

Green Building Evaluation System between China and South Africa. A Comparative Review.

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Abstract:

As the largest developing country in Africa, much research had been achieved, and the Durban World Climate Meeting was held in South Africa. Green Star South Africa (Green Star SA) is a rating system used to assess the design and construction of various building types from an environmental and human health perspective. China has entered a period of great prosperity, with about 1.6-2 billion to 2 billion new buildings built each year, representing about 40% of the world's new construction. Energy consumption of China's buildings and related emissions is expected to increase over the next 15 years. As a result, promoting the development of green buildings has become an urgent problem to be addressed in China. Through the comparative study on the green building evaluation system between China and South Africa, deficiencies of green building evaluation of China were discussed in depth to provide a reference for further improving China's green building evaluation system.

Key Word: Green Building; Evaluation System; Green Star SA; South Africa; China.

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I. Introduction

Green building is the practical achievement of sustainable development in the construction industry, which has been widely promoted in many countries and introduced into China in the 1990s[1]. In 2006 China promulgated and implemented the first edition of the Green Building Evaluation Standard and began to promote the development of green buildings with "evaluation"[2].

Due to different situations in different countries and regions, many different degrees of certification systems have been put in place to assess green buildings[3]. Essential assessment tools for green buildings used around the world include the US Leadership in Energy and Environmental Design (LEED) guidelines[4], the British Building Research Institute's Environmental Assessment Methodology (BREEAM)[5], and the Chinese Green Building Brand Assessment Standards [6]. At present, China is the largest construction market, with an annual construction area of 2 billion square meters, and is expected to account for about 50% of the world's new buildings in the next decade, the world's most significant contributor to carbon dioxide emissions[7-9]. While green buildings are becoming increasingly popular in China, they account for about 4% of the country's largest construction market[10]. Besides, the low level of management and lack of transparency in the design, construction, and operation of buildings make it difficult to implement the practice of green buildings[11]. Furthermore, with the Chinese government's "Belt and Road" policy and ongoing urbanization [12], China will have more opportunities to accelerate infrastructure construction. Because of these factors and the improvement of environmental awareness in China, there is a need to establish and use a good and effective construction assessment system[13].

Subsequently, green building design, construction standards, and evaluation standards of different green buildings were promulgated[14, 15]. The whole process, including survey, planning, design, construction, acceptance, operation, and maintenance, needs the relevant standards for improvement. At this stage, China cannot be like other countries. Relying solely on evaluation standards can fully promote the development of green buildings and needs a series of standards for the construction of green building norms and guidelines. China and South Africa are large developing countries and significant emerging economies[16, 17], with many similarities in economic conditions, construction technology level, and climatic conditions. South Africa has made outstanding achievements in developing green buildings, combating climate change, and successfully held the Durban World Climate Conference (UNFCCC) in December 2011 and adopted the Decision to implement the second commitment period of the Kyoto Protocol to launch the Green Climate Fund[18-20]. By studying the green building evaluation system in China and South Africa, an In-depth analysis of the implementation of green building evaluation in South Africa sorts out the advantages and disadvantages of China's green building

evaluation system to further improve the green building standard system and to promote the development of green buildings in China

II. Case study

1. South Africa

According to the Construction Industry Development Board (CIDB), the South African Government is committed to reducing greenhouse gas emissions through various mechanisms[21], such as a green building. This commitment was evident at the Climate Change Conference COP17, which was hosted by South Africa[22]. South Africa plans to reduce greenhouse gas emissions by 42% By 2025[23, 24]. The South African Government and non-governmental organizations are taking measures towards the green construction industry to help with its commitment to green buildings and has adopted the National Framework for Green Building in South Africa (NFGBSA) as its national framework Official Green Building in November 2011[25]. The primary key strategy of NFGBSA is the development of green buildings Regulations and standards. The South African Government-issued SANS 10400 as part of the building regulations that guide the design and construction of green buildings In South Africa[26, 27].

Currently, there are no regulations or policies for green buildings in South Africa, only the National Environmental Management Act of 1998 (National Environmental Management Act No. 107 of 1998) as a legal basis[28]. However, the South African government aims to build commercial buildings and public buildings by 2020. The building construction industry is expected to record a Compound Annual Growth Rate (CAGR) of 4.8% to reach ZAR 100 billion by 2024[29]. The residential construction industry, in value terms, increased at a CAGR of 2.3% during 2015-2019. The commercial building construction market, in value terms, is expected to record a CAGR of 3% over the forecast period and a 25% reduction in energy consumption.

