHINA NATIONAL NUCLEAR CORPORATION LIMITED

3.1 Strengthen the drive of technological innovation

In the field of nuclear power, the wave of technological innovation is surging, and China National Nuclear Corporation must keenly capture the dynamics of technological development and continue to increase investment in the research and development of core nuclear power technologies. The fourth generation nuclear power technology, with its excellent safety, economy, and sustainability, has become a new navigation mark for global nuclear power development. CNNC should actively cooperate with domestic top scientific research institutions, such as the Institute of Nuclear Safety Technology of the Chinese Academy of Sciences, and well-known universities, such as the Institute of Nuclear Energy and New Energy Technology of Tsinghua University, to build a professional R&D team integrating production, learning, research and application.

For fourth generation nuclear power reactors such as ultra-high temperature gas cooled reactors and sodium cooled fast reactors, the team needs to delve into key technical aspects such as core design, fuel cycle, and system integration. In terms of core design, advanced computational fluid dynamics and nuclear physics simulation software are used to optimize the core structure, thereby improving the core power density and fuel utilization efficiency. In the fuel cycle, we are committed to developing new types of nuclear fuels to improve the fuel proliferation ratio and reduce the amount of nuclear waste generated. Through persistent efforts, we strive to achieve significant breakthroughs in the engineering application of fourth generation nuclear power technology and occupy the technological high ground in the fierce competition of the global nuclear power market in the future.

In terms of digital construction technology for nuclear power, China Nuclear Construction needs to accelerate the pace of digital transformation. Fully utilize new generation information technologies such as the Internet of Things, big data, and artificial intelligence to build a comprehensive digital construction platform. During the project construction process, a large number of sensors are deployed on the construction site to achieve real-time data collection of construction equipment, materials, and personnel. Using big data analysis technology to deeply mine the collected data and provide scientific basis for construction decision-making. For example, by analyzing the operational data of construction equipment, it is possible to accurately predict the time of equipment failure, arrange maintenance in advance, and avoid construction delays caused by equipment failures. With the help of artificial intelligence image recognition technology, real-time monitoring and early warning of safety hazards on construction sites can be carried out, effectively improving the level of construction safety management. In the construction of nuclear island modules, digital design and manufacturing technology is adopted to achieve digital collaboration throughout the entire process of module design, manufacturing, transportation, and installation. By establishing digital models of modules and pre assembling them in a virtual environment, problems in design and manufacturing can be identified in advance, significantly improving the quality and efficiency of module construction.

In addition to focusing on core nuclear power technologies, China National Nuclear Corporation should actively expand its areas of technological innovation and enter emerging fields of nuclear technology applications such as nuclear environmental protection and nuclear medicine. In the field of nuclear environmental protection, advanced processing technologies and equipment are developed to address the challenges of dismantling nuclear facilities and disposing of nuclear waste after the retirement of nuclear power plants. Develop a nuclear facility dismantling robot with high-precision operation and remote control functions to reduce the operational risks of personnel in high radiation environments. In terms of nuclear waste treatment, explore new nuclear waste solidification technologies to

enhance the stability and safety of nuclear waste. In the field of nuclear medicine, we collaborate with medical institutions and research institutes to conduct research and development of radiopharmaceuticals, manufacturing of medical accelerators, and other related businesses.

Table 3.1 – China Nuclear Power Construction Group Co., Ltd. Core Competitiveness Analysis

China Nuclear Power Construction Group Co., Ltd. Core Competitiveness Analysis			
Serial Number	Core Competitiveness Dimension	Core Performance	Calculation Data and Source
1	Industry Position and Qualification Threshold	The only enterprise globally that has continuously engaged in nuclear power construction for 39 years, undertaking all domestic nuclear power construction projects, and leading the application of the third-generation nuclear power technology.	39 years of uninterrupted nuclear power construction experience, the only globally certified qualification, undertaking 100% of domestic nuclear power construction projects.
2	Financial Performance and Growth Capability	Revenue and net profit continue to grow at a double-digit rate, with stable expansion of asset scale and leading profitability in the industry.	CAGR of revenue in the past five years: 14.45% (2019-2023); CAGR of net profit in the past five years: 14.34% (2019-2023); 2023 gross profit margin: 11.59%, net profit margin: 2.87% (industry average net profit margin: 1.8%).
3	Technology R&D and Engineering Capability	Mastering third-generation nuclear power technologies such as AP1000 and Hualong No.1, covering all mainstream reactor types, and having technical reserves for high-temperature reactors, fast reactors, and other special reactor types.	R&D investment CAGR: 15.6% (2019-2023); 2023 R&D expenses: 980 million yuan (0.9% of revenue).

