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Finance, Banking and Insurance Department

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Completed:

Yang Bo

student of

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Supervisor

Puhach Yurii Vasylovych

PhD, assistant of the Department
of Finance, Banking and Insurance

Reviewer

Sosnytskyi Mykhailo Oleksandrovych

Director of GRAND META LLC

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ABSTRACT

Yang Bo. Green engineering management: practices and strategies for sustainable development.

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In this qualification work the theoretical and methodological foundations of green engineering were studied. A study of the state of green engineering in CSCEC has been carried out. Recommendations to improve the efficiency of green engineering in CSCEC have been developed.

In the first chapter ‘Theoretical and methodological foundations of green engineering, the evolution, concept, and essence of green engineering are investigated. The principles of green engineering are characterised. The stages of green engineering strategy formation in the company are considered. The key directions of green engineering are revealed.

Chapter two, ‘Investigating the status of green engineering in CSCEC’, which contains three sub-chapters, studies the management of green engineering in CSCEC.

Chapter three, ‘Improving Green Engineering at CSCEC’, which contains three sub-chapters, proposes recommendations to improve green engineering at CSCEC and evaluates the effectiveness of the proposed measures.

Improving green engineering in a construction company is a necessary step to achieve sustainable development and create a more prosperous future. Green technologies and construction practices can lead to cost savings in energy, water, and material costs. In addition, adopting green practices and obtaining environmental certifications enhances a company's reputation as a responsible and sustainable business.

Thus, the implementation of measures to improve green engineering at CSCEC will lead to positive changes in the company's performance in 2024, contributing to the further development of CSCEC and improving the efficiency of its core business.

Keywords: green engineering, environmental impact, environmental consequences, green project management.

АНОТАЦІЯ

Ян Бо. Управління зеленою інженерією: практики та стратегії для сталого розвитку.

Кваліфікаційна робота за спеціальністю 073 «Менеджмент» ОП «Адміністративний менеджмент» СНАУ, Суми-2024 - Рукопис.

У кваліфікаційній роботі досліджено теоретико-методологічні засади зеленої інженерії. Проведено дослідження стану зеленої інженерії в CSCEC. Розроблено рекомендації щодо підвищення ефективності зеленого інжинірингу в CSCEC.

У першому розділі «Теоретико-методологічні засади зеленої інженерії» досліджено еволюцію, поняття та сутність зеленої інженерії. Охарактеризовано принципи зеленої інженерії. Розглянуто етапи формування стратегії зеленої інженерії на підприємстві. Виявлено ключові напрямки управління зеленою інженерією.

У другому розділі «Дослідження стану зеленого інжинірингу в CSCEC», який складається з трьох підрозділів, досліджено управління зеленою інженерією в CSCEC.

У третьому розділі «Вдосконалення зеленої інженерії в CSCEC», який складається з трьох підрозділів, пропонуються рекомендації щодо вдосконалення зеленої інженерії в CSCEC та оцінюється ефективність запропонованих заходів.

Вдосконалення управління зеленою інженерією в будівельній компанії є необхідним кроком для досягнення сталого розвитку та створення більш процвітаючого майбутнього. Зелені технології та будівельні практики можуть призвести до економії витрат на енергію, воду та матеріали.

Таким чином, реалізація заходів з удосконалення зеленої інженерії в CSCEC призведе до позитивних змін у показниках діяльності компанії у 2024 році, що сприятиме подальшому розвитку CSCEC та підвищенню ефективності її основної діяльності.

Ключові слова: зелена інженерія, вплив на навколишнє середовище, екологічні наслідки, управління зеленими проектами.

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INTRODUCTION

Relevance of the topic. It is impossible to overstate the importance of green engineering in the modern world. Several factors are becoming increasingly critical in this regard.

The rise in global temperatures, alterations to climate patterns and the occurrence of extreme weather events are all consequences of anthropogenic impacts on the environment. The construction industry is a significant contributor to these changes, implementing green engineering principles essential to mitigate the negative impacts. The consumption of natural resources is occurring at an irreplaceable rate, and green engineering optimises the use of resources, reducing the consumption of materials, energy and water. This is important for achieving sustainable development. Furthermore, population growth and urbanisation are putting enormous pressure on infrastructure and natural resources. Green engineering helps create more efficient and sustainable urban environments, providing better living and working conditions for the public.

The implementation of green engineering principles can result in a reduction of operational costs, achieved through the conservation of energy and resources. Furthermore, it enhances the competitive advantage of construction companies in the marketplace, as clients demonstrate an increasing interest in green and sustainable projects.

The implementation of green engineering demonstrates the social responsibility of construction companies and engenders a healthier and safer environment for residents and employees alike.

The significance of green engineering is underscored by its intricate nature, which enables the simultaneous resolution of multiple challenges, encompassing environmental, social, and economic domains. Consequently, the implementation of green engineering is not merely a passing phenomenon; rather, it represents a crucial step towards the creation of a more sustainable and prosperous future.

The construction industry, which plays a pivotal role in economic activity, is also a major contributor to environmental degradation. The continued practice of

unsustainable methods, characterised by excessive resource consumption, greenhouse gas emissions and waste generation, represents a significant threat to the environmental sustainability of the planet.

In this regard, green engineering, an innovative approach aimed at reducing the negative environmental impact of construction and enhancing its sustainability, is becoming increasingly significant.

The purpose of the master's work is to develop recommendations for improving the efficiency of green engineering in China State Construction Engineering Corporation.

Research objectives:

- study the theoretical and methodological foundations of green engineering;
- conduct a study on the state of green engineering at CSCEC;
- develop recommendations to improve green engineering performance at CSCEC.

The purpose and objectives of the study determined the structure of the work, which consists of an introduction, three chapters a conclusion, and a list of sources used.

The first chapter reveals the concept and essence of green engineering and examines the stages of developing a green engineering strategy.

The second chapter presents the organizational and economic characteristics of CSCEC, assesses the management of green projects in CSCEC, and analyzes the development of green engineering in CSCEC.

The third chapter examines foreign experience in the development of green engineering, develops recommendations for improving green engineering at CSCEC, and evaluates the effectiveness of the proposed measures.

The object of the study is China State Construction Engineering Corporation.

The subject of the study is the management of green engineering in China State Construction Engineering Corporation.

Methods of research. The theoretical basis, scientific and methodological basis of the master's work is based on the provisions of the economic theory of enterprise management. To form the organizational and economic foundations of the management of green engineering in the Chinese State Engineering and Construction Corporation

(CSCEC), several modern scientific methods were used, in particular: the dialectical method of knowledge (a systematic approach to the study of economic phenomena); abstract-logical (with a theoretical generalization of the essence and content of management processes); economic analysis and comparison (in assessing the current state of the territorial community budget); tabular and graphical method (to display information on the financial status of CSCEC); formal and dialectical logic (to identify opportunities for adapting foreign experience).

The theoretical and methodological basis of the study is scientific and educational literature on the topic of research, as well as scientific periodicals, materials from scientific conferences, data from Internet sources, and statistical and analytical materials.

The scientific novelty of this research lies in its focus on enhancing green engineering management within the context of a large-scale, state-owned construction company, CSCEC. The study brings new insights into the integration of sustainable engineering principles with modern management practices, specifically in the construction industry.

received further development: the research provides further development in the area of sustainable project management, particularly through its focus on CSCEC's practices. It delves into the evolving application of green engineering principles, emphasizing the role of corporate governance in fostering sustainability. The development of comprehensive, multi-level management structures within CSCEC for overseeing environmental, social, and governance (ESG) initiatives further expands the knowledge of effective sustainable practices.

improved: the research improves upon existing frameworks by offering concrete recommendations on how to elevate green engineering practices in CSCEC. It refines the application of environmental technologies, such as low-carbon construction methods, and proposes an improved system for resource management and waste minimization. The study also improves the integration of sustainability with corporate strategy by introducing a refined model of communication and collaboration between various project stakeholders. Moreover, integrating Agile methodologies, enhances project flexibility, allowing for more dynamic and responsive management of green projects, which is

essential in the rapidly changing landscape of global construction demands.

The practical significance of the results is: the practical significance of the results is rooted in their direct applicability to improving green project management at CSCEC and beyond. The study offers actionable recommendations that can lead to more efficient use of resources, lower operational costs, and reduced environmental impacts.

Personal Achievements:

1. Yang Bo, Yurii Puhach. Green engineering in business management: benefits for a sustainable future. *Матеріали міжнар. наук.-практ. конф. “Сучасний стан та перспективи розвитку економіки, обліку, фінансів та права”*. м. Кременчук, 5 вересня 2024р. – Полтава: Видавництво ЦФЕНД, 2024. С. 24-26.

2. Yang Bo, Yurii Puhach. Agile methodology in green engineering as a tool for effective management of sustainable development projects. *Матеріали міжнар. наук.-практ. конф. “Сучасний стан та перспективи розвитку економіки, обліку, фінансів та права”*. м. Кременчук, 5 вересня 2024р. – Полтава: Видавництво ЦФЕНД, 2024. С. 53-55.

The structure and scope of work. Qualification work consists of an introduction, three chapters, conclusions and suggestions, a list of references, which consists of 42 titles. The main text is placed on 82 pages of computer text, the work contains 8 tables, 7 figures.

CHAPTER 1

THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF GREEN ENGINEERING

The field of green engineering is a relatively recent phenomenon, having emerged in the early 20th century. However, its conceptual foundations can be traced back to earlier notions of sustainability and ecology.

The stages of green engineering development are shown in Table 1.1.

Table 1.1 – Stages of Green Engineering Development

Period	Description
Early 20th century	The emergence of the environmental movement and the first studies on the impact of industry on the environment
1960s	Growing concern about environmental pollution and strengthening of the environmental movement
1970s	Formation of the first environmental agencies such as the EPA (USA) and the beginning of regulation of emissions and pollution
1980s	Development of the concept of sustainable development, emphasis on environmental and social aspects in production processes
1990s	The emergence of the term “green engineering” in scientific literature. Formation of the first green engineering curricula at universities. Development of standards and methods for assessing the environmental friendliness of products and processes
2000s	Increasing attention to green engineering in various industries, including automotive, chemical, food, etc. Development of new technologies and materials with low environmental impact. The emergence of new organizations and initiatives supporting the development of green engineering, such as the American Institute of Chemical Engineers (AIChE) and the Green Chemistry Institute
XXI century	Green engineering is actively developing, and integrating innovations in the field of ecology, materials science, energy and other areas. New technologies, materials and processes that meet the principles of green engineering are constantly emerging. Green engineering is becoming increasingly important to businesses as consumers become increasingly interested in environmentally responsible products and services.

Source: built on the source [1].

At present, green engineering constitutes an essential component of sustainable

development and is instrumental in addressing global environmental issues.

Green engineering is the design, commercialisation, and utilisation of processes and products in a manner that reduces pollution, promotes sustainability, and minimises risk to human health and the environment, while maintaining economic viability and efficiency [2].

The concept of green engineering espouses the view that the most efficacious and cost-effective decisions to safeguard human health and the environment can be made at the earliest stages of a process or product's design and development.

Green engineering is founded upon the tenets of sustainable development, with environmental considerations integrated into each stage of the product or process life cycle.

Green engineering processes and products:

- holistically use systems analysis and integrate environmental impact assessment tools;
- conserve and improve natural ecosystems while protecting human health and well-being;
- use life-cycle thinking in all engineering activities;
- ensure that all material and energy inputs and outputs are as inherently safe and benign as possible;
- minimize depletion of natural resources;
- strive to prevent waste [2].

Green engineering integrates the principles of sustainable development and engineering practice, focusing on:

1. Environmental sustainability:

- minimizing resource consumption. Using renewable energy sources, reducing water consumption, minimizing waste;
- reduction of pollution. Using environmentally friendly materials, reducing emissions of harmful substances into the atmosphere and water, reducing noise pollution;
- protection of biodiversity. Conservation of natural resources, restoration of

damaged ecosystems, minimization of negative impacts on flora and fauna.

2. Economic efficiency:

- cost reduction. Using more efficient technologies, reducing energy and material consumption, minimizing waste;
- increased productivity. Optimization of processes, use of advanced technologies, improvement of product quality;
- creation of new markets. Developing environmentally friendly products and services to meet the growing demand for sustainability.

3. Social responsibility:

- ensuring safe working conditions. Use of environmentally friendly materials, reducing risks to workers' health;
- improving the quality of life. Creating a cleaner and healthier environment, improving living conditions in cities and rural areas;
- development of local communities. creating new jobs, developing local economies, and attracting investment in environmentally friendly technologies.

Green engineers follow multiple principles that guide their design processes, including:

- holistic product creation. Green engineers may use system analysis and environmental impact assessment tools when designing products. These tools help identify how these changes affect a community and its environment before implementation;
- protecting human health. All green engineering techniques strive to protect human health and well-being. This principle may include identifying safer manufacturing methods and chemicals that don't affect human health;
- minimize natural resource depletion. The world contains limited natural resources and green engineers try to minimize their waste. They may focus on sustainable and long-lasting products and recyclable materials to help;
- remain culture-centered. Cultures and different regions may respond to green engineering changes in various ways. Engineers work to consider these beliefs and

integrate solutions that work for as many groups as possible;

- innovate and improve existing concepts. Engineering often includes taking known products and methods and improving them. Green engineers, following this concept, may take already successful processes and improve them;
- prevent problems first. Green engineers may focus on preventing problems before they occur rather than solving them after they arise. When problems occur, green engineers can find active and beneficial solutions;
- renew rather than deplete. Many professionals throw away products after minimal use, which may cause unnecessary waste. Green engineers work to prevent that problem by creating renewable and long-lasting products;
- minimize financial loss. Businesses require a profitable operation to remain open, and green engineers work to improve a company's operations. Their methods strive to create minimal financial loss and even foster economic growth when possible.

The main stages of developing a green engineering strategy are shown in Table 1.2.

Table 1.2 – Main stages of developing a green engineering strategy

Main stage	Step	Content
1	2	3
1. Definition of goals and objectives	Analysis of the current situation	Assessing the current environmental impact of the company's activities, identifying problem areas and risks
	Setting goals	Formulation of clear and measurable goals to reduce environmental impact, optimize resource consumption, increase efficiency in the use of materials and energy
	Prioritization	Selecting key areas for green engineering implementation, taking into account importance, feasibility and available resources
2. Creation of the concept of green engineering	Learning best practices	Analysis of existing solutions and technologies in the field of green engineering, comparison of their effectiveness and applicability to a specific situation
	Concept development	Formulation of principles and approaches to the implementation of green engineering in specific processes and products
	Selecting Tools	Determine the most effective tools and methodologies to achieve your goals, e.g. eco-design, life cycle analysis (LCA), ISO 14001, sustainable procurement

Continuation of Table 1.2

1	2	3
3. Implementation of the strategy	Developing an action plan	Clear planning of specific steps and activities for the implementation of green engineering
	Resource mobilization	Ensuring sufficient funding, attracting specialists, and allocating the necessary resources to implement the action plan
	Implementation of technologies and processes	Transition to environmentally cleaner technologies, optimization of production and consumption processes, introduction of resource management systems
4. Monitoring and evaluation	Data collection and analysis	Regular monitoring of environmental impact indicators, the effectiveness of implemented solutions and progress towards achieving goals
	Evaluation of results	Assessing the effectiveness of a green engineering strategy, identifying problem areas and adjustment needs
	Raising awareness	Informing employees, partners and customers about achievements in the field of green engineering

Source: built on the source [3].

