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# Research on the Sustainability in Green Building

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**ABSTRACT**
In the era of rapid development of architecture, green buildings have emerged as a sustainable development path with many urgent problems, the quality of the building and the subsequent maintenance management aspects are not fully implemented. This study is based on literature research on green buildings, analyzing the current development of green buildings and proposing existing problems and future directions for development. The analysis shows that there is a lack of management planning for the whole process of green buildings, and therefore proposes ideas for a green building management planning system that will allow for sustainable development of green buildings from design to completion.

***Keywords:*** *Green buildings, Sustainability, Sustainable buildings, Sustainable development*

## 1. INTRODUCTION

In recent times, the environmental pollution and heavy energy burden brought about by the rapid industrial development has posed a great challenge to China and even the world. In order to facilitate the sustainable development of China's construction industry in the current situation, it is necessary and urgent to create green buildings. At this stage, green building designs are emerging, from new energy sources to new structures, green buildings have emerged as a very large number of precedents in the design phase, new materials are being used in buildings more and more, and green buildings are growing year after year in terms of data, but there are still many problems that need to be solved, such as the green building protection system is not yet sound, the quality of buildings is still not high, the maintenance management of buildings after completion. Many studies have only given initial ratings to green buildings, but have not paid much attention to whether the subsequent results are as expected, so green buildings have only ever been in their infancy and have never been sustainable for long[1]. At present, green buildings in China are beginning to take steps, but they are still in the pilot stage of experimentation and have not yet formed a complete system. To make substantial progress, the government needs to be strongly managed in legal, economic, and administrative terms, with all parties participating to play an important role[2]. Therefore, more human and material resources need to be invested in green buildings, and more legal aspects are needed to monitor the whole process and make a final assessment of the building projects.

This study aims to analyze the current form of development of green buildings through a review of various literature and to identify the problems that exist in the future development of green buildings, to propose relevant measures to solve them, and to make a vision for their sustainable development. Green development is for better ecological development, and green building is an important part of this development path. If we want to make the economy and ecological civilization go hand in hand, we need to pay more attention to the sustainable development of the green building. This is not only to meet the needs of today's society, but is also important for the country to be able to develop sustainably and build for the long term.

## 2. LITERATURE REVIEW

### *2.1 Definition of Green Building*

Green architecture not only seeks to provide people with a comfortable and convenient living environment throughout the life cycle of a building, but also seeks to conserve energy and materials, maximize the use of natural resources, reduce waste and pollution, and bring people closer to nature, with artificially modified green buildings maintaining a dynamic balance between people and nature.

In its initial stages, green architecture was considered to be a product of an ideal state, and the concept he

 

represented was to conserve resources, protect the environment and make society sustainable with a low-carbon lifestyle. At this stage, green building has moved from a concept to reality, and many real estate developers are committed to bringing the green building to the Chinese market[3]. The problem with this is that the conceptualized houses do not integrate with the existing building system in many ways, resulting in developers being out of touch with reality from the design stage, with no pre-planning for future occupancy, which can hinder the sustainable development of green buildings. In this context, Li and Cui explore the relationship between human factors and stakeholders in the sustainable development of urban green buildings under the green building concept, and point out that given the environmental, social and economic advantages of green buildings, government departments need to adopt incentive policies to encourage more contractors to participate in the green building process[4].

Some research findings suggest that the lure of huge profits can stimulate contractors to act inappropriately and that the use of dynamic reward and punishment mechanisms is more appropriate for government regulatory policies[5].

## *2.2. The Failure Cases and Necessity of Green Buildings*

### *2.2.1 Failure Cases of Green Building*

The Gherkin building in London (designed by Foster & Partners in 2003) was designed as an open-floor ventilation system, but during the construction process, for safety reasons and cost, all the windows that could have been opened had to be closed. The open-floor ventilation system was designed as an open-floor ventilation system. This made the original open-floor design redundant and useless, and the ventilation of the whole building became worse, consuming far more energy than originally anticipated due to the additional artificial ventilation system. Such a green building has a very idealistic design, but because it was not initially considered practical and feasible, it instead loses the meaning of a green building. As a result, many buildings have been built without proper planning, and the results have often been contrary to the original expectations.