GBCSA's Green Star SA Rating Tool is based on the Australian Green Star tool, but was developed specifically for the background of South Africa and served as an alternative[30, 31]. The tool encourages the construction industry to minimize the environmental impact of their development to reduce landfills and create standard incentives such as more resource-saving designs. Green Star SA's success results from industry leaders such as large companies, banks, real estate developers, and government agencies who support the use of the tool. Nevertheless, Green Star SA is also unique to South Africa and is the natural focus of green building movements and boards in other parts of Africa. GBCSA seeks to work with seven other Green Building Councils in Africa through World GBC's Regional Network for Africa to adopt the Green Star SA tool to specific local environments; this is done through what GBCSA calls a local background report.

The relevant evaluation points in the South African Green Building Evaluation System are based on energy efficiency (Energy Efficiency In Buildings: SANS) of South Africa's national standards technical requirements. Building energy efficiency standards were issued by the South African National Standards Authority in 2008 but will not be enforced until government regulations are in place[32]; the standard is implemented solely to promote and make the public aware of information and knowledge about green buildings in South Africa, while promoting the government's mandatory use of phase in new buildings.

Regulations on green technology were introduced. In addition, the Government of South Africa is proposed to be led by the Department of Water Affairs and Forestry to develop a Water Efficiency Labelling and standards that enforce minimum performance metrics for water equipment.

2. China.

As a strategic emerging industry, green building provides an effective solution for China's energy conservation, emission reduction, and climate change.

The Energy Law is the fundamental law guiding China to build energy conservation and develop green buildings[33]. Establishing a long-term strategic policy for the development of the country's economy, it clarifies the government's responsibility to manage energy conservation and the obligation of energy-using units to use energy rationally and puts forward encouragement, support, and promotion, comprehensive energy-saving advanced technology requirements and provide for the relevant legal responsibilities.

The Outline of the National Medium and Long-Term Science and Technology Development Plan (2006-2020) gives priority to building energy conservation and green buildings in the areas of urbanization and urban development themes and development priorities[34]. In 2012, the State Council issued the 12th Five-Year Plan for the Development of Strategic Emerging Industries, including "energy-saving and environmental protection industries" as the first item[35-37]. The critical tasks are put forward in developing energy-efficient industries, which clearly stated that to improve the energy-saving standards of new buildings, carry out the existing building energy-saving transformation and vigorously develop green Building, promoting green building materials in order to promote the healthy development of green construction industry.

China's Ministry of Science and Technology issued the "12th Five-Year" Green Building Science and Technology Development Special in 2012. The project requires that during the 12th Five-Year Plan period,

China should promote the large-scale construction of green buildings and significantly enhance the independent innovation ability of green building technology, relying on scientific and technological progress to change the way the construction industry develops. In 2013, the State Council forwarded the Green Building Action Plan, which sets out the guiding ideology, main objectives, Basic principles, priorities, safeguards, etc. In addition, specific green energy-saving standards, measures, and subsidies to make detailed requirements, marking the development of green building regulations.

In the "13th Five-Year" energy-saving and China's development includes raising energy efficiency standards for buildings. The proportion of new buildings in cities promotes green buildings and the construction of new buildings, and gradually expand the use of renewable energy Scale. The policy aims to make construction projects more environmentally friendly, and the theme subject will propose a new Research direction[38].

In addition, the 2017 work plan includes "new methods and demos of Regional Climate Adaptation of Green Public Building Design," "Green Building Technology Model and a multicultural technology system based on the western region," "Chinese architectural background in developed regions," and implementation of data management in technology based on the whole process, which are the leading focus of green building projects Implementation of industrialization[39, 40].

III. Green building evaluation description

1. Evaluation system

Green Star SA, South Africa's green building evaluation system, is built from an environmentally friendly and human health perspective. The evaluation system tool is for systematic evaluation of the design and operation of different buildings; the Green Star SA rating system is based on the Australian Green Building Review.

The price system, combined with South Africa's climatic characteristics, is designed to recognize and reward the commercial real estate industry for coordinating construction through an objective evaluation of green buildings and contributions made in the interrelation with the environment. The rating system can be targeted at office buildings, retail centers, and multi-unit homes (Multi-Unit Residential), Public and Educational Buildings. Based on the final evaluation of each building.