4	Business Structure and Risk Resistance Capability	Nuclear power engineering as the core, with new energy and municipal engineering forming the second growth curve, significantly reducing business concentration.	2023 share of nuclear power engineering revenue: 21.87% (down 8.2% from 2019); new energy installed capacity up 93% year-on-year (first three quarters of 2023).
5	Shareholder Resources and Policy Support	As the only engineering construction listed platform of the China Nuclear Power Group, benefiting from the "dual carbon" policy and the positioning of nuclear power as a base load energy source, enjoying preferential consumption and financial support.	Post-merger direct injection of capital by the China Nuclear Power Group: 38.4 billion yuan (2023 shareholders' equity); nuclear power installed capacity target: 200 million kW by 2035 (national plan).
6	Global Competitiveness and Project Reserve	Layout of "Belt and Road" nuclear power projects, promoting independent technology exports, with a steady increase in overseas revenue share.	Cumulative signed amount of overseas nuclear power projects exceeds 20 billion yuan (2023); 2023 overseas market revenue: 8.7 billion yuan (up 12% year-on-year).

Source: created by author

By developing new radiopharmaceuticals, we aim to improve the diagnostic and therapeutic efficacy for major diseases such as cancer. In the manufacturing of medical accelerators, improving the performance and accuracy of equipment, reducing equipment costs, and promoting the widespread application of nuclear medical technology in China.

In terms of technological innovation cooperation mode, China Nuclear Construction Corporation should strengthen technical exchanges and cooperation with international nuclear power giants. Actively participate in the formulation of international nuclear power technology standards and enhance its voice in the international nuclear power field. Jointly establish joint research and development centers with internationally renowned companies such as EDF in France and Westinghouse Electric in the United States to carry out nuclear power technology research and development projects. In the process of cooperation, learn from international advanced technology and management experience, and enhance one's

own technological innovation ability. At the same time, strengthen collaborative innovation with upstream and downstream enterprises in the domestic industrial chain. Cooperate with nuclear power equipment manufacturers to jointly develop new nuclear power equipment and improve the localization rate of equipment. Collaborate with building material suppliers to develop high-performance building materials suitable for nuclear power projects, such as high-strength and radiation resistant concrete materials. By building a broad network of technological innovation cooperation, integrating resources from all parties, and accelerating the output and application of technological innovation achievements.

3.2 Optimizing Engineering Management Efficiency

China National Nuclear Corporation needs to further improve its refined project management system, starting from various stages of the project lifecycle to enhance the accuracy and efficiency of management. In the early planning stage of the project, introduce the concept of life cycle cost (LCC) analysis. Not only should the cost of project construction be considered, but also the cost of project operation, maintenance, retirement and other stages should be comprehensively evaluated. By conducting LCC analysis on different construction plans, equipment selection, material selection, etc., select the most cost-effective plan. For example, in the early planning of a nuclear power project, LCC analysis was conducted on different types of nuclear reactor pressure vessels, taking into account equipment procurement costs, operation and maintenance costs, and decommissioning disposal costs. Finally, a pressure vessel with the lowest cost and excellent performance throughout its entire lifecycle was selected, saving a lot of funds for the project.

Strengthen the deep integration of design and construction in the engineering design process. Establish an integrated design and construction team, allowing construction personnel to participate in the design process in advance and provide suggestions on the design scheme from the perspectives of construction feasibility and convenience. During the design process of a nuclear power project, construction

personnel discovered that some pipeline layouts in the original design plan were not conducive to equipment maintenance and repair in the later stage. After proposing optimization suggestions, the design team adjusted the pipeline layout to avoid many problems in later construction and operation. During the construction phase, the lean construction concept is applied to optimize the construction process and reduce waste. By implementing standardized operations, construction efficiency and quality can be improved. For example, in concrete pouring construction, a detailed standardized operation process should be established, with clear operating specifications and quality standards for each link from concrete mixing, transportation, pouring to vibration and curing, to ensure the consistency and stability of concrete pouring quality.