The Federal Building in Youngstown, Ohio, which was certified by the United States Green Building Council (USGBC), is famous for its white roof that reduces energy consumption and is designed to use mostly natural light, making it an iconic green building. However, after an investigation, it was found to have high utility bills and was therefore stripped of its Energy Star designation. According to a study by the building's owner, the General Services Administration, the source of the bills was due to the high energy-consuming operation of the building's cooling system. the USGBC said that from this year onwards the council will require all new buildings to provide a list of their energy and water bills for the first five years after they are put into use as a condition of achieving certification. As can be seen, green buildings have become a gimmick for some developers, inflating the highlights of their designs in an attempt to obscure the huge flaws in the actual operation of the buildings. Some designs that appear to be very low carbon and energy-efficient may result in huge energy consumption in other areas. Therefore, the assessment of green buildings needs to be viewed with a long-term perspective, from design to monitoring records and maintenance after commissioning, which will become an indispensable and important step for the future of green buildings.

### *2.2.2 The Environmental Necessity of Green Buildings*

The environment has become a key factor in assessing green buildings. In the development process, the environment is the basis for the survival of all things, and the building that provides the living space is the most crucial part of the environment. The sustainable development of buildings must first meet the green design throughout, from the raw materials used in construction to the technology that has the most environmental performance[6]. In addition to this, as urban land use becomes increasingly tight, it is important to achieve optimal planning for land resources while not damaging the environment, and the core of green building design is to reduce the use of natural resources and achieve the needs of the building through design.

### *2.2.3 The Social Necessity of Green Buildings*

With the development of the big data era, intelligent buildings have come to the forefront, and more and more buildings are becoming more intelligent from the inside out, while the advanced nature of green buildings means combining green and intelligence into one, promoting green buildings with intelligence and promoting intelligence with green ideas. Green intelligence is the synthesis of technology, through the computer network control technology for the building energy consumption and indoor environment and air quality of remote detection and control, green from the concept into the actual, and ultimately reflected in the data.

### *2.2.4 The Economic Necessity of Green Buildings*

Economic development may seem to be the least relevant aspect of green building, but rapid economic development will certainly promote the pursuit of a more suitable living environment, and the concept of green building design should be conducive to human health, with a comfortable environment and fresh air. In terms of

issues such as the cost of design solutions, they should be operable. Under the premise of effective cost control, choosing the most optimal design solution will be conducive to sustainable economic development in the future.

The ecological nature of green buildings means respecting ecological laws and protecting the ecological environment in design, construction and use; adapting to local conditions, combining local climatic characteristics and other geographical conditions, making maximum use of natural lighting and natural ventilation to reduce energy consumption and pollution, giving preference to environmentally friendly materials in material selection, efficient recycling of natural resources, and being as harmless as possible in waste discharge and reasonably recycled.

### *2.3 Achievement and Future*

With the wind of environmental protection blowing around the world, many cities have made "eco-cities" and "garden cities" their goal and mode of development to put themselves in a good position to compete. However, inevitably, some people are trying to attract funds under the guise of being 'eco' and 'green', and many of the 'green buildings' that are built are not what they seem to be.

Builders covet the Energy and Environmental Building Certificate, not only because it represents leadership in energy and environmental design, but also because of the tax breaks available. Many sustainable building schemes achieve their 'sustainable' criteria by installing a variety of energy-efficient equipment, such as less energy-intensive mechanical equipment and higher insulation rates. These devices may produce good energy savings in some parts of the building, but the overall energy consumption is high due to the outdated nature of the building plan and structure. And architects and builders don't even think about this. This is a problem of perception. There is another problem with perception: people often think that if they reduce the energy consumption of the whole building system, they will reduce their energy costs. In reality, however, the more energy efficient the building itself appears to be, the more recklessly its occupants waste energy, with the result that buildings that were supposed to be low-energy consuming become even more energy intensive in the process.

Green building design should be based on the protection of nature, not for the function of the building and more energy consumption and increased pollution, based on optimizing the traditional architectural design form, to adapt to the new era of ecological and green construction needs, to achieve the harmonious unity of architecture and people and nature, harmonious development.