Table no 1 Green Star Rating for South Africa. Green Star SA is divided into six levels from low to high, with a minimum of one star and a maximum of six stars, but only buildings that reach four, five, and six stars official certification is carried out. In contrast, one, two, and three-star buildings are considered ordinary green buildings.

Table no 1: Shows metabolic parameters of patients of the three groups before treatment.

Rating	Score	Represents	Labeling
One Star	10	Minimum Practice	*
Two Star	20	Average Practice	* *
Three Star	30	Good Practice	* * *
Four Star	45	Best Practice	* * * *
Five Star	60	South African Excellence	* * * * *
Six Star	75	World Leadership	* * * * * *

Green Star SA is divided into design identity and operational identity.

1) The design rating is at the end of the architectural design. After the structure is evaluated, the operating markings are usually carried out three years after the building is put into operation. 2), according to the final evaluation score of different types of buildings, a score of one-star, two-star, or three-star is given as the green building rating. Thus, the evaluation of green buildings in China is divided into design and stage operation; through this review, the project can obtain its evaluation mark or green building evaluation mark.

2. Organizational management

The Green Building Council of South Africa (GBCSA) was established in 2007 as one Independent, non-profit organization[24]. GBCSA, as South Africa's officially recognized National Green Building Council, is responsible for organizing all professional business units in the commercial real estate industry; evaluation agencies carry out green building evaluation work and organize the establishment of a green building evaluation system in South Africa, GBCSA is a member of the South African commercial real estate industry and the composition of units or institutions in all areas of expertise. Although GBCSA is an independent organization, it is supported by the government and is also provided to support the Government policy. The core function of

GBCSA is to promote the development of green buildings in South Africa, and at the same time to provide the community with policy advice on green building construction and management, Industry knowledge, and professional training. GBCSA is not involved in the consultation of green building projects and does not advise developers on the design of green buildings.

Unlike South Africa, China's green building evaluation is implemented and managed by departments and institutions authorized by the housing and urban-rural construction authorities. The competent department of township construction may organize and evaluate one-star and two-star green building. The evaluation of three-star green building shall be carried out by the competent department of housing, urban and rural construction.

The Ministry of Housing and Urban-Rural Development (MOHURD), Industrialization Development Center, and China Urban Science Research Association with Green Construction Research Center were entrusted with the work, and the green building evaluation ranking was established. However, the Management Office is responsible for the implementation[42].

3. Evaluation tool

The South African Green Building Evaluation Tool was developed by experts in the relevant fields of GBCSA organization for office buildings, commercial buildings, residential buildings, public buildings, and the evaluation method was also established in the educational building. Similar to other green building evaluation systems in the world, the Green Building Evaluation System in South Africa is divided into eight categories Table 2, including:

Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use and Ecology, Emissions. In addition, innovation is included to encourage the adoption of appropriate and innovative solutions in buildings. Each type of evaluation project corresponds to a weight value. However, different types of building weight values exist. At the same time, the higher the impact on the environment, the higher the corresponding weight value. After multiplying the weight values of each type of evaluation item with the weight value of the corresponding evaluation item, all reviews were done.

The unit price of the item is added together, and the total unit value of the building is obtained Fig 1. In 2006, China promulgated the national standard "Green Building Evaluation Standard" GB/T50378-2006, which summarizes the practice of green building in China at that time[43].

Based on experience and research results, drawing on the advanced experience in the implementation process of green buildings in developed countries, the comprehensive evaluation standards of multi-objective and multi-level green buildings have been formulated.

Table no 2: Green Building Evaluation Indicators for China and South Africa.