It is crucial to recognise that the development and implementation of a green engineering strategy represents an ongoing process that necessitates constant analysis, adaptation and improvement.

Key elements of a successful green engineering strategy include:

- full participation of management. Active support and involvement of management in the process of developing and implementing the strategy;
- integration into business processes. Introduction of green engineering principles into all stages of the production cycle and business processes;
- cooperation and communication. Effective interaction between various departments of the company, partners and suppliers;
- training and professional development. Providing employees with the necessary knowledge and skills to effectively implement green engineering;
- motivation and involvement. Creating a motivational environment for employees so that they understand their role in achieving environmental goals.

Examples of green engineering innovations:

1. Zero-energy buildings

The objective is to operate through the utilisation of renewable energy sources. While the initial cost may be considerable, the long-term benefits are likely to outweigh this investment. The utilisation of solar, wind, or hydro energy is a common means of attaining zero-energy consumption. Before construction, engineers utilise a technology that is capable of calculating the precise amount of energy required to attain a net-zero building [25].

2. Use of waste to create concrete alternatives

A variety of strategies have been developed for the production of construction materials based on green technology. The transformation of waste is intended to reduce the use of sand, decrease carbon emissions, and enhance waste management practices. The implementation of these strategies results in the creation of eco-concrete and eco-bricks. Experimentation demonstrated that concrete and bricks manufactured from waste have a lower carbon footprint and are non-toxic compared to commercially available products [34].

3. Water treatment systems

The excessive consumption of water represents a significant environmental concern in both residential and commercial settings. Water is one of the most utilized natural resources, and green engineers are committed to its conservation.

Wastewater, including grey water, can undergo treatment and subsequent recycling for alternative purposes. In contrast to black water, which is produced by toilets, grey water, comprising runoff from air conditioning and showers, can be treated and reused for a variety of purposes, including fueling boilers and irrigating plants. The objective of a water catchment system is to separate and recycle water for subsequent treatment and reuse in a controlled environment.

4. Clean and efficient energy systems

There is a growing global acceptance of solar power and other renewable energy sources in both domestic and commercial settings. These clean energy alternatives can be employed to supplement homes and buildings, thereby reducing their reliance on or even

rendering them independent of fossil fuels.

Solar technology is being developed further by manufacturing companies with the aim of improving its efficiency in gathering and storing energy. As a consequence of recent advances in manufacturing technology, companies are now in a position to offer solar panels to the public at a lower cost.

5. Nature-based heating and cooling

Ground source heat pumps are designed to extract energy from the sustained temperatures of the soil. This cost-effective heating and cooling alternative to traditional HVAC systems is capable of providing warmth in the winter and cooling in the summer. To further enhance energy efficiency and reduce utility costs, green engineers often supplement these energy sources with Energy Star-certified appliances.

Furthermore, triple-pane windows are gaining popularity, particularly in the context of office buildings. Glass is one of the most commonly used materials in the construction industry. Consequently, engineers and architects sought a means of rendering them more conducive to energy conservation. The triple-pane window is designed to deflect heat, thereby maintaining a cool environment in hot weather. Furthermore, this technology can assist in reducing heating costs by retaining heat during the colder months.

6. Intelligent lighting and climate control

It is essential that all buildings, whether residential or commercial, are equipped with an appropriate lighting system. Those engaged in the field of green engineering are aware of the crucial role that lighting plays in ensuring a comfortable standard of living and the ability to work. Given that lighting accounts for 18% of electricity consumption in buildings, green buildings must seek to optimise usage and enhance efficiency.

The most prevalent lighting technologies in smart homes and buildings today are LED and adaptive lighting. LED bulbs are 90% more efficient than incandescent bulbs, while adaptive lighting systems are designed to sense the presence of individuals within a room. Intelligent lighting systems are designed to adjust the intensity of the light in accordance with the needs of the inhabitants, the power levels required and the user preferences.

Furthermore, climate control is a crucial aspect that affects the quality of life and work in any given space. Through the implementation of a straightforward command, intelligent air conditioning units are capable of identifying the period of peak usage and subsequently adjusting the settings in one or all rooms accordingly. Furthermore, intelligent climate control systems are connected to the internet, thereby affording users the ability to control their settings and features even when situated a considerable distance from their homes [17].

7. Alternative construction materials

The field of green engineering acknowledges and addresses the necessity for enhanced construction and residential infrastructure. It is incumbent upon engineers to devise methods of rendering materials more sustainable. Cement, one of the most widely used construction materials, is responsible for at least 8% of global CO₂ emissions [4].

Researchers are currently exploring the potential for developing carbon-sequestering cement through the addition of sodium bicarbonate to the mixing process [30]. Other potential solutions include the utilisation of hempcrete and straw bales for the insulation of domestic properties, offering a low-impact, high-performance alternative.

Additionally, some architects favour the use of wood, particularly timber that has been responsibly sourced from sustainable farms. Cross-laminated wood has the potential to serve as a carbon storage medium in buildings, and it can be employed instead of steel and concrete in a number of applications. Green engineering is concerned with the re-evaluation of existing methodologies and the implementation of improvements. Each contribution is of benefit to the environment, allowing it to recover more quickly [29].

The introduction of green engineering principles brings a company a number of significant advantages that contribute to its sustainable development and increased competitiveness:

1. Economic efficiency:

- reduction of transaction costs. Saving energy, water, materials and resources leads to a reduction in the costs of production, operation and maintenance of buildings and structures;
- increasing investment attractiveness. Investors are increasingly choosing

projects that comply with the principles of sustainable development. Companies that apply green engineering gain an advantage in the capital market;

- reduction of tax payments. Some countries have tax incentives and incentive programs for companies implementing green technologies [6].

2. Improving image and reputation:

- increasing customer confidence. Customers increasingly value environmentally responsible companies. The implementation of green engineering demonstrates the company's concern for the environment and social responsibility;
- attracting talented employees. Today's professionals are increasingly looking to work for companies that share their values and are committed to sustainability;
- brand strengthening. Green engineering helps position a company as environmentally responsible, which increases its competitiveness in the market.

3. Reducing environmental impact:

- reduction of greenhouse gas emissions. The use of energy efficient solutions, the use of renewable energy sources and improved thermal insulation of buildings help reduce the company's environmental footprint;
- conservation of natural resources. The rational use of water, energy and materials contributes to the conservation of natural resources and ensures their sustainable use in the future;
- reduction of pollution. The use of green engineering reduces emissions of pollutants into the atmosphere, water and soil, which has a beneficial effect on the quality of the environment.

4. Improving the quality of life of employees:

- creating a comfortable working environment. The use of green technologies allows us to create a more comfortable working environment with a better microclimate, lighting and acoustics;
- improving employee health. Reducing pollution levels inside buildings has a positive effect on employee health, reducing the risk of developing respiratory diseases and allergies;

- increasing motivation. Employees are more motivated to work for a company that shares their values and is committed to sustainability.

It is important to note that the benefits of green engineering for a company are not limited to the above. Its application helps create a more sustainable and prosperous business model that benefits both the company and society as a whole [5].

At the end of this section, let's summarize.

Green engineering is the design, commercialisation, and utilisation of processes and products in a manner that reduces pollution, promotes sustainability, and minimises risk to human health and the environment, while maintaining economic viability and efficiency [16], [17].

The fundamental principles of green engineering encompass a range of strategies aimed at preventing environmental issues from arising in the initial stages of the design process. These include the utilisation of materials that are readily recyclable, biodegradable or derived from renewable sources, the optimisation of processes, the minimisation of waste, the deployment of more efficient technologies, the reuse of materials and resources, the recycling of waste, and the integration of environmental considerations into the design of products and systems throughout their life cycle. Additionally, green engineering involves collaboration with a diverse array of stakeholders, including suppliers, customers, governments and local communities.

Examples of applications of green engineering include the development of energy-efficient buildings utilising solar energy and geothermal heat, the production of environmentally friendly cars employing electric vehicles and hybrid technologies, the creation of water purification systems employing biological treatment methods, and the development of environmentally friendly agricultural practices such as organic farming [18].

Green engineering represents a promising field of study that enables the creation of more environmentally friendly and sustainable systems. It plays a significant role in addressing global issues such as climate change, pollution and the depletion of natural resources.

CHAPTER 2

INVESTIGATION OF THE STATE OF GREEN ENGINEERING IN CSCEC

2.1 Organisational and economic characteristics of CSCEC

China State Construction Engineering Corporation (hereinafter referred to as CSCEC) was officially established in 1982. It is a Chinese investment corporation with the longest development history in its industry, the most mature market management, the highest level of integration and the largest scale in the world.

The development history of CSCEC is shown in Table 2.1.

Table 2.1 – History of CSCEC development

Year	Characteristic
1	2
1982	On June 11, 1982, the China State Construction Engineering Corporation was officially established. English name: CHINA STATE CONSTRUCTION ENGINEERING CORPORATION (abbreviation CSCEC).
1984	From July 3 to July 5, 1984, a meeting was held in Beijing to exchange experiences of construction enterprises of the China Engineering and Construction Company. The main office and eight directly related engineering offices signed the 1984 financial responsibility documents. This marked the beginning of the introduction of a parent company responsibility system within the country.
1985	On July 18, 1985, the famous American magazine The Engineering News-Record published the 1984 ranking of the World's International Contractors. CSCEC took 21st place in the ranking with foreign turnover of 824 million US dollars. December 10 China Construction America, Inc. was registered in the state of Delaware, USA.
1987	On November 28, 1987, the China Construction Industry Federation awarded 12 Lu Ban Awards for the first time. The multi-story Shenzhen International Trade Center construction project carried out by Shenzhen First Construction and Construction Bureau, one of the three China Construction bureaus, was awarded the first Lu Ban Prize.
1988	In October 1988, a Lubuge CSCEC experience-sharing meeting was held in Wuhan. At the meeting, it was put forward that the implementation of Lubuge's experience should become a major part of the reform of the work of construction enterprises.

Continuation of Table 2.1

1	2
1990	On April 18, 1990, the former Kanhua China Urban Design Research Institute was incorporated into the structure of the China Construction Engineering Company and renamed the Beijing China Architecture and Construction Research Institute.
1991	On February 4, 1991, China Construction Engineering Company developed the "CSCEC" logo and badge seal. The logo and icon are square, which symbolizes the foundation stone of the building and indicates that the foundation is strong, the blue background symbolizes the blue sky and ocean, which indicates unified management at home and abroad, the inscription in English letters "CSCEC" is the abbreviation of the English name Chinese engineering and construction company CHINA STATE CONSTRUCTION ENGINEERING CORPORATION, the shape of the inscription symbolizes the architectural style.
1992	From 4 to 7 August 1992, ChinaOverseasHoldingsLimited was registered in Hong Kong with a subsidiary company ChinaOverseasLandandInvestmentLTD., 820 million new shares were sold at an offer price of HK\$1.03 per share, total capital concentration was HK\$845 million.
1993	On January 7, 1993, China Construction Engineering Company formulated the "Tertiary Manufacturing Industry Development Program during the Eighth Five-Year Plan Period (Project)": by 1995, the main economic and technical indicators of the tertiary industry should reach a turnover of 3.22 billion yuan, three times more compared to 1990.
1994	On June 7, 1994, the Chinese Academy of Engineering announced the list of the first batch of academicians (96 people). Zhang Jinqiu, chief architect of China Northwest Architectural Design and Research Institute CSCEC, has been elected as an academician of the Chinese Academy of Engineering.
1995	On June 21, 1995, CSCEC was established with China Construction Engineering Company as its core. CSCEC immediately convened a meeting of 37 full and controlling members to formulate the "CSCEC Charter" and began industrial and commercial registration procedures.
1996	In June 1996, CSCEC introduced the CI strategy, carried out the design and promotion of CI, and promoted the company's development as the embodiment of "quality on the inside and image on the outside."
1997	In March 1997, CSCEC held a computer work conference and required five years to implement CSCEC's three-tier computer network. In 1997, CSCEC headquarters mainly implemented a computer network.
1999	In April 1999, the Jiuquan satellite launch site, which was built by CSCEC's eighth bureau awarded the construction work, was awarded the "National First Science and Technology Award".
2000	In December 2000, CSCEC released the CSCEC Standards Identification Guide and the CSCEC Philosophy Identification Guide.
2001	On May 28, 2001, CSCEC moved its headquarters to a new office building at 15 Sanlihe Road, Haidian District, Beijing. Since 2001, China Construction Engineering Company has implemented an annual wage system for business entities of all wholly-owned and holding companies.

Continuation of Table 2.1

1	2
2002	In December 2002, CSCEC first proposed the international strategy of "One is the best, two is the top": to build CSCEC into "the international most competitive group of Chinese construction enterprises, operate on a global scale and become one of the world's top 500 overseas businesses by 2010 and among the top ten international contractors."
2004	On November 22, 2004, CSCEC and Shanghai Construction Engineering jointly won the tender for the Shanghai World Financial Center project. This is the first time that domestic construction companies independently entered into contracts with foreign investors.
2006	On July 12, 2006, the American magazine Fortune published a list of the "Top 500 Companies in the World" for 2006. The Chinese engineering and construction company ranks 486th, 4 years ahead of schedule, achieving the goal of "One is the best, two is beyond": to enter the "World Top 500".
2007	On December 8, 2007, the founding meeting of China State Construction Engineering Corporation Limited was held in Beijing, which marked the successful completion of the overall restructuring of CSCEC, and also marked the birth of a large-scale corporation operating in the field of modern buildings and real estate, with a perfect system, international standards and competitiveness in the market.
2008	On May 12, 2008, the Sichuan earthquake occurred. After the earthquake, China Construction built 1.1 million square meters. housing for temporary relocation in Sichuan and Gansu provinces. In recent years, China Construction has completed 51 projects in earthquake-affected areas and 71 projects under construction in the main building structure. In construction for the Beijing Olympic Games, CSCEC took over the construction of 40% of the venues and supporting facilities for the Beijing Olympic Games.
2009	On July 29, 2009, CSCEC listed shares on the Shanghai Stock Exchange, entered the Chinese capital market, and raised a total of RMB 50.16 billion in financing.
2010	In September 2010, China Construction applied for registration and approval with the National Trademark Office of 45 different trademarks "China Construction" and "China Construction + CSCEC". "China Construction" has become a registered trademark of China State Construction Engineering Corporation Limited.
2011	In February 2011, during the military turmoil in Libya, through careful management, China Construction successfully completed the evacuation of 1,242 Chinese employees and 957 employees from Bangladesh and Vietnam from Libya.
2013	On December 19, 2013, the Chinese Academy of Engineering announced the results of the joint selection of the 2013 Academician. Comrade Xiao Xiuwen from China Engineering and Construction Company was elected as an academician.
2014	On April 4, 2014, China Construction America, Inc., a wholly owned subsidiary of CSCEC, completed the acquisition of US-based Plaza Construction. This was China Construction's first overseas M&A transaction.

End of table 2.1

1	2
2015	On October 30, 2015, three renowned international rating agencies unanimously awarded China State Construction Engineering Corporation Limited (China Construction, 601668) the highest global credit rating in the industry, namely S&P A/Moody A2/Fitch A, the rating is expected to remain stable.
2016	On January 21, 2016, China Construction signed a contract worth US\$2.7 billion for a project to build a new capital in Egypt. Chinese President Xi Jinping and Egyptian President El-Sisi jointly witnessed the signing.
2017	On January 19, 2017, the 2030 target of "1211" was proposed at the 2017 China Construction Working Conference. In December 2017, China Construction Engineering Company was renamed CHINA STATE CONSTRUCTION ENGINEERING CORPORATION through restructuring.