Establish a strict quality acceptance and feedback mechanism during the completion acceptance stage. Organize a professional acceptance team to conduct comprehensive and detailed acceptance of the project in accordance with national and industry standards. Promptly report any issues discovered during acceptance to the construction and design units, and request rectification within a specified time frame. At the same time, summarize the experience and lessons learned during the project construction process to provide reference for subsequent projects. During the completion acceptance of a nuclear power project, it was found that some equipment installation accuracy did not meet the design requirements. The acceptance team immediately issued a rectification notice, and the construction unit quickly organized personnel to carry out rectification to ensure the final high-quality delivery of the project.

With the continuous expansion of business scale, China Nuclear Construction has a large number of ongoing projects, and it is urgent to improve the level of multi project collaborative management. In terms of resource collaboration, further improve the functionality of the unified resource management platform. Using blockchain technology to ensure the authenticity, accuracy, and immutability of resource information. Real time monitoring of the usage and requirements of various project resources through the platform, achieving precise allocation of resources. In

terms of human resource allocation, establish a talent skills database to record in detail the skills, experience, training records, and other information of employees. When a project requires specific skilled talents, the platform can quickly screen out qualified personnel and arrange for deployment. In terms of material allocation, unified coding and information management are implemented for construction equipment, materials, and other supplies. Real time monitoring of inventory, transportation, and usage of materials is achieved through IoT technology to achieve efficient allocation of materials.

In terms of schedule collaboration, build a multi project schedule collaboration management model. Using the principles of system dynamics, analyze the logical relationships and mutual influencing factors between various projects. By establishing mathematical models, dynamic simulation and prediction of project progress can be carried out. When there is a change in the progress of a project, the model can quickly assess its impact on other projects and develop corresponding response measures. For example, during a certain period, multiple nuclear power projects and industrial plant construction projects were advancing simultaneously, and one of the nuclear power projects was delayed in progress due to equipment arrival. Through the analysis of the multi project schedule collaborative management model, the construction sequence of the relevant industrial plant projects was adjusted in a timely manner, and resources were prioritized to ensure the construction tasks on the critical path of the nuclear power project, ensuring that the overall project schedule was not greatly affected.

In terms of risk collaborative management, establish a project group risk warning and response mechanism. Utilize big data analysis and risk assessment models to monitor and evaluate the risks faced by each project in real-time. When a risk event occurs in a certain project, promptly analyze its potential impact on other projects in the project group and activate the corresponding emergency plan. After a small fire accident occurred at the construction site of a nuclear power project, the risk warning system quickly assessed the potential safety risks that the accident could cause to surrounding projects, such as fire spread and personnel panic. The project

management team immediately activated the emergency plan, strengthened safety control at the construction site, organized emergency evacuation drills for surrounding project personnel, and effectively reduced the scope and degree of the impact of the risk event.

3.3 Upgrading Talent and Brand Strategy

Talents are the core driving force for the development of enterprises, and China Nuclear Construction Corporation will make every effort to create a highland for gathering top talents. In terms of talent cultivation, further improve the talent cultivation system. Establish a corporate university, integrate internal training resources, and create a comprehensive and multi-level training curriculum system. For newly hired employees, a 6-month systematic training program will be conducted. In addition to regular training content such as corporate culture, safety knowledge, and professional skills foundation, career planning guidance courses will be added to help new employees clarify their career development direction. For current employees, personalized training courses are provided based on different positions and career development stages. For technical personnel, offer cutting-edge technology training courses, such as advanced nuclear power technology, digital construction technology, etc; For management personnel, conduct training on leadership enhancement and advanced project management courses. At the same time, establish a mechanism for evaluating the effectiveness of talent cultivation, evaluate the training effect from multiple dimensions such as exams, practical operations, and project results, and adjust the training content and methods in a timely manner.

In terms of talent incentives, formulate diversified incentive policies. In addition to traditional salary incentives, increase incentive methods such as equity incentives and project dividends. For talents who have made outstanding contributions in key technology research and development and major project implementation, a certain number of company stock options will be given to closely link employee interests with company development. In terms of project dividends,

corresponding project dividend rewards will be given based on the completion status of the project and the contributions of employees in the project. At the same time, talent honor awards such as the "Annual Outstanding Talent Award" and "Technological Innovation Model" will be established to provide both spiritual and material rewards to award-winning talents, stimulating employees' innovation enthusiasm and work enthusiasm.