Evaluation system	Evaluation indicator	Evaluation requirement
Evaluation system of green building in China	Land saving and outdoor environment	In the evaluation process, all control items should be met and grade according to the total unit score.
	Energy-saving and energy utilization	
	Water-saving and utilization of water resources	
	Material saving and utilization of material resources	
	Indoor environment quality	
	Construction management	
	Operation management	
Evaluation of green building system in South Africa	Administration	There is no control item, and the rating is based on the total unit score in the evaluation process.
	Indoor environment quality	
	Energy	
	Transport	
	Water	

	Material Science	
	Land use and Ecology	
	Discharge	

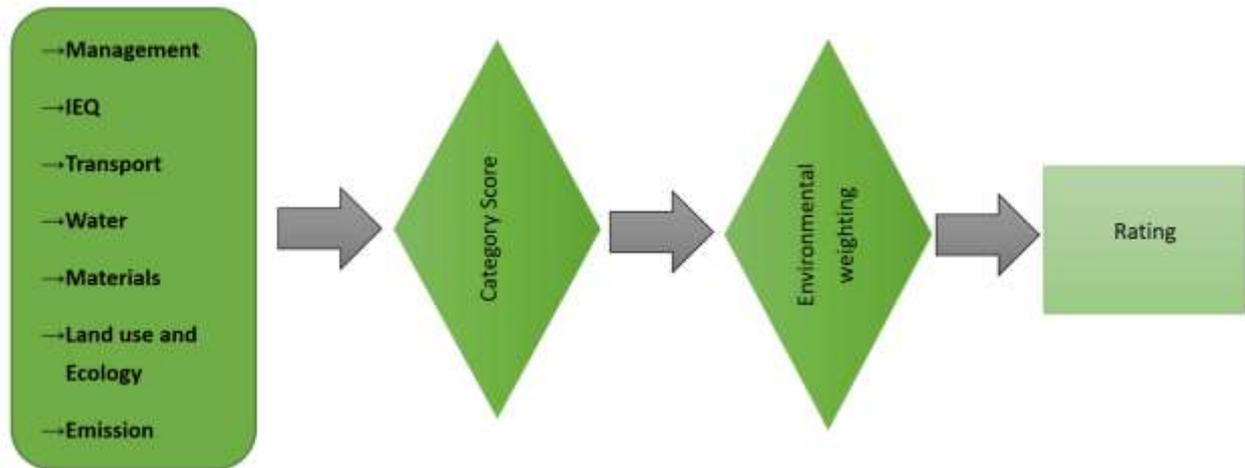


Figure 1 : South Africa's Green Star evaluation methodology[44].

China's green evaluation standards from land and outdoor environment, energy conservation and energy use, water conservation and water resources utilization, material and material resource utilization, indoor environmental quality, and operation.

A total Management of six category indicators were implemented to evaluate buildings. In 2013, the new national standard "Green Building Evaluation Standard" GB/T50378-2014 was revised and applied[45]. It is surrounded by office buildings, shopping malls, and hotel buildings in residential and public buildings and has been further extended to the main types of civil buildings.

The evaluation content of industrial management has to realize the coverage of the whole life of the building. With the continuous improvement of China's green building evaluation standards, green architecture has formed China. Green building evaluation standards are the primary tools, while the evaluation tool system supplements exceptional building evaluation standards.

4. Evaluation procedures

The Green Star evaluation process in South Africa includes project registration, documentation, project pre-assessment, assessment review, and certification Figure 2, Design identification and shipping. The evaluation procedures identified in the line are consistent, but the assessment information submitted differs, as follows:

- 1) The evaluation project is registered through the GBCSA official website and the relevant project information is submitted;
- 2) collection of relevant supporting and documentation materials during operation;
- 3) the GBCSA technical team organizes a pre-assessment by the evaluation team upon receipt of the project materials;
- 4) Pre-assessment is generally carried out during the architectural design phase, which not only helps to implement the idea of green building from the design stage, but also helps to minimize the resulting impact and Incremental cost, but also conducive in urging the evaluation of the project comprehensive response evaluation as requirements;
- 5) after the pre-assessment, the evaluation project can be based on the pre-assessment comments to supplement the relevant materials, Address the issues mentioned in the pre-assessment comments and submit them again for review. Finally, the formal assessment reviews the project materials and technical documentation relevant to the GBCSA technical team.

After submitting to the reviewer, the accessor does not go to the construction site and instead only reviews the documents. GBCSA's certification star rating is based on the final total score value of the project and Officially awarded to the South African Green Star for the project.