Source: built by author based on CSCEC data.

CSCEC is a publicly traded company on the stock exchange (stock code 601668.SH). It has eight public companies and over one hundred secondary subsidiary holding companies.

CSCEC has become a significant enterprise within the global construction industry, with the value of new contracts awarded and annual revenue simultaneously reaching in excess of 1 trillion yuan. The corporation has ascended to the 9th position on the 2022 Fortune Global 500 list, the 3rd position on China's Top 500 list, and has been ranked first among Engineering News Record's 2021 Top 250 Global Construction Contractors. CSCEC retains the industry's highest global credit rating. The brand's competitive advantage and market presence are consistently expanding, and its dominant position in the construction industry is becoming more entrenched.

CSCEC has a global reach, with operations in over 100 countries and regions worldwide. Its business interests encompass real estate investment, construction (housing, infrastructure, commercial real estate), and design and survey work in emerging fields such as green building. Furthermore, the company's activities encompass energy saving, environmental protection and e-commerce. In China, CSCEC has constructed over 90% of skyscrapers exceeding 300 meters in height, three-quarters of key airports, three-quarters of satellite launch sites, three-quarters of city communication tunnels and half of the country's nuclear power plants. One in every 25 residents of China has a residence

constructed by CSCEC.

CSCEC has formulated its mission statement as follows: "Expanding the space for happiness." This statement can be interpreted to mean that the company's objective is to expand the space for happiness and to create value for customers. China Construction's entire value is contingent upon the high recognition and complete trust that customers have in the company. It is the customer who is the ultimate arbiter of enterprise value. The company's primary objective is to identify and address customer requirements, exceeding expectations where possible, and offering comprehensive solutions.

CSCEC has articulated a vision of "becoming the most competitive investment and construction group in the world." This signifies that within the domain of investment and construction, the company aspires to attain a competitive edge across the entire industry spectrum, thereby becoming a renowned and globally competitive group of enterprises and a public joint-stock company. CSCEC preserves its distinctive advantages, enhances its competitive position through continuous innovation and systematic marketing, and provides customers (government, enterprises, individuals, etc.) with high-quality value-added products and services. It creates value for employees, shareholders, partners and other stakeholders, and contributes to the economic development of China and even the world as the "Construction Force of CSCEC."

As one of the most integrated and largest investment and development conglomerates, boasting the longest history of specialised development and market-oriented operation in China, with the most extensive business operations worldwide, CSCEC is a market leader in housing construction engineering, infrastructure construction and investment, real estate development and investment, survey and design, and other related fields. CSCEC was ranked 13th in the 2023 Fortune Global 500 and 4th on the Fortune China 500 list and maintained its position as the top-ranked company on the Top 250 Global Contractors list published by Engineering News-Record (ENR). In 2023, CSCEC was awarded a Grade A rating for the 18th consecutive year in the annual performance evaluation conducted by the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council. The three leading global rating agencies, namely S&P Global Ratings, Moody's Investors Service and Fitch

Ratings, assigned CSCEC ratings of A/A2/A, respectively, each with a "Stable" outlook. This represents the highest credit rating among global industry peers [20].

CSCEC is widely regarded as one of the most competitive investors in China, with a particular focus on real estate development, financing and investment in construction projects, integrated urban construction, and related areas. The company's business model, which it refers to as the "four in one" model, integrates planning and design, investment and development, infrastructure construction, and housing construction engineering. This model allows the company to provide turnkey solutions that address all aspects, processes, and elements of urban development projects. The company places a premium on the integration of its internal resources and business development.

CSCEC is the largest engineering contractor in the world, with operations in over 100 countries and regions. The company's specialisations span the full range of urban development and encompass all phases of construction projects. The company is well equipped with the capabilities of comprehensive design, construction and land development, and has a complete industry chain of construction products ranging from product and technology R&D, survey and design, real estate development, construction contracting, equipment manufacturing and asset operation to property management. It is the developer of the majority of super-high-rise buildings (300 meters and above) in China, as well as numerous other technically and structurally sophisticated buildings.

CSCEC is a preeminent entity in the field of housing construction, both within China and on the global stage. The company's activities encompass the full spectrum of urban and facility construction. The corporation has been awarded numerous construction contracts and has erected a considerable number of landmarks in a variety of sectors, including public buildings, offices, airports, hotels, educational and sports institutions, human settlements, medical institutions, embassies, industry, national defense and other areas. It has extensive experience in the field of super high-rise structures.

CSCEC is dedicated to offering comprehensive services for the design and execution of diverse, intricate construction projects for domestic and international clients. The company adheres to a marketing strategy of "large owner, large market, large project" and a business management strategy of "low-cost competition, high-quality

management". This is achieved through ongoing assessment of capabilities, rigorous cost control, and rigorous quality management. The company is committed to customer satisfaction and other measures to ensure national and international standards of engineering quality and enhanced services.

CSCEC is engaged in two distinct but interrelated areas of activity: engineering construction and project investment. On the one hand, the company relies on technology, human capital and management advantages to facilitate rapid development in capital construction fields, including urban rail transport, high-speed railways, super-large bridges, expressways, urban communication tunnels, ports and airways, electric power, mining, metallurgy, petrochemicals, airports, nuclear islands and other infrastructure facilities, both domestically and internationally. Conversely, leveraging a robust capital base, CSCEC has rapidly ascended to become a preeminent infrastructure investment and financing developer within China. The company has made significant investments in numerous nationally and locally pivotal projects in China, and has engaged in the construction of BT, BOT, and PPP projects. Presently, the company has established long-term strategic cooperative relationships with infrastructure investment and construction in several provinces (regions) directly under the leadership of the central government and a dozen key cities. In terms of overseas operations, CSCEC infrastructure construction has a presence in dozens of countries and regions, including North America, Central America, Hong Kong, Macau, Southeast Asia, North Africa, Central and West Africa, South Africa, the Middle East and Central Asia.

China Construction represents one of the most significant investors in China. The primary areas of investment encompass development activities, investments and construction, in addition to integrated urban construction. Zhonghai Real Estate has consistently held a dominant position within the Chinese real estate industry. The brand has been ranked first in the industry for 14 consecutive years, according to the "China's Leading Real Estate Brand Company" ranking.

China Construction's objective is to achieve vertical integration across the investment, development, design, construction, operation and maintenance spectrum. A comprehensive investment management and risk management system has been

established, and considerable expertise has been amassed in investment and financing management. Additionally, a substantial number of professionals are engaged in the oversight of investment activities. Concurrently, financial transactions are being developed and the integration of industry and finance is being promoted. China Construction Fangcheng represents a novel approach to urban investment, prioritising comprehensive area development and land value enhancement. The company's experience has enabled it to develop the capacity for comprehensive urban integration.

China Construction represents one of the largest integrated enterprise groups in the field of architectural design, urban planning, engineering surveying and municipal utilities. CSCEC is comprised of seven large-scale research and development enterprises with A-grade qualifications. The company has completed a significant number of exemplary architectural and construction projects with national characteristics and in the spirit of the times, including airports, hotels, sports buildings, exhibition buildings, ancient buildings, super-tall structures, and other structures. CSCEC continues to occupy a leading position in the country.

China Construction employs nearly 10,000 professionals in the fields of architectural design, municipal engineering design, engineering survey and rock soil. This constitutes the largest total number of high-quality specialists in the industry. Through the development of originality, technological innovation, standards and other aspects, these professionals have made important contributions to industry development.

CSCEC has a complex governance structure (Figure 2.1). It is divided into several key divisions that work together to achieve its business goals.

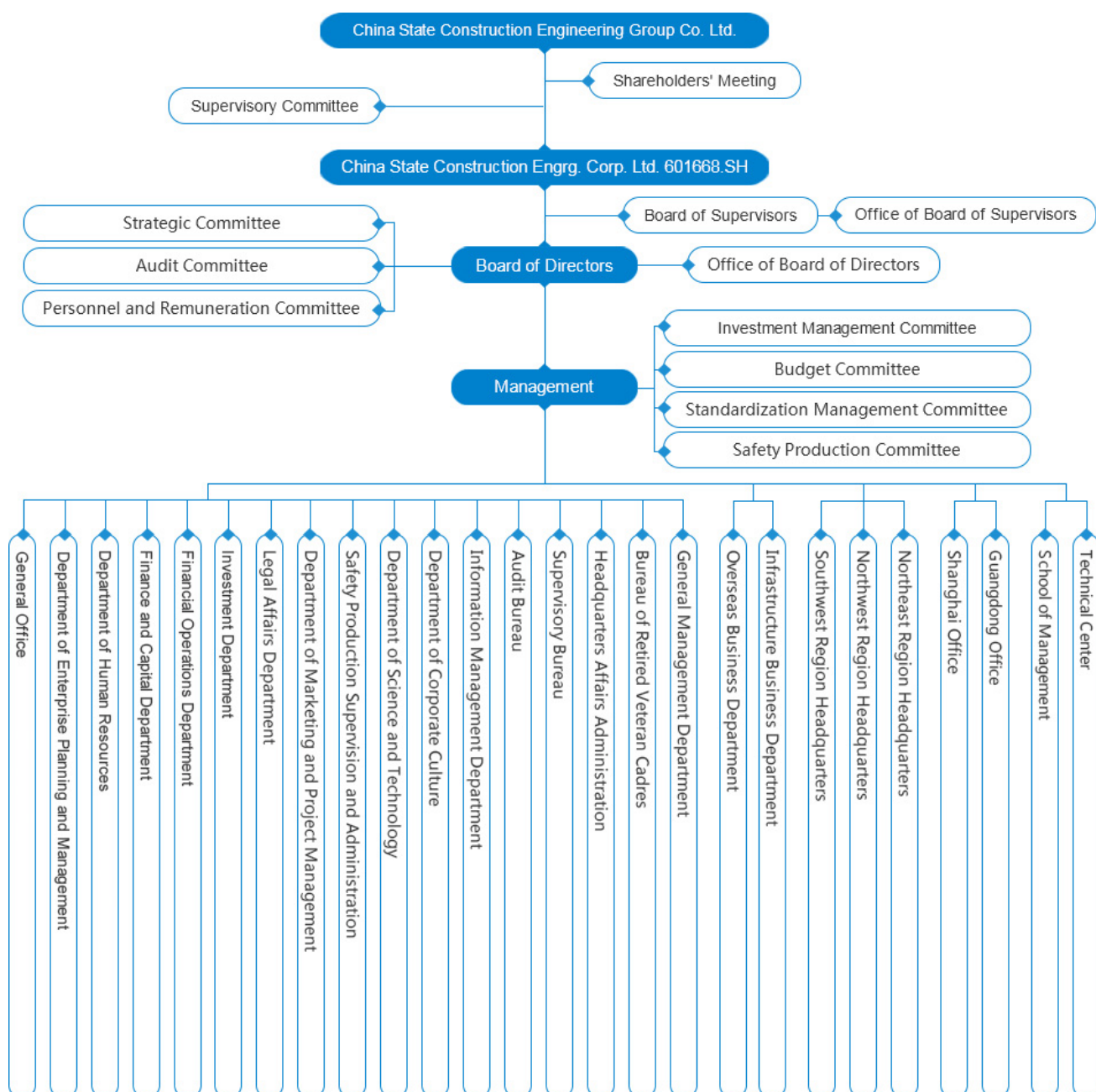


Figure 2.1 – Diagram of the organizational structure of CSCEC management

Source: built by author based on CSCEC data.

The company has a complete staff of administrative, engineering, and production personnel who possess the necessary qualifications to carry out current production tasks.

CSCEC's organizational structure was developed with a focus on the process of making and implementing management decisions. It is built on a functional principle, which enables the enterprise to address diverse issues related to its activities.

CSCEC's personnel policy aims to develop highly qualified personnel who are

motivated to work efficiently and professionally, ensuring effective solutions to the companies current and future challenges. The following individuals are employed by CSCEC:

- the individual possesses a high level of professionalism and educational qualifications;
- responsible approach to work and result orientation;
- the desire and ability to participate independently;
- initiative, focus on actively looking for solutions;
- the desire and ability to learn and use acquired knowledge practically;
- ability to adapt, psychological stability, and adaptability;
- a strong commitment to corporate values and traditions.

In 2023, CSCEC's revenue was 2266 million yuan, an increase of 10.2% compared to 2022 (Figure 2.2).

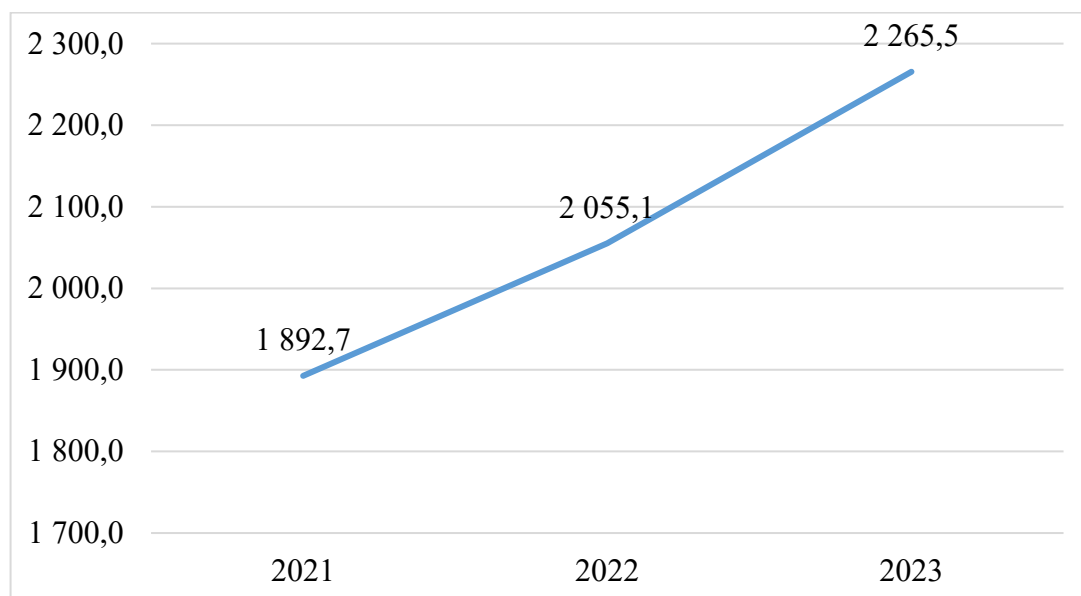


Figure 2.2 – The CSCEC's revenue (in million yuan)

Source: prepared by the author.

The dynamics of changes in CSCEC's profit before taxes are shown in Figure 2.3.