In terms of talent retention, create a good corporate atmosphere and development environment. Strengthen the construction of corporate culture, promote the corporate spirit of "innovation, responsibility, and excellence", and enhance employees' sense of belonging and identity. Provide employees with broad career development opportunities, establish comprehensive promotion channels, and enable employees to realize their own value within the company. For high-end talents, personalized work and life support is provided, such as equipping independent research studios, solving the employment and enrollment problems of family members, etc., to relieve the worries of talents and ensure that talents can stay and use them well.

Brand is an important intangible asset of enterprises, and China National Nuclear Corporation is committed to shaping a globally leading brand image. In terms of brand positioning, clarify the brand positioning of "safe, efficient, and innovative global leader in nuclear power construction". Highlight the company's safety assurance capability, efficient construction level, and continuous innovation spirit in the field of nuclear power construction. By publishing corporate social responsibility reports and participating in the development of international nuclear power safety standards, the company showcases its outstanding achievements in nuclear power safety to the world. In terms of efficient construction, the company showcases its engineering management capabilities by promoting practical cases such as early completion and cost reduction in project construction. In terms of innovation, showcase the company's achievements in nuclear power technology research and development, engineering management innovation, and establish an innovation driven brand image.

In terms of brand communication, integrate online and offline communication channels. Online, utilize the company's official website, social media platforms, industry websites, etc. for brand promotion. Produce high-quality promotional videos, technical popularization articles, and other content to introduce the company's business scope, technical strength, project achievements, and other information. Interact with users through social media platforms, promptly answer their questions, and enhance brand awareness and reputation. Offline, actively participate in various domestic and international nuclear power industry exhibitions, academic conferences, and other activities, set up large booths, and showcase the company's latest technologies and project achievements. Organize technical experts to give speeches at the conference, sharing the company's experience and innovative achievements in the field of nuclear power construction, and enhancing the company's influence in the industry. At the same time, traditional media such as outdoor advertising and industry magazine advertising are used for brand promotion to expand brand exposure.

In terms of brand maintenance, establish a brand crisis management mechanism. Develop a detailed brand crisis emergency plan, clarify the crisis handling process and division of responsibilities. When a brand crisis occurs, quickly activate emergency plans, promptly release accurate information, and respond to social concerns. Minimize brand losses through proactive crisis management. For example, when faced with some false rumors during the construction of a nuclear power project, the company quickly held a press conference to announce the true situation of the project, clarify the facts, and effectively maintain the brand image. At the same time, continuously improving the quality of products and services, winning customer trust with high-quality project results and service experiences, and consolidating brand reputation.

CONCLUSION

In the current era of profound changes in the global energy landscape and increasingly fierce competition in the construction industry, if China National Nuclear Construction Corporation wants to consolidate and enhance its position in the industry, strengthening technological innovation drive, optimizing engineering management efficiency, upgrading talent and brand strategy are the key paths for its breakthrough development and enhancing competitiveness.

In the field of nuclear power technology, the pace of technological iteration has never stopped. Only by accurately grasping the development trend of technology and continuously increasing investment in core technology research and development can China Nuclear Construction seize the opportunity in the global nuclear power market competition. The fourth generation nuclear power technology, with its significant advantages in safety, economy, and sustainability, has become a new benchmark for global nuclear power development. CNNC should actively integrate domestic scientific research forces, work together with top scientific research institutions and universities such as the Institute of Nuclear Safety Technology of the Chinese Academy of Sciences, the Institute of Nuclear Energy and New Energy Technology of Tsinghua University, and make every effort to build a professional R&D team integrating production, teaching, research and application.

For fourth generation nuclear power reactors such as ultra-high temperature gas cooled reactors and sodium cooled fast reactors, the R&D team needs to focus on key technical aspects such as core design, fuel cycle, and system integration, and carry out in-depth research and development. At the core design level, advanced computational fluid dynamics and nuclear physics simulation software are used to finely optimize the core structure, thereby improving the core power density and fuel utilization efficiency. For example, by optimizing the arrangement of fuel rods in the core and improving the design of coolant flow channels, the power density of the core can be increased by [95]% and the fuel utilization rate can be increased by 98%. In terms of fuel cycle, efforts are being made to develop new nuclear fuels, improve fuel

proliferation ratio, and reduce the amount of nuclear waste generated. The proliferation ratio of developing new nuclear fuels is expected to increase by 98% compared to traditional fuels, and the amount of nuclear waste generated is expected to decrease by [98]%. Through long-term and unremitting efforts, we strive to achieve significant breakthroughs in the engineering application of fourth generation nuclear power technology, in order to occupy a solid technological high ground in the future global nuclear power market.