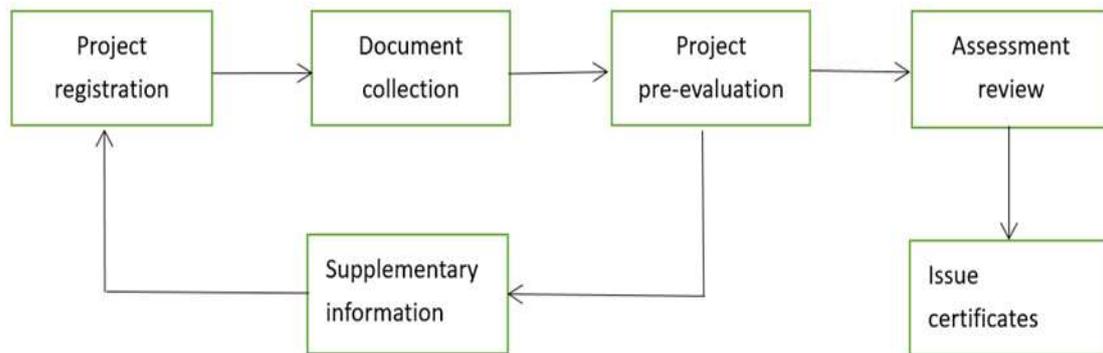


Figure 2: South Africa's Green Star evaluation process.

China's green building evaluation rating by the owner units or real estate development units is to apply and encourage design phase, construction phase and property management, and other related units with participation in the declaration. Residential buildings and public buildings applying for the "Green Architectural Design Evaluation Mark" shall complete the construction drawing design, pass the construction drawing review and obtain the construction permit.

Residential and public buildings applying for the "Green Building Evaluation Mark" shall pass the project quality acceptance and be used for more than one year. Different stages, different stars of green building rating. Green building evaluation rating declaration procedures include:

1) The reporting unit submits the declaration data; 2) the green building evaluation and marking management agency conducts the formal examination; 3) the professional evaluation and expert evaluation; 4) the evaluation passes. The project shall be publicized and filed by the competent department of housing urban and rural construction; 5) the public announcement shall be made. The certificate shall be issued after the period of publicity expires.

IV. Conclusion

By comparing the evaluation system of green buildings between China and South Africa, the following conclusions were obtained, and some suggestions are made for further development of green buildings in China and South Africa:

(1) China and South Africa are both developing countries; the two countries have started late in developing green buildings and the relevant policy measures for green building evaluation are relatively weak. Evaluation tools are also being refined. At the same time, because the western developed countries influence the green building evaluation system, the two countries have similarities in the organization management and evaluation procedures. However, compared with developed countries, green buildings in the two countries still lack mandatory measures and market implementation in lasting vitality and momentum.

(2) China's green building development has moved from the strategic planning level to the practical level, the national level issued the "Green Building Action Plan" and "12th Five-Year Plan" During this period, China's new green buildings and existing buildings energy-saving transformation of the task objectives, but green buildings in China are still in the initial stage. Exhibition experience solidly contributed to basic research with the continuous development of China's technology and economy and constantly improve the top floor design of green buildings, following the long-term planning set phase, step-by-step implementation, and gradually promote supporting measures.

(3) Although China continues to carry out research and practice on green buildings, it has not yet fully covered all climate regions of the country and how to implement the "four sections and one environmental protection fully."

There is still a lack of in-depth research, especially on developing green buildings according to non-systematic local conditions to Strengthen the basis of energy resource consumption and carbon dioxide emissions. The construction of the database, speed up the development of green building technology and products, the development of additional tools according to local conditions to carry out the regional adaptability of green buildings and other essential research work; this will help to improve the adaptability of green buildings in China.

(4) At present, China's green building evaluation standards are gradually improving the Civil Building Green Design Norms, Green Building Evaluation Standards, Green Industrial Building Evaluation Standards, Green

Office Building Evaluation Standard, Green Construction Standard for Construction Works, and Green Construction Evaluation Standard for Construction Projects has been promulgated and implemented one after another. Green Shop Building Evaluation Standards, Green Hotel Building Evaluation Standards, Green Expo Building Evaluation Standards, Green Hospital Evaluation Standards, Green Campus Evaluation Standards, Green Photo Ming Testing, and Evaluation Standards, Existing Building Renovation Green Evaluation Standards and so on are also in the process of preparation. The "green" goal achieved by existing green building projects is not determined by the design standards but by following the green building evaluation standards in the green building planning stage. In addition, standards for the operation and management of green buildings remain inadequate.

Therefore, perfecting the construction of the green building standard system will help standardize the construction of green buildings in both China and South Africa during the whole life period and provide technical support for the development of green buildings.

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