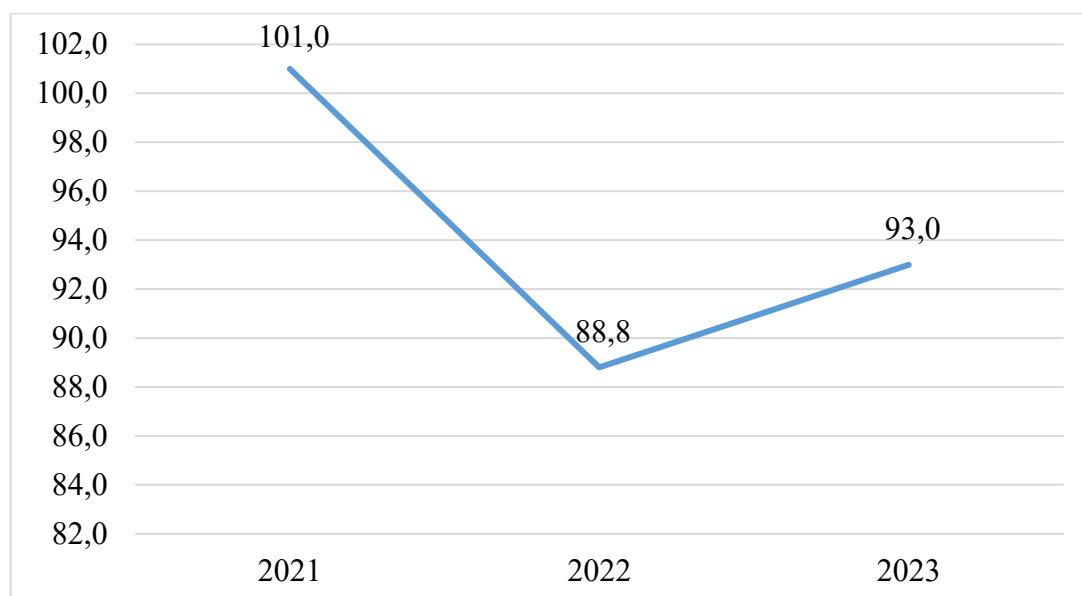


Figure 2.3 – Dynamics of changes in CSCEC profit before taxes (in million yuan)

Source: prepared by the author.

According to the data shown in Figure 2.3, CSCEC's profit before tax in 2023 was RMB 93 million, an increase of RMB 5.8 million or 4.7% over 2022.

The dynamics of changes in CSCEC assets are shown in Figure 2.4.

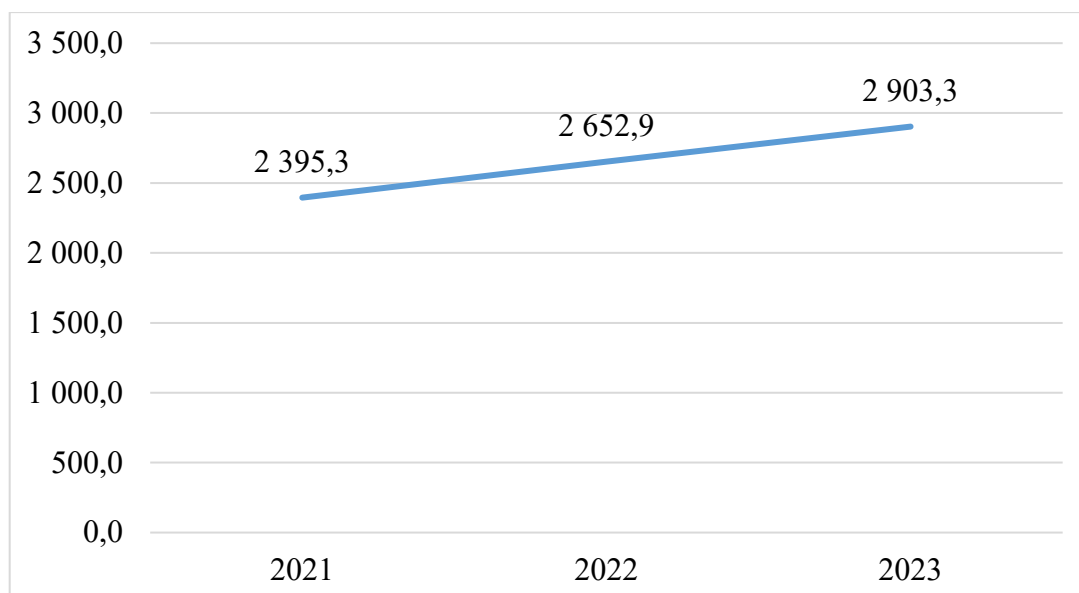


Figure 2.4 – Dynamics of changes in CSCEC assets (in million yuan)

Source: prepared by the author.

According to the data presented in Figure 2.4, CSCEC's assets in 2023 amounted to 2,903.3 million yuan, an increase of 250.4 million yuan or 9.4% compared to 2022.

Thus, CSCEC is a giant in the world of construction, with a number of key characteristics that define its place in the market. CSCEC ranks first in the world in terms of revenue, ahead of its closest competitors. The company operates in more than 100 countries around the world, implementing projects from residential buildings to infrastructure and complex engineering structures. CSCEC has extensive experience in a variety of sectors including civil engineering, industrial engineering, infrastructure, real estate and energy.

CSCEC plays an active role in China's Belt and Road Initiative, building infrastructure in countries around the world. CSCEC has extensive experience with large infrastructure projects such as high-speed rail, airports and seaports.

Key performance indicators of CSCEC for 2021-2023. show an upward trend.

2.2 Evaluation of Green Project Management in CSCEC

CSCEC, as the largest construction company in the world, is under intense public scrutiny in the context of environmental sustainability.

As CSCEC's business continues to expand, the Board places significant emphasis on sustainability management. CSCEC has established a comprehensive, effective and executable ESG governance system.

CSCEC attaches great importance to corporate sustainability and ESG management practices in its business operations. By adhering to improving internal sustainability governance, and strengthening the management and control of corporate development's impact on the environment and society, CSCEC strives to create value for its stakeholders. CSCEC has established an ESG governance structure (Figure 2.5) with the Board as the ultimate responsible body and set up the Sustainability Committee and the Sustainability Department. This has resulted in comprehensive top-down coordination and management of sustainability affairs. A closed ESG execution and management loop is formed covering strategy, objectives, organisation and resources, performance and

culture. This continues to drive the effective implementation of sustainability strategy and goals. In order to reinforce the effective implementation of sustainability strategy and goals, CSCEC links specific sustainability performance metrics, including environmental emission reduction targets, chemical safety management targets and staff training coverage, to executive variable compensation (e.g. bonuses). This is done in different departments and corresponding functions.

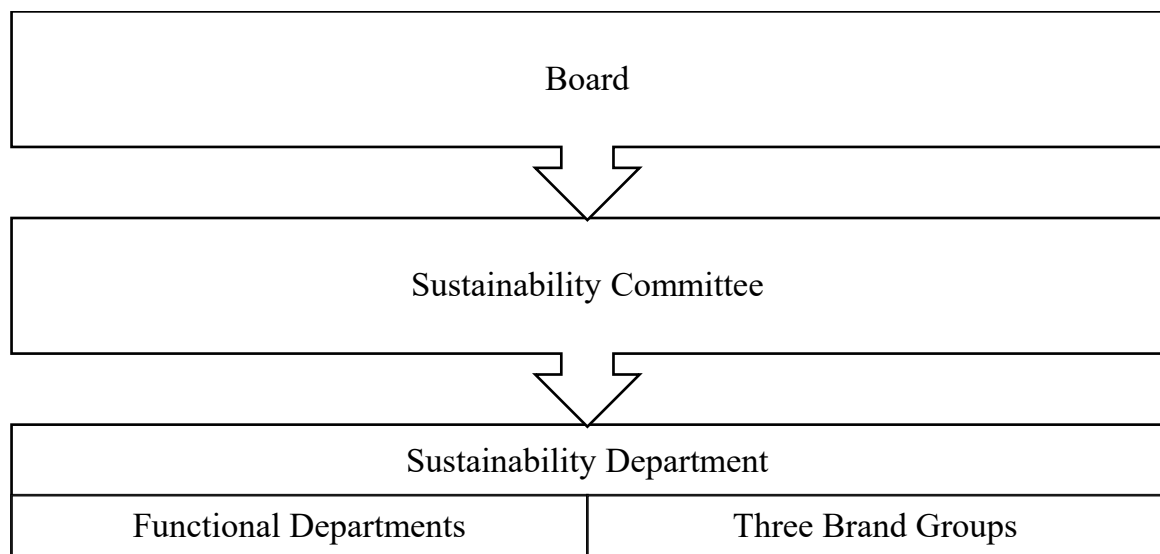


Figure 2.5 – ESG Governance Structure

Source: prepared by the author.

The Board assumes overall responsibility for the Group's ESG matters and oversees the Group's ESG governance.

The Sustainability Committee, which has been delegated (with relevant authorities) by the Board, assists the Board in the following ways: a) to conduct effective governance and oversight of ESG matters; b) to formulate and review the Company's sustainability strategic objectives; c) to lead and promote each department to improve its mindsets and operational initiatives in a) To analyse various business processes from a sustainability perspective; b) To identify, assess and manage material ESG risks; 3) To coordinate and standardise the collection of ESG-related data and information in order to enhance the quality of ESG information disclosure, thereby improving the effectiveness of the

Group's ESG governance [9].

The Sustainability Department is tasked with coordinating the ESG work of other departments and promoting the implementation and execution of the Company's sustainability strategic objectives.

The Sustainability Committee consists of two executive Directors, four independent non-executive Directors and two managers appointed by the Board. The members of the Committee have diverse experience and expertise in corporate responsibility and sustainable development. Their professional competences include: corporate governance, environmental, social and governance risk management, development and implementation of sustainable development strategies. The composition of the Committee ensures effective oversight of risks and opportunities related to sustainable development [28].

By implementing a series of ESG risk management protective measures and conducting relevant training, CSCEC is committed to promoting an effective risk management culture throughout the entire company in the long term. This ensures that all members within the organisation understand the importance of corporate risk management while enhancing the company's risk management procedures. In terms of training, CSCEC regularly updates the directors (including non-executive directors) on the latest developments and provides training on ESG risk management [24]. The objective is to maintain a high level of awareness of risk among all members of the organisation and to facilitate the effective role of non-executive directors in overseeing and controlling corporate risks, including ESG risks. CSCEC encourages employees to proactively identify and report potential risks and to continually improve the risk feedback process and risk management practices.

CSCEC continuously enhances its sustainability management systems by adhering to a variety of internationally recognized standards and frameworks, including ISO 5001:2018 Energy Management System, ISO 14001:2015 Environmental Management System, and ISO 45001:2018 Occupational Health and Safety. This enables the Group to effectively operate its business while minimizing its impact on the environment and natural resources, as well as maximizing its positive social impacts.

In light of the shift towards an environmentally conscious, low-carbon economy and the national call for advancing the construction of an ecological civilisation system, CSCEC has been committed to sourcing environmentally friendly raw materials and reducing carbon emissions along the production and value chain. As its fundamental commitment, the Group ensures that it stays compliant with the relevant environmental laws and regulations in its operating regions, including but not limited to:

- Environmental Protection Law of the People’s Republic of China;
- Law of the People’s Republic of China on the Prevention and Control of Atmospheric Pollution;
- Law of the People’s Republic of China on Prevention and Control of Water Pollution;
- Law of the People’s Republic of China on the Prevention and Control of Solid Waste Pollution;
- Law of the People’s Republic of China on Prevention and Control of Environmental Noise Pollution.

In the year 2023, CSCEC complied with the applicable laws and regulations about air and GHG emissions, discharges into water and land, generation of hazardous and non-hazardous wastes, and noise, all of which have a significant impact on the Group.

During the year under review, the air pollutants emitted from the Group, including sulphur oxides (“SOX”), nitrogen oxides (“NOX”) and particulate matter (“PM”), were mainly generated by the use of vehicles.

CSCEC mainly emits greenhouse gases from the combustion of fossil fuels for transportation, electricity consumption for operations, and business travel. The non-hazardous waste disposed by the Group primarily comprised of domestic and commercial waste, along with manufacturing wastes.

Let's conduct a PEST analysis of the company (Table 2.2). PEST analysis is a strategic planning tool that analyzes external factors affecting a company into four categories: political, economic, social and technological.

Table 2.2 – CSCEC PEST analysis

Group of factors	factor	Impact on CSCEC
1	2	3
Political factors	China's political stability	CSCEC is a state-owned company and therefore benefits from China's stable political environment. This ensures business sustainability and access to government projects
	The influence of political decisions on international projects	Policy decisions such as the Belt and Road Initiative and Made in China 2025 are driving CSCEC's international expansion
	Construction regulation	CSCEC must follow strict rules and standards in construction, which can either help or limit its activities
	Trade wars and sanctions	CSCEC may face difficulties in the international market due to trade wars and sanctions, which may hinder its activities in some countries
Economic factors	China's economic growth	China's rapid economic growth is a key driver for CSCEC, driving demand for construction work
	Investment programs	Government investments in infrastructure, real estate and other sectors create opportunities for CSCEC
	World economic situation	CSCEC is influenced by the global economic situation, for example, recessions and crises can reduce the demand for construction services
	Material prices	Changes in construction material prices could impact CSCEC's profitability
Socio-cultural factors	Urbanization	Rapid urbanization in China and around the world is creating huge demand for residential and commercial real estate
	Demographic changes	An aging population may reduce demand for housing, but will increase demand for infrastructure for health and social services
	Environmental issues	Rising environmental concerns such as climate change are impacting CSCEC's construction projects and green technology efforts
	Social responsibility	CSCEC faces increasing pressure from the public and investors to integrate social responsibility and sustainability into its projects

Continuation of Table 2.2

1	2	3
Technological factors	Development of construction technologies	CSCEC should keep up with the latest developments in the field of construction, such as introducing BIM modeling and 3D printing technologies
	Digitalization	Digitalization of the construction industry opens up new opportunities for CSCEC, such as intelligent control systems and online procurement platforms
	Automation	The use of robots and automated systems can increase productivity and reduce costs, but can also lead to job losses
	Environmental technologies	CSCEC should implement new technologies to reduce the environmental impact of its projects, such as using solar energy and renewable materials

Source: prepared by the author based on the data CSCEC

A PEST analysis demonstrates that CSCEC operates within a dynamic environment, characterised by the presence of both opportunities and challenges. To maintain competitiveness and success, a company must adapt to changing political, economic, social and technological conditions.

Let's look at the project management process in CSCEC:

1 Planning:

- defining the goals, boundaries and results of the project;
- identifying and documenting stakeholder needs and expectations;
- creating a work schedule, assigning resources, and determining deadlines and budgets.

2 Execution:

- starting a project and creating a project team;
- dividing project tasks into smaller elements and assigning them to team members;
- regularly monitoring the progress of the project and making adjustments if necessary.

3 Monitoring and control:

- collecting data on actual progress, costs and risks;

- interpret data to identify trends, problems and potential risks;
- making adjustments to the project plan to eliminate schedule deviations and ensure project goals are achieved.

4 Closing:

- delivery of the completed project to stakeholders;
- conducting project evaluations and lessons learned;
- storing project documentation and materials for future reference.

CSCEC has managed to establish itself as a leading technology company and continues to launch innovative products to the global market. To the features of project management in CSCEC:

- customer orientation. CSCEC places utmost importance on customer feedback and actively involves them in the product development process through beta testing and collecting feedback;
- fast iteration. CSCEC strives to bring products to market as quickly as possible, using fast iteration cycles and continuous delivery;
- continuous improvement. CSCEC is constantly looking for ways to improve its processes and products, promoting a culture of continuous learning and innovation;
- teamwork and cross-functional collaboration. CSCEC creates high-performing project teams consisting of members from different functions who collaborate closely and exchange ideas;
- use of data and analytics. CSCEC uses data and analytics to make informed decisions, track project progress and identify areas for improvement;
- technology integration. CSCEC uses various technological tools and platforms to manage projects, increase efficiency and improve communication;
- strong emphasis on testing and quality control. CSCEC places utmost importance on testing and quality control to ensure high-quality products are released.