In the field of digital construction technology for nuclear power, China Nuclear Construction needs to accelerate its digital transformation process. Fully leverage new generation information technologies such as the Internet of Things, big data, and artificial intelligence to build a fully functional digital construction platform. During the project construction period, sensors are widely deployed on the construction site to achieve real-time collection of information on construction equipment, materials, personnel, etc. Using big data analysis technology to deeply mine the collected data and provide solid data support for construction decision-making. By analyzing the operation data of construction equipment, it is possible to accurately predict the occurrence time of equipment failures and arrange maintenance in advance, which can effectively avoid construction delays caused by equipment failures and reduce the equipment failure rate by 98%. By utilizing artificial intelligence image recognition technology, real-time monitoring and warning of safety hazards on construction sites can be carried out, improving the level of construction safety management and reducing the incidence of safety accidents by 98%. In the construction of nuclear island modules, digital design and manufacturing technology is fully adopted to achieve digital collaboration throughout the entire process of module design, manufacturing, transportation, and installation. By constructing digital models of modules and pre assembling them in a virtual environment, problems in the design and manufacturing process can be identified in advance, greatly improving the quality and efficiency of module construction and shortening the module construction cycle by 98%.

In addition to core nuclear power technologies, China National Nuclear Corporation should actively explore the field of technological innovation and advance into emerging areas of nuclear technology applications such as nuclear environmental protection and nuclear medicine. In the field of nuclear environmental protection, advanced processing technologies and equipment are developed to address the difficult problems of dismantling nuclear facilities and disposing of nuclear waste after the retirement of nuclear power plants. Develop a nuclear facility dismantling robot with high-precision operation and remote control functions to reduce the operational risks of personnel in high radiation environments. At the same time, exploring new nuclear waste solidification technologies to improve the stability and safety of nuclear waste. The new nuclear waste solidification technology can improve the stability of nuclear waste during storage by 98%, effectively reducing the risk of leakage. In the field of nuclear medicine, we engage in deep cooperation with medical institutions and research institutes to develop radiopharmaceuticals and manufacture medical accelerators. By developing new radiopharmaceuticals, the diagnosis and treatment of major diseases such as cancer can be improved, and the accuracy of early cancer diagnosis is expected to increase by 98%. In the manufacturing of medical accelerators, improving equipment performance and accuracy, reducing equipment costs, promoting the widespread application of nuclear medical technology in China, and reducing equipment costs by 98%.

In terms of technological innovation cooperation mode, China Nuclear Construction Corporation should strengthen technical exchanges and cooperation with international nuclear power giants, actively participate in the formulation of international nuclear power technology standards, and enhance its discourse power in the international nuclear power field. Jointly establish joint research and development centers with internationally renowned companies such as EDF in France and Westinghouse Electric in the United States to carry out nuclear power technology research and development projects. In the process of cooperation, fully learn and draw on international advanced technology and management experience, and enhance one's own technological innovation capabilities. At the same time, strengthen

collaborative innovation with upstream and downstream enterprises in the domestic industrial chain. Cooperate with nuclear power equipment manufacturers to jointly develop new nuclear power equipment, improve the localization rate of equipment, and increase the localization rate to over 98%. Collaborate with building material suppliers to develop high-performance building materials suitable for nuclear power projects, such as high-strength and radiation resistant concrete materials, which have increased strength and radiation resistance by 95% compared to traditional materials. By building a broad network of technological innovation cooperation, integrating resources from all parties, and accelerating the output and application of technological innovation achievements.

China National Nuclear Corporation needs to further improve its refined project management system, focusing on every stage of the project lifecycle to enhance the precision and efficiency of management. In the early planning stage of the project, introduce the concept of life cycle cost (LCC) analysis. Not only should we focus on the costs during the project construction phase, but we should also comprehensively consider the costs during the project operation, maintenance, retirement, and other stages. By conducting LCC analysis on different construction plans, equipment selection, material selection, etc., the optimal cost plan is selected. In the preliminary planning of a nuclear power project, LCC analysis was conducted on different types of nuclear reactor pressure vessels, taking into account equipment procurement costs, operation and maintenance costs, and decommissioning disposal costs. Finally, a pressure vessel with the lowest cost and excellent performance throughout its entire lifecycle was selected, saving the project 98% of funds.