The main theme of green building design is to save resources and environmental protection, therefore, green building design should not be carried out at the cost of environmental pollution, user-health infringement and natural environment change, to highlight the function of green building design, to promote the moderate function of green building, to achieve savings and efficiency, so that green building better play the function and system value, to achieve the goal of designing the green building.

| | Green building materials | Traditional building materials |
|---|---|---|
| Composition | Tailings, Fly ash, Industrial waste, Agricultural waste | Clay, Gypsum, Granite |
| Material | Aluminum alloy, Green concrete, Carbon fiber, Green vacuum glass | Cement, Clay brick, Wood board |
| Performance | Heat insulation, Moisture resistance, Fire prevention | Single function, Low ignition point, Easy to mold |
| Production Process | Low energy consumption process, Clean production | Prone to generate Large amounts of waste |

**Figure 1.** Comparison of the two building materials

## 3. SUSTAINABLE DEVELOPMENT OF GREEN BUILDINGS

### *3.1 New Building Material Design*

When a building reaches the end of its service life, it will be demolished, and the resulting construction waste not only causes waste of resources, but also causes serious pollution to the environment. There will also be a lot of reusable materials in the construction waste, so in order to reduce the cost expenditure of construction materials, the waste construction materials can be sorted and then recycled, which not only reduces the cost input of the building, but also reduces the pollution caused to the environment.

The increased use of renewable materials such as wood, waste paper and fibre insulation in construction not only reduces the investment in construction, but also alleviates the ecological problems caused by the over-exploitation of natural resources by humans. In the past, the traditional construction industry was often very vague about the use of materials, but with the development of technology, people's concepts are gradually updated. The concept of renewable is gradually gaining ground. Renewable means multi-level use of materials, inexhaustible, which can not only reduce the cost of materials, but also maximize the advantages and save materials while causing less damage to the environment. But it cannot be claimed indefinitely, and renewable materials need to be used while the environmental carrying capacity is acceptable.

As shown in figure 1, the materials used in green buildings have very clear advantages over traditional ones[7]. Producers use industrial waste and other wastes as raw materials and use clean production techniques to produce green building materials, reducing natural energy consumption and environmental pollution while increasing the utilization of resources.

According to research, suitable building materials are often sourced from materials that can be sourced or manufactured locally[8]. Some materials may have excellent properties in their own right, but are not green due to their longevity, reusability and origin. When selecting green building materials, it is important to consider not only the impact of the material itself, but also the energy consumption due to transport and extraction, and the damage to the ecosystem. To achieve a reduction in transport costs and CO2 emissions, they should be derived from inexhaustible assets, produce less harmful gases for humans and at the same time need to be economical.

Over the past few decades, material maintainability has become an important indicator, and new materials are no longer being pursued for their low-carbon capability, but rather for their overall serviceability in a comprehensive manner.

Prutha Patel and Anant Patel suggest that plastic waste, when recycled, can be used to make certain attractive decorative items as a rapidly consumable resource with a limited but highly reusable lifespan[9]. Green building materials are therefore often renewable resources that can effectively reduce the use of limited resources, improve the durability of buildings and reduce harmful emissions and radiation from products. Figure 2 below, shows the various sustainable building materials used in green building construction[10].