CSCEC, as a large construction company, implements many projects that demonstrate its commitment to sustainable development and the implementation of environmental technologies. Here are some examples of such projects:

1. "Green" residential real estate:

1.1 "Green" residential building in Shanghai. CSCEC has built a high-tech residential building in Shanghai that is LEED Platinum certified. The building has features such as the use of solar energy, rainwater harvesting systems, and environmentally friendly materials.

1.2 "Green" residential complex in Beijing. The company has designed and built a green apartment complex in Beijing. The complex features energy efficient systems, the use of renewable energy sources and environmentally friendly materials, which reduces energy and resource consumption.

2. Green infrastructure:

2.1 Bridge over the Yangtze River in Nanjing. CSCEC built one of the longest bridges across the Yangtze River in Nanjing. The bridge includes a rainwater collection and purification system, as well as the use of environmentally friendly building materials.

2.2 Beijing-Shanghai high-speed railway. CSCEC participated in the construction of the Beijing-Shanghai high-speed railway, which uses energy-efficient technologies and has minimal environmental impact.

3. Renewable energy sources:

3.1 Solar power plant in the Gobi Desert. CSCEC has built one of the largest solar power plants in the world in the Gobi Desert. This plant provides clean energy to millions of people.

3.2 Offshore wind farm. The company has been involved in the construction of an offshore wind farm that provides clean energy to coastal cities.

4. Water purification:

4.1 Water purification project in India. CSCEC has built several water treatment plants in India to improve access to clean drinking water for local communities.

4.2 Wastewater treatment project in China. The company is introducing modern technologies for wastewater treatment in China to reduce the burden on the environment.

5. Ecological restoration projects:

5.1 Desert greening project in China. CSCEC is involved in desert greening projects in China to restore ecological balance and improve the living conditions of local

people [14].

5.2 Project for reforestation in Africa. The company is involved in reforestation projects in Africa to protect biodiversity and ensure sustainable development of the region.

These examples demonstrate that CSCEC is actively working to implement environmentally friendly projects that are aimed at increasing the company's environmental responsibility.

However, it is necessary to continue to monitor CSCEC's activities and monitor its environmental standards to ensure that the company truly follows its sustainability principles in practice.

Thus, CSCEC has a strong focus on sustainability management and has implemented a multi-level sustainability management system. CSCEC has established an environmental, social, and governance framework that encompasses the Board of Directors as the highest authority, the Sustainability Committee, and the Sustainability Department to ensure comprehensive coordination and top-down management of sustainability concerns [22].

CSCEC, the world's largest construction company, has been subjected to a PEST analysis, examining the political, economic, social, and technological factors that impact the company. In terms of political factors, CSCEC benefits from China's stable political environment and government support for international expansion through initiatives like One Belt, One Road and Made in China 2025. However, strict construction regulations and trade wars/sanctions can pose challenges. Economically, China's rapid economic growth provides demand for CSCEC's construction work, while government investment in infrastructure and real estate creates opportunities [7]. The global economic situation and fluctuating material prices can also impact the company's profitability. Socially, rapid urbanization and demographic changes drive demand for residential, commercial, and healthcare infrastructure, while environmental concerns and the need to meet public expectations for social responsibility and sustainability also influence CSCEC. Technologically, CSCEC must stay updated with advancements in construction technology, embrace digitalization, explore automation for increased productivity, and

incorporate environmental technologies into its projects [8].

The project management approach at CSCEC encompasses a customer-centric focus, rapid iteration, teamwork and cross-functional collaboration, the utilization of data and analytics, technology integration, and a strong emphasis on testing and quality control.

2.3 Analysing the development of green engineering in CSCEC

During 2023, a total of 119 construction projects of the Company's subsidiaries received administrative penalties due to environmental problems such as construction noise, dust, sewage and solid waste, involving a total fine of approximately RMB 7.1772 million.

The Company attaches great importance to ecological environmental protection. During the Reporting Period, there were no emergency environmental incidents in the Company. The impact of the production and operation activities of the Company on the environment mainly included noise, dust and solid waste, most of which took place in the course of construction. To minimize the impact on the environment, prior to the commencement of a project, the Company identified the environmental factors and prepared preliminary planning and schemes for environmental protection and green construction in accordance with relevant requirements. The Company was also equipped with and operated in a standardized manner various pollution prevention facilities such as automatic spraying, vehicle washing, sedimentation tanks and acoustic sheds, giving priority to new technologies and processes of energy conservation and environmental protection to reduce energy consumption and pollutant discharge, so as to minimize the impact of production on the environment [10].

Guided by President Xi Jinping's Thought on Ecological Civilization, the Company thoroughly implemented the decision and deployment on strengthening ecological environmental protection of the CPC Central Committee and the State Council. The Company persevered in integrating the concept of "ecological priority and green development" into the entire life-cycle of project investment, design, construction and

operation, accelerating the transformation of green construction methods, and continuously improving the level of environmental protection:

1. Strengthening green investment. During the 2023, the Company actively expanded its investments in the ecological and environmental protection field. the Company successively invested in 12 projects in the clean energy and water environmental protection sectors, including the Fengdongkou Pumped Storage Power Station Project in Liuyang City, Hunan Province, and the Comprehensive Treatment EOD Project in the Chenghu Area of Wuzhong District, Suzhou City, Jiangsu Province, with a total investment of about RMB 71.154 billion.

2. Strengthening green design. During the 2023, the Company effectively promoted green and low-carbon design. With a focus on application scenarios such as ultra-low energy consumption buildings, buildings with virtually zero energy consumption, and zero-carbon buildings, the Company consistently promoted the adoption of green and low-carbon technologies across all stages of building life-cycle starting with design as the driving force. The Science and Technology Innovation Building of China Construction Fourth Bureau was officially designated by the China Association of Building Energy Efficiency as a virtually zero energy consumption building. Additionally, the Company was designated as a national demonstration project for advanced green and low-carbon technologies by the National Development and Reform Commission [34].

3. Strengthening green construction. As the first advocator of green construction in the industry, the Company integrates the green concept into the whole process of project construction. The Company rigorously enforce requirements imposed by the government for green construction, duly carry out ecological environment protection and energy conservation and emission reduction work, actively promote the application of green and low-carbon technologies, products, and services at construction sites, and strengthen green demonstration and leadership efforts, actively creating green demonstration projects. During the Reporting Period, the Company's construction of the Shenzhen Guanlan Cultural Town project was designated as one of the first 30 pilot projects nationwide for "zero waste construction sites". Additionally, three projects – Jinhu Wetland in Zhijiang, Hubei, Wuliangsu Hai, and Guangyang Island in Chongqing – were

included in the first 15 excellent and typical cases of the national “landscape projects” initiative [12].

4. Strengthening green operation. During the 2023, the Company continued to strengthen the operation of water environmental protection while actively expanding into new business areas such as pumped storage energy and photovoltaic power generation. Three projects have already been put into operation, including the Guangdong Longchuan Distributed Photovoltaic Power Generation Project and the Langfang Distributed Roof Photovoltaic Power Generation Project, totaling a cumulative electricity generation of 43.839 million kilowatt-hours. The progressive implementation of green operation businesses not only provides strong support for achieving “dual carbon” targets but also plays an important role in improving ecological environment governance and enhancing living environments [13].

5. Strengthening green technological R&D The Company has been consistently increasing its efforts in green and low-carbon technology research and development, innovating and applying cutting-edge construction techniques, and exploring innovative construction models to drive the transition of production methods towards green and low-carbon practices. During the Reporting Period, the Company established the “CSCEC Green Construction Engineering Research Center (中国建筑绿色建造工程研究中心)” focusing on two major directions: “Buildings centred around Health and Comfort” and “Industrialization Technology of Building Mechanical and Electrical Systems and Decoration”. This centre devoted itself to the research and development of interdisciplinary innovative technologies in the design, construction, operation, and maintenance of healthy and suitable dwelling environments throughout the entire chain, as well as green and healthy electrical and mechanical installations and decoration technology, to improve the ecological environment continuously with the high-standard development of science and technology.

The SWOT analysis of green engineering development in CSCEC is given in Table 2.3.

Table 2.3 – SWOT analysis of green engineering development in CSCEC

Factor	Characteristic
Strengths	
Financial resources	CSCEC has significant financial resources to invest in green engineering research and development
Great experience	CSCEC has extensive experience in construction, which gives it an advantage in delivering complex and large-scale green projects
Political support	CSCEC receives support from the Chinese government, which promotes sustainable development and green technology policies
Developed infrastructure	CSCEC has access to a wide range of resources and technologies needed to implement green projects
Experience in international projects	CSCEC has experience in various countries, which allows it to implement green technologies in different climatic and cultural conditions
Weaknesses	
Dependence on traditional methods	CSCEC has not yet completely abandoned traditional construction methods, which may be less environmentally friendly
Lack of experience in some green technologies	CSCEC has not yet fully embraced some green technologies, such as solar energy and energy-efficient building
Lack of a clear green engineering strategy	CSCEC does not have a clear green engineering strategy, which may hamper its efforts to implement green technologies.
Lack of qualified specialists	CSCEC may experience shortage of qualified green engineering professionals
Lack of sufficient transparency regarding green projects	CSCEC may not be transparent enough about its green projects with the public
Opportunities	
Growing demand for green projects	Demand for green projects is growing around the world, opening up new opportunities for CSCEC
Development of "green" technologies	The development of green technologies opens up new opportunities for CSCEC to implement innovative solutions in its projects
Political initiatives	Chinese government promotes green technology, creating favorable environment for CSCEC
Cooperation with international organizations	CSCEC can collaborate with international organizations specializing in green engineering
Development of new standards	CSCEC may be involved in developing new green engineering standards
Threats	
Competition	The construction services market is highly competitive and many companies are also developing green engineering
Regulation	Changes in environmental legislation could pose challenges for CSCEC
Technological changes	Rapid development of green technologies could cause CSCEC to fall behind competitors
Reputational risks	CSCEC may face reputational risks if its green projects do not live up to expectations
Financial risks	Investing in green technologies can be risky and may not always yield the expected returns

CSCEC has considerable potential to advance green engineering, yet it concurrently confronts a multitude of challenges. The company must persevere with investment in green technology research and development, the formulation of a comprehensive green engineering strategy and the enhancement of transparency about green projects.

Based on publicly available data and expert opinions, it can be assumed that CSCEC is in a transitional phase, moving towards more mature green project management.

Signs of maturity:

- CSCEC receives support from the Chinese government, which actively promotes sustainable development policies. This creates favorable conditions for the development of green management;
- CSCEC integrates a range of green technologies into its projects, such as energy-efficient construction, renewable energy and sustainable materials;
- the company participates in the development of national standards in the field of green building and sustainable development;
- CSCEC actively participates in international initiatives such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method).

However, there are also signs of immaturity:

- CSCEC does not have a clear and unified strategy for green project management, which leads to fragmented efforts and inefficient use of resources;
- CSCEC is experiencing a shortage of qualified green project management professionals;
- CSCEC is not always transparent enough to inform the public about its green projects, which may raise doubts about its intentions;
- Despite some successes, the adoption of green technologies at CSCEC is not yet widespread.

Thus, CSCEC is in a transition phase from traditional project management to green.

CSCEC has begun to integrate green technologies and standards into its projects but has not yet fully integrated green management [37].

At the end of the chapter, let's summarize.

CSCEC is a prominent entity within the construction industry, exhibiting several distinctive attributes that contribute to its market positioning. In terms of revenue, CSCEC is the world's leading construction company, outperforming its closest competitors. The company operates in over 100 countries worldwide, undertaking projects encompassing residential buildings, infrastructure, and complex engineering structures. CSCEC has considerable experience in several sectors, including civil engineering, industrial engineering, infrastructure, real estate and energy.

CSCEC plays an active role in China's Belt and Road Initiative, contributing to the construction of infrastructure in countries across the globe. CSCEC has considerable experience in the implementation of large-scale infrastructure projects, including high-speed rail, airports and seaports.

Key performance indicators of CSCEC for 2021-2023. show an upward trend.

CSCEC places a significant emphasis on sustainability management, having implemented a comprehensive multi-level sustainability management system. CSCEC has established an environmental, social, and governance framework that encompasses the Board of Directors as the highest authority, the Sustainability Committee, and the Sustainability Department. This structure ensures comprehensive coordination and top-down management of sustainability concerns [11].

A PEST analysis has been conducted on CSCEC, the largest construction company in the world, to examine the political, economic, social, and technological factors that impact the company. In terms of political factors, CSCEC benefits from China's stable political environment and government support for international expansion, as evidenced by initiatives such as the One Belt, One Road and Made in China 2025 programs. However, the implementation of rigorous construction regulations and the occurrence of trade wars and sanctions may present obstacles. From an economic standpoint, China's rapid economic growth provides a robust demand for CSCEC's construction work, while government investment in infrastructure and real estate creates a plethora of

opportunities. Additionally, fluctuations in the global economic situation and material prices can impact the company's profitability. From a social perspective, the rapid urbanisation and demographic shifts that are occurring in many countries drive demand for residential, commercial, and healthcare infrastructure. Additionally, environmental concerns and the need to meet public expectations for social responsibility and sustainability also influence CSCEC. Technologically, CSCEC is required to remain abreast of developments in construction technology, embrace digitalisation, explore the potential of automation for increased productivity, and incorporate environmental technologies into its projects.

The project management approach at CSCEC is customer-centric, with a focus on rapid iteration, teamwork and cross-functional collaboration. It also incorporates the utilisation of data and analytics, technology integration and a strong emphasis on testing and quality control [39], [40].

In 2023, the company's subsidiaries were subject to administrative penalties for environmental infractions, including construction noise, dust, sewage, and solid waste, resulting in a total fine of approximately RMB 7.1772 million. The company implemented President Xi Jinping's 'Thought on Ecological Civilization' by adhering to the directives of the CPC Central Committee and the State Council, to enhance ecological protection. A priority is placed on ecological development throughout the entire life cycle of the projects in question, including the stages of investment, design, construction and operation. The company expanded its green investment portfolio by investing in 12 clean energy and water environment protection projects, representing a total investment of approximately RMB71.154 billion. Furthermore, the promotion of green and low-carbon design was undertaken, with the implementation of green and low-carbon technologies in building design, thereby achieving near-zero energy buildings. Furthermore, the company emphasized green construction and ensured compliance with government regulations, thereby promoting the utilisation of green and low-carbon technologies, products and services. The implementation of these strategies served to consolidate their position as a leader in the field of green construction.

CSCEC is making progress towards achieving green project management

standards, but there is still a significant gap in terms of reaching a higher level of maturity. The company must intensify its endeavours in this domain to establish itself as a pioneering entity within the construction sector concerning sustainability.

CHAPTER 3

IMPROVING THE EFFICIENCY OF GREEN ENGINEERING IN CSCEC

3.1 Foreign experience in green engineering development

Green engineering is rapidly developing around the world, becoming an increasingly important factor in sustainable development.