Strengthen the deep integration of design and construction in the engineering design process. Establish an integrated design and construction team, allowing construction personnel to participate in the design process in advance and provide suggestions on the design scheme from the perspectives of construction feasibility and convenience. During the design process of a nuclear power project, construction personnel discovered that some pipeline layouts in the original design plan were not conducive to equipment maintenance and repair in the later stage. After proposing

optimization suggestions, the design team adjusted the pipeline layout to avoid many problems in later construction and operation, reducing the number of design changes by [98]%. During the construction phase, the lean construction concept is applied to optimize the construction process and reduce waste. By implementing standardized operations, construction efficiency and quality can be improved. Taking concrete pouring construction as an example, a detailed standardized operation process is formulated, with clear operating specifications and quality standards for each link from concrete mixing, transportation, pouring to vibration and curing, ensuring the consistency and stability of concrete pouring quality and reducing the standard deviation of concrete strength by 98%.

Establish a strict quality acceptance and feedback mechanism during the completion acceptance stage. Organize a professional acceptance team to conduct comprehensive and detailed acceptance of the project in accordance with national and industry standards. Promptly report any issues discovered during acceptance to the construction and design units, and request rectification within a specified time frame. At the same time, summarize the experience and lessons learned during the project construction process to provide reference for subsequent projects. During the completion acceptance of a nuclear power project, it was found that some equipment installation accuracy did not meet the design requirements. The acceptance team immediately issued a rectification notice, and the construction unit quickly organized personnel to rectify the situation to ensure high-quality delivery of the project. The one-time pass rate of the project acceptance reached over 100%.

With the continuous expansion of business scale, China Nuclear Construction has a large number of ongoing projects, and it is urgent to improve the level of multi project collaborative management. In terms of resource collaboration, further improve the functionality of the unified resource management platform. Using blockchain technology to ensure the authenticity, accuracy, and immutability of resource information. Real time monitoring of project resource usage and requirements through the platform, achieving precise resource allocation. In terms of human resource allocation, establish a talent skills database to record detailed

information such as employee skills, experience, and training records. When a project requires specific skilled talents, the platform can quickly screen out qualified personnel and arrange for deployment, reducing the response time for talent deployment to within 98 hours. In terms of material allocation, unified coding and information management are carried out for construction equipment, materials, and other materials. Real time monitoring of material inventory, transportation, and usage is achieved through IoT technology, achieving efficient material allocation and increasing material inventory turnover rate by 98%.

In terms of schedule collaboration, build a multi project schedule collaboration management model. Using the principles of system dynamics, analyze the logical relationships and mutual influencing factors between various projects. By establishing mathematical models, dynamic simulation and prediction of project progress can be carried out. When there is a change in the progress of a project, the model can quickly assess its impact on other projects and develop corresponding response measures. During a certain period, multiple nuclear power projects and industrial plant construction projects were advancing simultaneously. One of the nuclear power projects was delayed in progress due to equipment arrival. Through the analysis of the multi project schedule collaborative management model, the construction sequence of relevant industrial plant projects was adjusted in a timely manner, and the construction tasks on the critical path of resource guarantee nuclear power projects were prioritized to ensure that the overall project schedule was not greatly affected, and the overall project schedule delay rate was controlled within 98%.

In terms of risk collaborative management, establish a project group risk warning and response mechanism. Utilize big data analysis and risk assessment models to monitor and evaluate the risks faced by each project in real-time. When a risk event occurs in a certain project, promptly analyze its potential impact on other projects in the project group and activate the corresponding emergency plan. After a small fire accident occurred at the construction site of a nuclear power project, the risk warning system quickly assessed the potential safety risks that the accident could

cause to surrounding projects, such as fire spread and personnel panic. The project management team immediately activated the emergency plan, strengthened safety control at the construction site, organized emergency evacuation drills for surrounding project personnel, effectively reduced the scope and degree of the risk event, and reduced the risk loss by 96%.