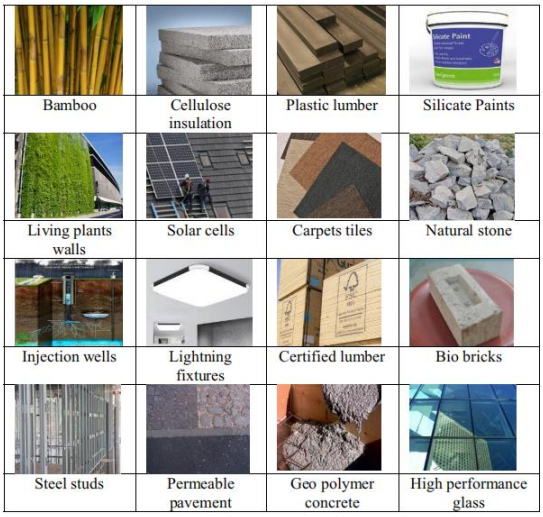


**Figure 2**. Sustainable materials for green building construction

### *3.2 New Energy Architecture Design (Solar Architecture)*

In the increasingly tight situation of energy worldwide, environmental pollution has also become more serious, so the development and use of clean energy should be increased, not only to reduce energy consumption, but also to reduce the pollution caused to the environment. At this stage, the efficiency of wind and solar energy use is greater, so in the design of buildings, clean energy should be used as much as possible, such as solar water heaters and solar power, which is an important means in green design[11].

Solar energy is an inexhaustible new green natural energy source that is free to use, constantly renewable, no need for transport, no pollutant emissions, no noise in the application of clean energy, so it is very much in line with China's current national policy of "energy-saving and emission reduction", and has been widely used[12].

For a long time, the energy used by humans has been mainly fossil fuels such as oil, natural gas and coal, which are non-renewable energy sources. Therefore, the use of solar energy technology in building design makes a lot of sense. The main two types of solar energy utilized in an active way are currently solar thermal utilization and photoelectric utilization: photoelectric utilization is the use of solar cells to generate electricity to provide energy. As technology advances, photovoltaic conversion efficiency will also increase and costs will be further reduced. Solar cells can also be combined with building materials to form a new type of photovoltaic building material, such as solar photovoltaic roofs, solar electric walls and solar photovoltaic glass. These materials can not only generate electricity, through the appropriate design can also make the building components at the same time set multi-functional in one, as the future of ecological building composite materials, its application does not affect the building aesthetics, but also for the building shape gives a high technology connotation, is the future direction of sustainable development of the building.

For example, transparent thermal walls can store solar heat in summer and use the stored heat for heating in winter, a widely used approach to solar energy systems.

The installation of solar panels is one of the most prevalent green building practices in Malaysia. Malaysia is located in the sunny global sunbelt, which is ideal for generating electricity from solar energy, and the government has set a target to increase the share of renewable energy in the local electricity generation mix from the current 5% to 20% by 2025. As a result, the local adoption of solar energy is expected to increase significantly in the coming years, creating a huge scope for Hong Kong companies providing solar engineering, consultancy and project design services.

In January 2019, Malaysia implemented two financial incentives to make the installation of solar panels more financially viable. Firstly, under the Supply Agreement for Renewable Energy (SARE) scheme, residential, commercial and industrial customers can enter into lease agreements with solar panel suppliers who install and maintain solar systems, an arrangement that removes the barrier of upfront costs. Secondly, under the Net Energy

Metering (NEM) scheme, customers can sell excess energy generated by solar panels to the national grid in exchange for credits to offset electricity consumption.

### *3.3 GB Structural Design (Roof Gardens)*

Roof gardens can usually be divided into two categories, one of which is the simple roof garden, which has a soil layer consisting of mosses and grasses that can be planted with a number of grasses, these plants do not require a very strong roof structure or perfect conditions to survive and therefore only require normal watering and care[13]. This simple roof garden is commonly the most economical way to maintain a green appearance for a long time and also to prevent the roof from becoming too hot for the building.

The second is the fine garden, where the roof needs to be strong enough for the purpose of growing a large number of different types of plants, some of which include small ponds. Usually, these gardens require a soil thickness of 20-50 cm and a minimum load of 200-300 kg per square metre. Buildings built after the 1980s often used concrete and bricks as the main building material, and because of the conditions, the people involved in architectural design did not have much knowledge of the concept of a roof garden, and a fine roof garden with large plants would have been too heavy for the roofs of buildings of the time. This has therefore given some insight into modern architecture, where designers have to consider in advance the changes that may occur in the next hundred years, for example by designing roofs with a view to the various drainage problems that will be brought about by future roof gardens.

Speaking of drainage problems, gardens built on roofs often encounter difficulties in accessing water, so most designs are watered by collecting rainwater, which also places certain demands on the soil storage capacity of the garden to ensure that there is sufficient water to support it in both extreme conditions of drought and heavy rainfall.