Key trends include:

1. Increased attention to environmental aspects. Engineering solutions are increasingly being designed with environmental impact in mind.
2. Development of environmentally friendly technologies. Technologies that use renewable energy sources, and recyclable materials and minimize emissions are actively developing.
3. Digital transformation in green engineering. Artificial intelligence, machine learning and digital modelling are increasingly being used to optimize processes and resources, making engineering solutions more environmentally friendly.
4. Political support and regulations. Governments in many countries are introducing new laws and standards to promote green engineering.
5. Investment growth. The attractiveness of green engineering for investors is increasing, as it promises not only environmental but also economic benefits.
6. Collaboration. The development of green engineering requires active collaboration between various sectors, including government, business and academia.

The USA is a pioneer in the field of green engineering, actively developing it since the end of the 20th century. Here are some key aspects of its development in the US:

1. Certification systems and standards:

LEED (Leadership in Energy and Environmental Design): Developed in the USA, LEED has become the global standard for green building. It covers energy efficiency, water use, materials use, air quality and other environmental aspects.

WELL Building Standard: Also developed in the USA, WELL focuses on the health and well-being of people in buildings. It takes into account air quality, lighting, acoustics, access to nature and other factors.

Living Building Challenge: This standard strives to create buildings that are completely energy and water-self-sufficient and environmentally friendly.

2. Innovative technologies and materials:

BIM (Building Information Modeling): Widely used in the US for design and construction optimization.

3D printing: Actively developing in the USA, used to create individual building elements.

Renewable Energy: The US is one of the leaders in the use of solar and wind energy.

Eco-friendly materials: The US is developing and introducing recycled and biodegradable materials.

3. Integration of green engineering into government policies:

Tax Incentives: The US provides tax incentives for green building and the use of green technologies.

Legislation: The United States has laws regulating the energy efficiency of buildings and the use of environmentally friendly materials.

Government Investment: The US government is investing in green engineering research and development.

4. Successful examples:

The Edge (Amsterdam, Netherlands): Designed by an American company, this building is one of the most energy-efficient in the world.

The GreenPix Zero Energy Building (New York, USA): This is the first zero-energy building in the United States, using only renewable energy sources.

The Green Roofs of Chicago: Chicago is the leader in the number of green roofs in the United States, improving air quality and reducing the city's heat island.

Germany is also one of the world leaders in green engineering, demonstrating a strong commitment to sustainable development.

Among the main development factors, it is necessary to note:

- political will and support. Germany has a long-term strategy for the transition to a green economy, established by laws and policies that support the development of environmentally friendly technologies;
- strong emphasis on research and development. Germany devotes significant resources to research and development in the field of green engineering, which leads to innovative solutions;
- developed infrastructure. Germany has a well-developed infrastructure for the implementation of green technologies, including renewable energy networks and public transport systems;
- industrial culture. German industry is known for its quality and innovation, which allows it to successfully introduce environmentally friendly technologies into production;
- public opinion. The German public values environmental issues highly and supports the transition to sustainable development.

Examples of green engineering development in Germany include:

- energy. Germany is a leader in renewable energy. More than 40% of the country's electricity comes from renewable sources, mainly solar and wind power;
- construction. In Germany, the construction of energy-efficient buildings is actively developing, “green” roofs are being used and environmentally friendly building materials are being used;
- transport. Germany is developing electric cars, public transport and cycling infrastructure to reduce emissions from road transport;
- industry. German industry is actively introducing technologies that minimize emissions and increase energy efficiency.

France is also actively working on the development of green engineering, setting ambitious goals for the transition to sustainable development. Key development factors:

- political will. The French government actively supports the development of green engineering, introducing relevant laws that stimulate environmentally friendly

technologies;

- investments. France devotes significant resources to research and development in green engineering and to supporting green enterprises;
- public support. The French are generally concerned about environmental issues and support the transition to a green economy;
- developed infrastructure. France has a well-developed infrastructure that supports the implementation of environmentally friendly solutions, including renewable energy networks and a public transport system.

France is actively developing renewable energy sources, especially solar and wind. The country is also committed to reducing its dependence on nuclear power. In addition, France is actively constructing energy-efficient buildings and using environmentally friendly building materials and technologies. France is also developing public transport, electric vehicles and cycling infrastructure to reduce emissions from road transport.

Japan, as a country with limited natural resources, has long strived for sustainable development. Green engineering in Japan has several characteristics:

- focus on efficiency. Japanese engineers are known for their commitment to efficiency and minimizing waste. This leads to the development of technologies that make maximum use of resources and have minimal impact on the environment;
- innovative technologies. Japanese companies are leaders in the development of innovative green technologies, including solar energy, hydrogen fuel cells and environmentally friendly materials;
- public consciousness. Japanese society values environmental issues highly and supports sustainable development. This contributes to the fact that “green” technologies are rapidly being implemented in various spheres of life;
- integration of "green" solutions. Japan is committed to integrating green solutions into all areas of life, from construction and transport to manufacturing and agriculture;
- long-term perspective. Japan takes a long-term approach to green technology development, investing in research and development and sustainable infrastructure

projects.

Examples of green engineering in Japan include:

- energy. Japan is actively developing renewable energy sources, including solar, wind, geothermal and hydropower;
- construction. Japanese buildings are known for their high energy efficiency, as well as the use of environmentally friendly building materials;
- transport. Japan is developing public transport, electric vehicles and high-speed rail to reduce emissions from road transport;
- industry. Japanese businesses are making a significant move towards green technologies, recycling waste, reducing emissions and improving energy efficiency.

Foreign experience in the development of green engineering demonstrates many successful examples and innovations that can serve as inspiration and direction for other countries.

The experience of foreign countries shows that the development of green engineering requires an integrated approach, including:

- development of standards and certification;
- investing in research and development of green technologies;
- introducing government policies to encourage green building;
- promotion and training in the field of green engineering.

CSCEC can benefit from overseas experience to develop its green engineering strategy and contribute to creating a more sustainable future.

3.2 Development of recommendations for improving green engineering in CSCEC within the framework of the sustainable development strategy

CSCEC, as China's largest construction company, has significant potential to implement sustainable practices and improve green engineering. These recommendations are aimed at improving the environmental efficiency and sustainability of CSCEC [28].

1. Resource management

- efficient use of materials (introduction of BIM modelling to optimize material consumption, use of recycled and recyclable materials in construction, development of standards for the use of local and environmentally friendly materials);
- optimization of water use (implementation of rainwater collection and reuse systems, use of low-flow plumbing systems, development of strategies to prevent water pollution);
- energy efficiency (use of energy-efficient materials and equipment, introduction of solar and wind energy systems, optimization of lighting and ventilation).

2. Creation of sustainable objects:

- environmentally friendly architecture (application of bioclimatic design principles, introduction of green roofs and vertical gardens, creation of a comfortable urban environment taking into account green areas);
- environmental technologies (use of wastewater treatment and waste disposal systems, introduction of technologies to reduce greenhouse gas emissions, use of environmentally friendly paints and varnishes);
- taking into account environmental impacts (conducting environmental assessments of projects, developing plans to minimize the impact on the environment, introducing an environmental monitoring system).

3. Improvement of employee qualifications

- employee training (conducting training on green engineering and sustainable construction, creating an online platform for sharing knowledge and experience, encouraging employee participation in professional conferences and forums);
- employee motivation (introduction of a reward system for the implementation of environmentally friendly solutions, creation of a corporate culture focused on sustainable development);
- implementation of standards (development of internal standards for green engineering, certification of facilities according to international standards for sustainable construction (LEED, BREEAM)).

4. Collaboration and Innovation:

- cooperation with universities and scientific institutes (joint research and development in the field of green engineering, attracting young professionals and students);
- introduction of innovative technologies (creation of a research centre on sustainable construction, encouraging the use of the latest technologies in the field of green engineering);
- exchange of experience with other companies (participation in international forums and exhibitions, interaction with other construction companies to exchange best practices).

Implementation of these recommendations will position CSCEC as a leader in green engineering and sustainable building. This will not only improve the company's environmental efficiency but will also create a competitive advantage in the international market.

To improve the efficiency of managing green projects in CSCEC, it is recommended to use flexible technologies.

The Agile methodology is a set of approaches and methods designed for flexible project management in various areas, including software creation and the implementation of marketing campaigns.

The Agile methodology is based on the following principles:

- iterative approach. Projects are divided into small iterations, which allows you to regularly check and adjust the results;
- interactive team interaction. Team members actively participate in the development process, ensuring transparency and timely resolution of problems;
- fast adaptation. Agile methodology allows you to quickly respond to changing requirements and conditions, avoiding rigid plans and excessive bureaucracy.

The main goal of Agile is to increase the efficiency of project activities due to the following factors:

- acceleration of development. An iterative approach and rapid adaptation make it possible to reduce the time required to complete tasks;

- minimizing risks. Regular monitoring and changing priorities help to avoid major mistakes and reduce the likelihood of failures;
- improving the quality of results. Active team involvement and prompt feedback ensure that the product meets customer expectations.

The values espoused by the Agile methodology assert that individuals are of greater consequence than processes and standardised tools. The creation of a product is deemed to be of greater importance than the selection and agreement upon documentation. Furthermore, the client's position is to be given greater consideration than the contract, and adjustments are to be made in preference to the initially developed strategy.

Those who espouse the tenets of the Agile methodology adhere to the primacy of the human factor and teamwork over tools, plans, and documentation. Adopting an Agile approach necessitates a refocusing on new goals, objectives and principles, thereby enabling organisations to adapt flexibly to a dynamic market and changing customer needs.

Agile proponents believe that:

- people and teams are more important than processes. Successful projects are based on qualified specialists and effective interaction within the team;
- working software is more important than comprehensive documentation. Creating a valuable product takes priority over creating extensive plans and reports;
- cooperation with the customer is more important than formal contracts. Constant dialogue and feedback with the customer ensures that the product meets his needs;
- adapting to change is more important than following a plan: Agile allows you to quickly adjust plans in response to changing market conditions and customer requirements.

The introduction of Agile leads to the following changes:

- transition from a waterfall model to an iterative one. Projects are broken down into smaller parts, allowing results to be reviewed and improved more often;
- creation of self-organizing teams. Teams become more autonomous and

independently determine their goals and methods of work;

- introduction of daily standups and sprints. Regular meetings and short development cycles promote transparency and prompt resolution of obstacles;
- adopting the principle of continuous integration and deployment. Process automation allows you to quickly and efficiently integrate changes and release new versions of the product.

There are several benefits to moving to Agile, including:

- an iterative approach and automation speed up the product creation process;
- regular testing and feedback from the customer improve the quality of the final product;
- active participation of the customer in the development process ensures that the product meets his expectations;
- Agile allows organizations to quickly adapt to changing market conditions and customer needs.

The use of Agile methods and tools in project management contributes to the active use of motivated human potential and also ensures more efficient use of financial and time resources because they:

- focus the team on customer needs and problems;
- improve the organizational structure and value-creation processes;
- ensure projects are completed in short cycles;
- use feedback to improve the product;
- involve increasing the powers and responsibility of employees;
- represent an image of systems thinking.

The approach does not necessitate any additional efforts on the part of management to enhance or modify the product. Instead, the team is responsible for identifying the necessary changes and improvements through interactions with user experience and the appropriateness of actions.

The following business representatives are among the companies that have implemented flexible project management:

- news nonprofit National Public Radio uses Agile methods to develop its broadcast programming;
- John Deere uses them to develop new machines;
- the Swedish company Saab - for the production of new fighter aircraft;
- leader in cloud backup technologies - Intronis uses them for marketing;
- global provider of 3PL logistics services - CH Robinson applies them in the field of personnel management;
- Mission Bell Winery uses them in everything from wine production to warehousing to the senior management team.

For the successful implementation of Agile technologies in CSCEC, it is necessary to implement several activities presented in Figure 3.1.

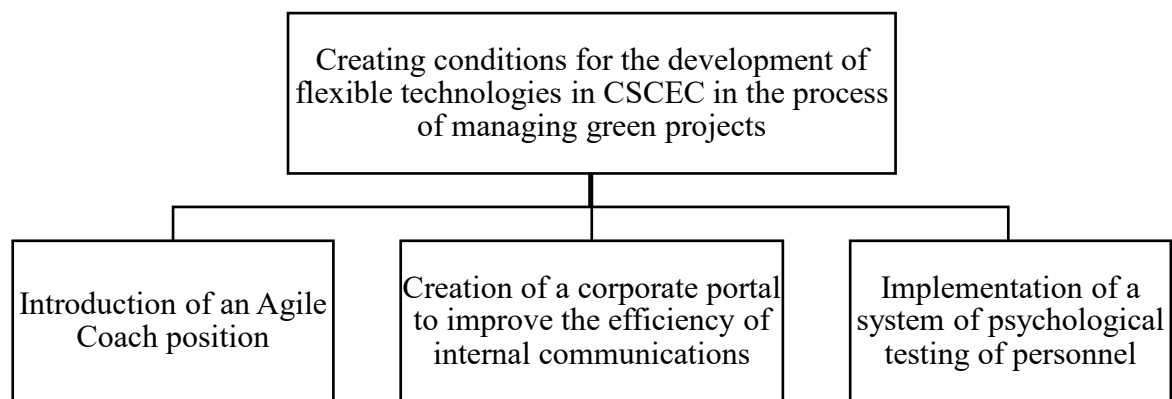


Figure 3.1 – Recommendations for creating conditions for the development of Agile technologies in CSCEC

Source: prepared by the author

As illustrated in Figure 3.1, to facilitate the effective development of Agile technologies within CSCEC, it is proposed that the position of an Agile coach be introduced, a corporate portal be created to enhance the efficiency of internal communications, and a system of psychological testing of personnel be implemented.

Experts have observed that coaching agile teams allows the team to transition to a new work model with efficiency in 98% of cases. Furthermore, they have noted that this process allows for the objective assessment of areas for growth and improvement in the

quality of products [27].

An Agile coach is a specialist in the implementation of Agile methodology. The role of the Agile coach is to create and enhance Agile processes within an individual team or across an entire company. They are also responsible for training in an agile approach to software development and monitoring the performance of work.

An Agile coach is a generalist who must:

- have experience in project and product management, software development, or another area of expertise depending on the company's field of activity;
- have skills in working with Scrum, Kanban and SAFe;
- have experience in mentoring;
- be able to help teams solve problems that arise during the work process.

Job responsibilities of Agile Coaching Specialists include:

- training Agile processes for all team members;
- maintaining project planning;
- identification of risks associated with the work process;
- analysis and assistance in resolving controversial issues;
- identifying problems in working using the Agile methodology;
- assisting product owners in writing user stories;
- supporting Scrum Masters in preparing for meetings;
- instruction on working with Scrum and Kanban tools;
- developing a culture of Agile thinking among all team members;
- monitoring the effectiveness of the transition to Agile.

In essence, the role of an Agile coach is not merely to introduce a novel work methodology in theory and practice; it is also to facilitate a shift in the mindset of team members, encouraging them to adopt a more flexible approach to work processes.

The primary objective of an Agile coach is to educate the project or product team about the technology in question.

Depending on how much Agile coaches delve into the team's work process and with whom in the company they interact, there are 3 types of specialists in implementing

flexible working methodology:

1 Agile team facilitator. In addition, he may be referred to as a Scrum master, Scrum coach, or iteration manager. Nevertheless, this does not alter the fundamental nature of the role. This role requires a specialist who is able to interact closely with the team, participate in the work process, and therefore must be well versed in the development process. The objective is to enhance the productivity of a specific team. This could be a developer who is responsible for maintaining and improving the Agile process in parallel with coding.