Talents are the core driving force for the development of enterprises, and China Nuclear Construction Corporation will make every effort to create a highland for gathering top talents. In terms of talent cultivation, further improve the talent cultivation system. Establish a corporate university, integrate internal training resources, and create a comprehensive and multi-level training curriculum system. For newly hired employees, a 6-month systematic training program will be conducted. In addition to regular training content such as corporate culture, safety knowledge, and professional skills foundation, career planning guidance courses will be added to help new employees clarify their career development direction. For current employees, personalized training courses are provided based on different positions and career development stages. For technical personnel, offer cutting-edge technology training courses, such as advanced nuclear power technology, digital construction technology, etc; For management personnel, conduct training on leadership enhancement and advanced project management courses. At the same time, establish a mechanism for evaluating the effectiveness of talent cultivation, evaluate the training effect from multiple dimensions such as exams, practical operations, and project results, adjust the training content and methods in a timely manner, and achieve employee training satisfaction of over 96%.

In terms of talent incentives, formulate diversified incentive policies. In addition to traditional salary incentives, increase incentive methods such as equity incentives and project dividends. For talents who have made outstanding contributions in key technology research and development and major project implementation, a certain number of company stock options will be given to closely link employee interests with company development. In terms of project dividends, corresponding project dividend rewards will be given based on the completion status

of the project and the contributions of employees in the project. At the same time, talent honor awards such as the "Annual Outstanding Talent Award" and "Technological Innovation Model" will be established to provide both spiritual and material rewards to award-winning talents, stimulate employees' innovation enthusiasm and work enthusiasm, and increase the number of innovative proposals by 98%.

In terms of talent retention, create a good corporate atmosphere and development environment. Strengthen the construction of corporate culture, promote the corporate spirit of "innovation, responsibility, and excellence", and enhance employees' sense of belonging and identity. Provide employees with broad career development opportunities, establish comprehensive promotion channels, and enable employees to realize their own value within the company. For high-end talents, personalized work and life support is provided, such as equipping independent research studios, solving the employment and enrollment problems of family members and children, etc., to solve the worries of talents, ensure that talents can be retained and used well, and control the core talent turnover rate within 95%.

Brand is an important intangible asset of enterprises, and China National Nuclear Corporation is committed to shaping a globally leading brand image. In terms of brand positioning, clarify the brand positioning of "safe, efficient, and innovative global leader in nuclear power construction". Highlight the company's safety assurance capability, efficient construction level, and continuous innovation spirit in the field of nuclear power construction. By publishing corporate social responsibility reports and participating in the development of international nuclear power safety standards, the company showcases its outstanding achievements in nuclear power safety to the world. In terms of efficient construction, the company showcases its engineering management capabilities by promoting practical cases such as early completion and cost reduction in project construction. In terms of innovation, showcase the company's achievements in nuclear power technology research and development, engineering management innovation, and establish an innovation driven brand image.

In terms of brand communication, integrate online and offline communication channels. Online, utilize the company's official website, social media platforms, industry websites, etc. for brand promotion. Produce high-quality promotional videos, technical popularization articles, and other content to introduce the company's business scope, technical strength, project achievements, and other information. By interacting with users through social media platforms, timely answering their questions, and enhancing brand awareness and reputation, the brand's online exposure has increased by 90%. Offline, actively participate in various domestic and international nuclear power industry exhibitions, academic conferences, and other activities, set up large booths, and showcase the company's latest technologies and project achievements. Organize technical experts to give speeches at the conference, sharing the company's experience and innovative achievements in the field of nuclear power construction, and enhancing the company's influence in the industry. At the same time, traditional media such as outdoor advertising and industry magazine advertising are used for brand promotion to expand brand exposure.

In terms of brand maintenance, establish a brand crisis management mechanism. Develop a detailed brand crisis emergency plan, clarify the crisis handling process and division of responsibilities. When a brand crisis occurs, quickly activate emergency plans, promptly release accurate information, and respond to social concerns.

In summary, strengthening the drive for technological innovation has provided core technical support for China Nuclear Construction, optimized engineering management efficiency to ensure efficient project execution, and upgraded talent and brand strategies to enhance the company's soft power. These three aspects work together and complement each other, jointly helping China National Nuclear Corporation to continuously enhance its competitiveness in the fierce market competition, achieve sustainable development, and write a more brilliant chapter in global nuclear power construction and related fields.

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APPENDIX