The following structural advantages of rooftop gardens are drawn from past experience [14]. In environmental terms, roof gardens can purify urban air and improve the ecological environment by planting plants with the ability to purify the air, while, as an external structure to the building, it can effectively reduce roof drainage, alleviate urban flooding and provide protection to the building's structural layer. Aesthetics, an integral part of green architecture, places certain appearance requirements on green buildings, and roof gardens carry a unique spectacle of plants that can be used to beautify cities and enhance their image.

## 4. FUTURE VISION OF THE GB MANAGEMENT SYSTEM

This design focuses more on creating a comprehensive new system for the overall planning and management of green buildings from all stages. This includes: firstly, setting up a green building standard that is appropriate to the social environment in which the building is located (e.g. by using the existing LEED green building rating system, the building can be initially rated according to the standard during the design phase[15]) and conducting feasibility tests through simulations of energy efficient equipment or new building materials that are ready to be put into use; during the construction phase, comparing the final In the construction phase, the final results of the building and the expected results are compared and analysed to find the areas that were not implemented or exceeded expectations during the construction process, quantify the degree of completion of each part of the building, and give relevant analysis reports through data analysis to provide more valuable information for the subsequent implementation of green buildings; in the use phase, relevant indicators (such as air index, carbon content, the actual effect of new materials, the efficiency of new energy use, etc.) are recorded; the development of intelligent applications in the early stages of the building allows for online viewing of building data to ensure that problems can be identified and maintained as soon as possible when defects arise after a long period of use.

The Institute has designed a green building planning and management system that can, on the one hand, serve as a guiding suggestion for the early stages of design, and provide an initial rating and testing of the design, paving the way for a good screening for the actual putting into operation; on the other hand, adding a supervisory and management process to the construction and maintenance phases, solving the problem of tiger heads and snakes, and quantity without quality. In the age of intelligence, the system enables green buildings to develop sustainably and no longer operate in a disorderly manner.

As a member of a group that is very concerned about the sustainability of buildings and the environment, the current phase of green building engineering has reached a time when it needs to be reorganized and improved, and the green building planning management system designed by this research programme is the most appropriate tool for the current trend. Since the 20th century, many valuable talents have emerged in the field of green building design, bringing with them scientific experience and research papers on the design of new building materials and new energy sources. New materials and new energy sources are an essential part of a sustainable society and have been used in a wide range of areas other than buildings, so it is fair to say that much experience has been gained in creating green buildings. However, even though the number of buildings with the

green label is increasing year on year, in reality, we only see an increase in quantity but not in quality, and the issue of sustainability brought about by buildings is still not perfectly solved, because the public vision hardly pays attention to the subsequent effects brought about by the buildings themselves. Many developers rush to start construction before giving any thought to the overall planning and management of a green building project and end up leaving the project unattended. This unscientific and irrational approach to construction is very widespread in green buildings, not only because of the lack of awareness of sustainable development, but more importantly because of the lack of regulatory management and the lack of scientific and standardized guidance for green buildings. Therefore, at this time, the design of tools to address this issue should be a top priority, and this research project could create a new segment of the field to assist in the sustainable development of green buildings.

## 5. CONCLUSION

Sustainable green development is the theme of our time and green building is the embodiment of this concept in the field of architecture. The ultimate goal of green architecture is to provide a harmonious and green living environment that can effectively reduce global carbon emissions and work tirelessly to combat global warming. In recent years, the state has attached more importance to the development of green architecture, and the rapid development of green architecture requires contemporary designers to carry out in-depth analysis and research. However, in this development process, the problem of difficulty in harmonizing design with reality has arisen, and the supervision of the whole process of green buildings is still inadequate. Therefore, for the long-term development of green buildings, the focus needs to be on the aspect of city-wide management and subsequent maintenance. The idea of a green building management system can go some way to solving the various problems before and after construction and ensuring the viability and practicality of green buildings, but it still needs to be supported by policy and a green building construction system. This study only provides a macro view of the whole process of green building, but does not provide specific solutions to specific case studies, so the next study will focus on how the green building management system can be set up and running smoothly.

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