2 Agile coach. As a rule, he interacts with scrum masters of teams (less often directly with developers) and is involved in the integration of Agile teams or departments into companies working according to a different methodology.

3 Corporate agile coach. Such specialists work at the enterprise level. Their primary tasks are managing changes in the enterprise and coaching senior managers. They need to understand corporate Agile frameworks (SAFe, LeSS, DaD).

According to a McKinsey report, 93% of business units that fully adopted an agile model were more successful than business units that did not.

Thanks to coaching Agile teams, CSCEC will receive:

- extensive knowledge and experience. Coaches have extensive experience working with diverse organizations and know all the details of this process from the inside;
- quick process of transition to a new work model. An experienced Agile coach immediately directs the team in the right direction, which helps to avoid many mistakes at the start of transformation;
- view from the outside. Sometimes, to improve the efficiency of a company, you simply need the opinion of an independent expert. By inviting an Agile coach to the team, CSCEC will have the opportunity to unbiasedly identify target areas for change and growth;
- improving product quality and customer loyalty. An Agile trainer can fill a gap in much-needed employee training. Constant development allows the team to stay up

to date with the latest trends. As a result, customers receive a high-quality product and their satisfaction with the products increases.

Furthermore, for Agile flexible management methods to be successfully implemented within a company, it is necessary to establish an effective communication system between Agile teams.

To achieve this objective, it is recommended that a corporate portal be created for communication between CSCEC employees. A corporate portal based on the Intranet is a voluminous and complex tool that allows users to perform a wide range of tasks. This is not merely an independent website; it is, in fact, a comprehensive suite of products, including a document management system, a task tracker, an ERP system, and numerous others, tailored to the specific needs of each organization. The portal integrates the functions of file and document storage, social networking, and information resource management. Concurrently, any portal is designed to facilitate two primary functions: the collective work of employees on assigned tasks and the effective internal communication of information.

A corporate portal is a valuable tool that can be utilized to enhance work discipline, consolidate a substantial amount of information, facilitate interactions between employees, streamline operations, boost productivity, conserve working hours, and reduce costs.

The corporate portal as an internal information and communication network has several advantages:

- unites the company's information resources, providing all participants with universal access to data;
- improves interaction with colleagues through the corporate network;
- plays a big role in motivating and involving staff to increase productivity and promptly complete work tasks;
- provides the opportunity for group work to discuss and adjust joint plans by expanding staff collaboration within the company;
- increases educational potential by providing access to accumulated business

knowledge;

- increases the loyalty of visitors who can perform actions remotely from any mobile device;
- ensures the security of commercial information, since only employees or those to whom access is granted can access the web resource. Moreover, each user can set their access level;
- allows you to form and develop an internal corporate culture.

The CSCEC corporate portal should include a certain set of modules for solving problems related to information processing. The approximate content of the corporate portal for CSCEC is shown in Figure 3.2.



Figure 3.2 – Approximate content of the corporate portal for CSCEC

Source: prepared by the author

Let's look at the approximate content of the corporate portal for CSCEC in more detail:

1 Organizational directory: forms a visual representation of the organizational structure and allows you to search by various details (last name, phone number, room

number, etc.).

2 Applications: the module provides automation of the processes of formation, coordination, approval and execution of applications of various types, including: applications for passes, office equipment, various information and technical resources of the company.

3 Electronic document archive: designed for centralized storage of documents and providing users with access to them, including the implementation of opportunities for collaboration on documents.

4 Portal usage statistics: allows you to generate various statistical reports on access to various sections of the portal to monitor user activity and optimize the structure and content of its sections.

5 News: provides tools for managing the publication on the portal and distribution of news and announcements among users; includes developed mechanisms for personalizing their presentation and ensuring automatic import from various sources.

6 Working time control: provides the ability to monitor and record employees' working time. The module receives data from a system for recording the time of arrival and departure of employees from their workplaces. If the user has the appropriate rights, the module displays late arrivals and early departures of employees from their workplaces following the specified work schedule personally for each employee.

7 Resource reservation: solves the problem of organizing the sharing of common resources, which is relevant for each enterprise. If there is a need for a certain shared resource, an employee can look at the availability schedule of this resource and book this resource for a certain time. An employee can change or cancel their reservation.

8 Informers: automatically updated graphic elements that are installed on the portal and serve to provide daily financial, political, sports and other information. Examples of informers: charts of the most popular stock indices, a ticker with news about politics and economics, a ticker with news about high technologies, exchange rates, and weather forecasts.

Among other elements, you can add a forum, site search, authorization system and administration section to the corporate portal for CSCEC.

The corporate portal will help CSCEC:

- create a unified image of the company;
- increase the company's manageability by introducing collaboration standards, optimizing information storage, and increasing control over the implementation of assigned tasks;
- simplify communications by creating a single address book with contacts, positions and other useful information about a person;
- organize collaboration within working groups with opportunities for discussions, setting and monitoring instructions, storing files and searching for information;
- inform employees: news, orders, information letters;
- create a unified knowledge base and expand it;
- conduct training, testing and other employee surveys;
- communicate the company's history, goals and values;
- provide access to unofficial information: stories and events from the personal lives of employees: congratulations, competitions, achievements, photo gallery;
- speed up the onboarding process for a new employee.

In addition, the corporate portal will allow CSCEC employees to:

- always have at hand the structure of the organization, with a detailed division into departments and work groups, indicating managers and their contact information;
- keep abreast of the latest company news, colleagues' birthdays and other events;
- know your colleagues by sight and get maximum general information about employees using only a contact card.

As evidenced by empirical evidence, a corporate portal is capable of effectively addressing work plan issues, including the establishment and monitoring of task implementation, analytics, the creation of a system for the storage of crucial information, the automation of business processes, and the implementation of customer relationship management systems.

Furthermore, the implementation of portals has proven to be an effective means of facilitating rapid communication between different departments of the company. For instance, there is no longer a need for each department to be individually informed of new developments or significant occurrences. Instead, the relevant information can be posted on the portal, ensuring that it is made available to all relevant parties simultaneously. Additionally, employees have uninterrupted access to the company's knowledge base.

With regard to effective communication between employees, the portal offers the potential for instantaneous communication through an integrated social network, enabling the discussion of both work-related and personal matters in forums and groups.

It is important to note that the purpose of a corporate portal is to foster a positive social and psychological environment within an organisation. This can help to enhance staff loyalty to the company, facilitate the integration of new employees, and serve as a valuable tool for addressing a range of other critical issues.

Furthermore, in order for Agile technology to be developed in the context of project management, it is essential that the team is operating within a favourable socio-psychological climate and that stress levels are kept to a minimum.

In order to form Agile teams comprising individuals who are most suitable for each other psychologically, it is recommended that they be tested. In order to achieve this, it is proposed that the AVELife TestGold Studio software product be purchased.

This software product is a professional testing tool that enables the creation of tests, comprehensive knowledge tests and psychological tests to address typical problems such as personnel assessment when hiring, periodic assessment and certification of employees, testing the knowledge of students and students in the learning process.

Software product functions:

1. Creation of knowledge tests and psychological tests.

A developed test format for creating professional knowledge tests, basic psychological tests and multifactorial psychological questionnaires.

Creation of knowledge tests and psychological questionnaires for testing students, assessment and certification of personnel 12 types of questions: Psychological, Yes/No, Yes/No/Don't know, Degree of agreement, Single choice, Multiple choice, Sequence,

Matching, Entering a line, Entering a set of lines, Inputting a Sequence of Lines, Essay.

Advanced formatting of question and answer text with customization of fonts and paragraphs, use of images, lists, tables in a powerful built-in text editor.

Hint mechanism, feedback, introduction to the test and question, use of multimedia data (images, audio, video) in questions and answers, two types of adaptive testing, grouping questions into sections.

A comprehensive system of scoring and drawing conclusions for creating multifactor psychological questionnaires, such as the Cattell test, the PARI technique, and the Leonhard characterological questionnaire.

2. Knowledge testing and psychological testing.

Knowledge testing and psychological testing locally on a separate computer, centrally in the organization's local network and remotely.

Limiting the availability of tests for testing by defining users or groups of users who are allowed to take the test.

The system allows for the configuration of automatic selection of questions used during testing and their order. This includes the mixing of questions (questions are presented to the test taker in random order), the automatic selection of a specified number of questions from sections (questions can be combined into sections and, during testing, automatically selected only a specified number of questions from each section), and adaptive testing (the questions used and their order are selected automatically during the interim assessment of the test taker's answers to each question of the test or the questions of the assessment section).

To prevent the distortion of test results, several special measures have been implemented. These include the mixing of questions and answer options, the automatic selection of a specified number of questions from sections, the limitation of the time allowed for a test and a question, the tracking of the action of "conducting a testing session", the limitation of the number of test runs, and the sending of a notification about the start of a testing session to an email address.

3. Storage and analysis of test results.

The software is designed to account for test takers, undertake a comprehensive

analysis of test results, generate reports based on editable templates, and export data to external formats such as XML, HTML, XLS, and CSV. This allows for the integration of test data with other software or the use of data in specialized programs with additional design, presentation, and analysis capabilities.

The storage of detailed data about each test taker within an account. The grouping of users to ascertain the availability of tests and the filtering of users and test results according to the appropriate selection criteria.

The test results are accumulated and made available for viewing in the form of a list (table), with the ability to filter by test, test subject and date of testing.

The initial analysis of the results is conducted through the generation of comparative graphical presentations in the form of bar charts, which illustrate the performance of individual test takers on specific tests. Additionally, summary reports are generated on each test taker, which provides an aggregate overview of their characteristics. Finally, the responses of individual test takers to specific test questions are analysed.

It is possible to generate reports based on custom templates using the built-in report designer for editing them.

Thus, to improve the efficiency of project management in CSCEC, it is recommended to use Agile technologies, which are a set of methods and practices for flexible project management in various application areas, from software development to the implementation of marketing strategies, to increase the speed of creating finished products and minimize risks due to iterative execution, interactive interaction of team members and quick response to changes.

For the successful implementation of Agile technologies in CSCEC, it is proposed to introduce the position of an Agile coach, create a corporate portal to increase the efficiency of internal communications, and introduce a system of psychological testing of personnel.

3.3 Assessing the effectiveness of the proposed measures

To assess the efficacy of the project in facilitating the advancement of Agile technology within CSCEC, it is essential to quantify the associated costs [15].

The average annual salary of an Agile coach with the international Certified ICAgile Professional certificate is 310 thousand yuan.

It is recommended that an internal corporate portal for CSCEC be developed by ESRI China, a software and computer games developer. The estimated production time is two to three months.

The costs of developing an internal corporate portal for CSCEC are shown in Table 3.1.

Table 3.1 – Costs for developing the CSCEC internal corporate portal

Name of the expense item	Amount, thousand yuan
Development of a corporate portal	1 200
Training of IT specialists and portal administrator	150
Total	1 350

Source: prepared by author based on CSCEC data

As evidenced by the data presented in Table 3.1, the estimated cost of developing an internal corporate portal for CSCEC is 1,350 thousand yuan.

A further calculation is required to determine the costs of implementing the AVELife TestGold Studio software product into CSCEC's work (Table 3.2).

Table 3.2 – Costs of implementing the AVELife TestGold Studio 5 software product into CSCEC work

Name of the expense item	Amount, thousand yuan
Software product AVELife TestGold Studio	260
Training of personnel who will be active users of the system	80
Total	340

Source: prepared by author based on CSCEC data

As can be seen from the data given in Table 3.2, the cost of implementing the AVELife TestGold Studio software product into CSCEC's work will be 340 thousand yuan.

The total costs of implementing a project to develop Agile technology in the CSCEC project management process are presented in Table 3.3.

Table 3.3 – Total costs for implementing a project to develop Agile technology in CSCEC

Name of the expense item	Amount, thousand yuan
Introduction of the Agile Coach position	310
Development of an internal corporate portal	1 350
Implementation of the AVELife TestGold Studio software product	340
Total	2000

Source: prepared by author based on CSCEC data

As evidenced by the data presented in Table 3.3, the total costs of implementing the project for the development of Agile technology in CSCEC project management are estimated to be 2,000,000 yuan.

The utilisation of Agile technology in project management has been demonstrated to enhance efficiency, resulting in a minimum increase of 0.2% in sales.

Let's calculate the efficiency based on these data. Then the additional inflow of revenue from sales will be equal to

$$\Delta R = 2265.5 \times 0.002 = 4\,531 \text{ million yuan}$$

It is assumed that the net profit margin will remain at the level of 2023 (4.1%), then the additional net profit will be:

$$PE = 4\,531 \times 4.1 / 100 = 185.8 \text{ million yuan}$$

Next, we will calculate RFP, the coefficient of profit received as a result of the costs of developing Agile technology in the CSCEC project management process.

The RFC coefficient is calculated using the formula:

$$\text{RFC} = \text{PE} / \text{C}, \quad (3.1)$$

where PE – the amount of additional net profit;

C – costs of implementing activities.

Hence

$$\text{RFP} = 185.8 / 2 = 92.9 \text{ yuan}$$

According to calculations, the return on investment in the development of Agile technology in the project management process will be 92.9 yuan of net profit per 1 yuan of costs, which indicates the feasibility of its implementation.

Thus, based on the results of the calculations, we can conclude that the additional inflow of revenue will be 4 531 million yuan, the additional influx of net profit will be equal to 185.8 million yuan, the return on investment in the development of Agile technology in the project management process will be 92.9 yuan of net profit per 1 yuan of costs.

In addition, introducing Agile technology into the CSCEC project management process will achieve the following effects:

- increasing employee satisfaction. Agile methodologies focus on creating high-performing teams, which leads to greater autonomy, responsibility and employee engagement;
- improved communication. Agile practices such as daily standups and sprint reviews promote open and constant communication between team members and stakeholders;
- creating a more inclusive work environment. Agile practices encourage collaboration and participation from all team members, regardless of their level or position;
- reducing stress. The iterative and iterative nature of Agile processes reduces

the stress associated with traditional project management approaches;

- reduction of project completion time. Agile processes are focused on the rapid delivery of small, functional units, which reduces project completion time;
- quality improvement. The iterative and incremental nature of Agile processes allows errors to be detected and corrected early, which improves overall quality.
- increased flexibility. Agile approaches allow you to easily adapt to changing requirements and market conditions, which can lead to competitive advantages.

At the end of the chapter, let's summarize the results.

To optimise the efficacy of project management within the context of CSCEC, it is recommended that the utilisation of Agile technologies be employed. These technologies represent a comprehensive set of methodologies and practices that facilitate flexible project management across a diverse range of domains, including software development and the implementation of marketing strategies. The implementation of Agile technologies is anticipated to expedite the production of completed products and mitigate risks through the iterative completion of tasks, the interactive involvement of team members, and a responsive approach to changes.

To successfully implement Agile technologies within CSCEC, it is proposed that the following measures be taken: the appointment of an Agile coach, the creation of a corporate portal to enhance internal communication efficiency, and the introduction of a system of psychological testing for personnel.

The function of the Agile coach is to facilitate the creation and enhancement of Agile processes within a specific team or across the entire organisation. Moreover, the Agile coach bears the responsibility of instructing personnel in the tenets of an agile approach to software development and of monitoring the performance of work. The role of the Agile coach is not merely to introduce a new work methodology in theory and practice; it is also to facilitate a change in the mentality of team members, encouraging them to think and approach the work process in a more flexible manner.

Moreover, the successful implementation of Agile flexible management methods within a company is contingent upon the establishment of an effective communication

system between Agile teams. In order to achieve this objective, it is recommended that a corporate portal be established for communication between CSCEC employees. A unified work environment allows for the dissemination of up-to-date information from the company in a systematic and efficient manner.

In order to optimise the effectiveness of the formation of Agile teams, it is recommended that the AVELife TestGold Studio software product be introduced. The software product offers a range of functions, including the creation of knowledge and psychological tests, the administration of tests, and the storage and analysis of test results.

The projected cost of implementing the project to develop Agile technology in the project management process at CSCEC is estimated to be 2,000,000 yuan. The results of the calculations indicate that the additional inflow of revenue will be 4,531 million yuan, while the additional influx of net profit will be equal to 185.8 million yuan. Moreover, the return on investment in the development of Agile technology in the project management process is projected to be 92.9 yuan in net profit for every 1 yuan of costs, which lends support to the feasibility of its implementation.

CONCLUSION

Green engineering is the design, commercialisation, and utilisation of processes and products in a manner that reduces pollution, promotes sustainability, and minimises risk to human health and the environment, while maintaining economic viability and efficiency. The fundamental principles of green engineering encompass a range of strategies aimed at preventing environmental issues from arising in the initial stages of the design process. These include the utilisation of materials that are readily recyclable, biodegradable or derived from renewable sources, the optimisation of processes, the minimisation of waste, the deployment of more efficient technologies, the reuse of materials and resources, the recycling of waste, and the integration of environmental considerations into the design of products and systems throughout their life cycle. Additionally, green engineering involves collaboration with a diverse array of stakeholders, including suppliers, customers, governments and local communities.

Examples of applications of green engineering include the development of energy-efficient buildings utilising solar energy and geothermal heat, the production of environmentally friendly cars employing electric vehicles and hybrid technologies, the creation of water purification systems employing biological treatment methods, and the development of environmentally friendly agricultural practices such as organic farming.

Green engineering represents a promising field of study that enables the creation of more environmentally friendly and sustainable systems. It plays a significant role in addressing global issues such as climate change, pollution and the depletion of natural resources.

CSCEC is a prominent entity within the construction industry, exhibiting a number of distinctive attributes that contribute to its market positioning. In terms of revenue, CSCEC is the world's leading construction company, outperforming its closest competitors. The company operates in over 100 countries worldwide, undertaking projects encompassing residential buildings, infrastructure, and complex engineering structures. CSCEC has considerable experience in several sectors, including civil engineering, industrial engineering, infrastructure, real estate and energy.

CSCEC plays an active role in China's Belt and Road Initiative, contributing to the construction of infrastructure in countries across the globe. CSCEC has considerable experience in the implementation of large-scale infrastructure projects, including high-speed rail, airports and seaports.

Key performance indicators of CSCEC for 2021-2023. show an upward trend.

CSCEC places a significant emphasis on sustainability management, having implemented a comprehensive multi-level sustainability management system. CSCEC has established an environmental, social, and governance framework that encompasses the Board of Directors as the highest authority, the Sustainability Committee, and the Sustainability Department. This structure ensures comprehensive coordination and top-down management of sustainability concerns.

A PEST analysis has been conducted on CSCEC, the largest construction company in the world, to examine the political, economic, social, and technological factors that impact the company. In terms of political factors, CSCEC benefits from China's stable political environment and government support for international expansion, as evidenced by initiatives such as the One Belt, One Road and Made in China 2025 programmes. However, the implementation of rigorous construction regulations and the occurrence of trade wars and sanctions may present obstacles. From an economic standpoint, China's rapid economic growth provides a robust demand for CSCEC's construction work, while government investment in infrastructure and real estate creates a plethora of opportunities. Additionally, fluctuations in the global economic situation and material prices can impact the company's profitability. From a social perspective, the rapid urbanisation and demographic shifts that are occurring in many countries drive demand for residential, commercial, and healthcare infrastructure. Additionally, environmental concerns and the need to meet public expectations for social responsibility and sustainability also influence CSCEC. Technologically, CSCEC is required to remain abreast of developments in construction technology, embrace digitalisation, explore the potential of automation for increased productivity, and incorporate environmental technologies into its projects.

The project management approach at CSCEC is customer-centric, with a focus on

rapid iteration, teamwork and cross-functional collaboration. It also incorporates the utilisation of data and analytics, technology integration and a strong emphasis on testing and quality control.

In 2023, the company's subsidiaries were subject to administrative penalties for environmental infractions, including construction noise, dust, sewage, and solid waste, resulting in a total fine of approximately RMB 7.1772 million. The company implemented President Xi Jinping's 'Thought on Ecological Civilization' by adhering to the directives of the CPC Central Committee and the State Council, to enhance ecological protection. A priority is placed on ecological development throughout the entire life cycle of the projects in question, including the stages of investment, design, construction and operation. The company expanded its green investment portfolio by investing in 12 clean energy and water environment protection projects, representing a total investment of approximately RMB 71.154 billion. Furthermore, the promotion of green and low-carbon design was undertaken, with the implementation of green and low-carbon technologies in building design, thereby achieving near-zero energy buildings. Furthermore, the company emphasized green construction and ensured compliance with government regulations, thereby promoting the utilisation of green and low-carbon technologies, products and services. The implementation of these strategies served to consolidate their position as a leader in the field of green construction.

CSCEC is making progress towards achieving green project management standards, but there is still a significant gap in terms of reaching a higher level of maturity. The company must intensify its endeavours in this domain to establish itself as a pioneering entity within the construction sector of sustainability.

To optimise the efficacy of project management within the context of CSCEC, it is recommended that the utilisation of Agile technologies be employed. These technologies represent a comprehensive set of methodologies and practices that facilitate flexible project management across a diverse range of domains, including software development and the implementation of marketing strategies. The implementation of Agile technologies is anticipated to expedite the production of completed products and mitigate risks through the iterative completion of tasks, the interactive involvement of team

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REFERENCES

1. A Brief History of Corporate Social Responsibility (CSR). URL: <https://www.thomasnet.com/insights/history-of-corporate-social-responsibility/> (date of access: 16.08.2024).
2. About Green Engineering. URL: <https://www.epa.gov/green-engineering/about-green-engineering> (date of access: 16.08.2024).
3. Agle B.R. Ensuring validity in the measurement of Corporate Social Performance: Lessons from Corporate United Way and PAC campaigns. *Journal of Business Ethics*. 2001. № 31(3). P. 271-284.
4. Bagnoli M., Watts S. Selling to socially responsible consumers: Competition and the private provision of public goods. *Journal of Economics and Management Strategy*. 2003. № 12 (3). P. 419-445.
5. Bartol K. Management. New York; St. Louis; San Francisco : McGraw-Hill, Inc., 1991. 911 p.
6. Besley T., Ghatak M. Retailing public goods: The Economics of Corporate Social Responsibility. *Journal of Public Economics*. 2007. № 91(9). P. 1645-1663.
7. Chen M.C., Delmas M. Measuring corporate social performance: An efficiency perspective. *Production and Operations Management*. 2011. № 20 (6). P. 789-804.
8. Cooper S., Owen D. Corporate Social Responsibility and Stakeholder Accountability: The Missing Link. *Accounting, Organizational and Society*. 2007. № 32(7-8). P. 649-667.
9. Creating a CSR Strategy: How to Forge a Lasting. URL: <https://doublethedonation.com/csr-strategy/> (date of access: 16.08.2024).
10. Ehsan S., Kaleem A. An empirical investigation of the relationship between corporate social responsibility and financial performance (Evidence from the manufacturing sector of Pakistan). *Journal of Basic and Applied Scientific Research*. 2012. № 2 (3). P. 2909-2922.
11. Emerson, J. The blended value proposition: Integrating social and financial

returns. *California Management Review*. 2003. № 45 (4). P. 35-51.

12. Environmental & Social Management System. URL: https://agra.org/wp-content/uploads/2020/07/Environmental-Social-Management-System_v4.pdf. (date of access: 16.08.2024).

13. Environmental and Social Impacts. URL: <https://www.mfat.govt.nz/assets/Aid-Prog-docs/Tools-and-guides/Environment-Guideline.pdf>. (date of access: 16.08.2024).

14. Environmental and Social Management and Monitoring Plan (ESMMP). URL: <https://www.energean.com/media/1045/esia-chapter-13-environmental-social-management-and-monitoring-plan.pdf>. (date of access: 16.08.2024).

15. Goodall T. Measuring Corporate Sustainability Performance and Its Impact on Corporate Financial Performance. *Applied Research in Environmental Economics*. 2005. № 31. P. 51-70.

16. Green Engineering. URL: <https://medium.com/@Cleanwatertech/green-engineering-f9741331e14b>. (date of access: 16.08.2024).

17. Green Engineering Examples and Benefits to the Environment. URL: https://environment.co/green-engineering-examples-and-benefits/#google_vignette. (date of access: 16.08.2024).

18. Green Engineering In Commercial And Industrial Recover. URL: <https://www.forbes.com/councils/forbestechcouncil/2022/03/21/green-engineering-in-commercial-and-industrial-recovery/>. (date of access: 16.08.2024).

19. Heal G. Corporate social responsibility: An economic and financial framework. *Geneva Papers on Risk and Insurance: Issues and Practice*. 2005. № 30 (3). P. 387-409.

20. Hillman A., G. Keim. Shareholder value, stakeholder management, and social issues: what's the bottom line? *Strategic Management Journal*. 2001. № 22 (2). P. 125-139.

21. Kang K.H., Lee C. Impacts of positive and negative corporate social responsibility activities on company performance in the hospitality industry. *International Journal of Hospitality Management*. 2010. № 29 (1). P. 72-82.

22. Lee C., Shrestha R. The impact of project management on environmental sustainability. *Journal of Cleaner Production*. 2017. № 142. P. 2512-2522.
23. Ma J. A Study on the Models for Corporate Social Responsibility of Small and Medium Enterprises. *Physics Procedia*. 2012. № 25. P. 435-442.
24. Mackey A., Mackey T.B., Barney J.B. Corporate social responsibility and firm performance: Investor preferences and corporate strategies. *Academy of Management Review*. 2007. № 32 (3). P. 817-835.
25. Quick Links Green Engineering: A Growth Mindset. URL: <https://www.greentechnologyinfo.com/what-is-green-engineering-and-its-contribution-for-sustainable-development/> (date of access: 16.08.2024).
26. Schwartz M., Carroll A. Corporate Social Responsibility: A Three-Domain Approach. *Business Ethics Quarterly*. 2003. № 13. P. 503-530.
27. Social and Environmental Assessment and Management. URL: https://info.undp.org/sites/bpps/SES_Toolkit/SES%20Document%20Library/Uploaded%20October%202016/UNDP%20SES%20Assessment%20and%20Management%20GN%20-%20Final%20Nov2020.pdf (date of access: 16.08.2024).
28. Sustainability in Project Management. URL: <https://www.projectmanagement.ie/blog/sustainability-in-project-management/> (date of access: 16.08.2024).
29. The seven key elements of an Environmental and Social Management System. URL: <https://blogs.iadb.org/sostenibilidad/en/espf-environmental-and-social-management-system/> (date of access: 16.08.2024).
30. Top 5 Green Engineering Trends. URL: <https://www.eit.edu.au/top-5-green-engineering-trends/> (date of access: 16.08.2024).
31. Turker D. Measuring corporate social responsibility: A scale development study. *Journal of Business Ethics*. 2009. № 85. P. 411-427.
32. United Nations Industrial Development Organization URL: <https://www.unido.org>. (date of access: 16.08.2024).
33. What is corporate social responsibility. URL: <https://www.ionos.com/startupguide/grow-your-business/corporate-social->

[responsibility/](#) (date of access: 16.08.2024).

34. What is Green Engineering and Its Contribution For Sustainable Development? URL: <https://www.greentechnologyinfo.com/what-is-green-engineering-and-its-contribution-for-sustainable-development/> (date of access: 16.08.2024).

35. Willis A. The Role of the Global Reporting Initiative's Sustainability Reporting Guidelines in the Social Screening of Investments. *Journal of Business Ethics*. 2003. № 43. P. 233-237.

36. Wisebrod J. Social Impact Ratings: How to Make Responsible Investment Appealing. *Finance and the Common Good/Bien Common*. 2007. № 27(2). P. 29-40.

37. Xie L., Liu X., Liu B. The impact of project management on environmental protection in China. *Journal of Environmental Management*. 2019. № 250. P. 45-50.

38. Yang Y. Corporative social responsibility: some aspects of the evolution of the concept. *Science, technology and education*. 2022. № 2 (85). P. 53-57.

39. Zhai X., Liu J., Lu Y. The impact of project management on construction safety performance. *Journal of Cleaner Production*. 2019. № 38. P. 11-17.

40. Zhang H., Cai J., Li Q. Research on the impact of project management on environmental protection in urban infrastructure projects. *Journal of Cleaner Production*. 2019. № 4. P. 31-36.

41. Yang Bo, Yurii Puhach. Green engineering in business management: benefits for a sustainable future. *Materials of international. scientific and practical conference. "The current state and prospects of economic development, accounting, finance and law."* Kremenchug, September 5, 2024 - Poltava: TSFEND Publishing House, 2024.

42. Yang Bo, Yurii Puhach. Agile methodology in green engineering as a tool for effective management of sustainable development projects. *Materials of international. scientific and practical conference. "The current state and prospects of economic development, accounting, finance and law."* Kremenchug, September 5, 2024 - Poltava: TSFEND Publishing House, 2024.

Appendix

APPENDIX A

VII. Key Accounting Data and Financial Indicators for the Last Three Years

(I) Key accounting data

Unit: '000 yuan Currency: RMB

Key accounting data	2023	2022	Change YoY (%)	2021 (After adjustment)
Revenue	2,265,529,244	2,055,052,070	10.2	1,892,706,307
Profit before income taxes	92,995,473	88,835,435	4.7	101,038,185
Net profit attributable to shareholders of the Company	54,264,173	50,950,301	6.5	51,548,576
Net profit attributable to shareholders of the Company after deducting non-recurring profit or loss	48,538,669	45,233,864	7.3	49,521,361
Net cash flows from operating activities	11,030,123	3,828,927	188.1	13,989,638
	At the end of 2023	At the end of 2022	Change YoY (%)	At the end of 2021 (After adjustment)
Net assets attributable to shareholders of the Company	427,609,892	384,322,141	11.3	345,627,781
Total assets	2,903,322,519	2,652,903,306	9.4	2,395,321,862
Total share capital at the end of the Reporting Period	41,919,514	41,934,433	-0.04	41,948,168

(II) Key financial indicators

Key financial indicators	2023	2022	Change YoY (%)	2021 (After adjustment)
Basic earnings per share (RMB/share)	1.31	1.23	6.5	1.25
Diluted earnings per share (RMB/share)	1.31	1.23	6.5	1.25
Basic earnings per share (RMB/share) after deducting non-recurring profit or loss	1.17	1.07	9.3	1.17
Weighted average return on net assets (%)	13.36	13.94	Decrease by 0.58 percentage point	15.90
Weighted average return on net assets after deducting non-recurring profit or loss (%)	11.94	12.42	Decrease by 0.48 percentage point	15.34
Net assets per share attributable to ordinary shareholders (RMB/share)	9.98	8.93	11.8	8.00
Dividend per 10 shares (RMB)	2.7145	2.527	7.4	2.50