Analyzing the Existing Problems in the Operation and Management of Green Public Buildings

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Abstract. This thesis aims to analyze and solve the problems faced by green public buildings in sustainable operation and management, and propose a series of comprehensive solutions. Firstly, the paper introduces the importance of green public buildings in the rapid development of urbanization in China as well as their potentials and impacts in sustainable development, and analyzes the advantages and shortcomings of different green building certification systems and standards. It then presents the purpose and importance of the study, which aims to analyze in depth the problems in the operation and management of green public buildings and to explore ways to solve these problems. In this paper, based on the current problems in the operation and management of green public buildings, we propose solutions to these problems. Through the case study of "Bullitt Center", we analyze the core areas of energy management, water management, indoor environmental quality, and sustainable operation and maintenance, and extend them to technological innovations, solutions, and policy and regulatory support. solutions, and policy and regulatory support. Finally, the paper looks at future trends in green public building operations and management, including innovations in smart building management, carbon neutral buildings, and eco-buildings.

Keywords: Green public buildings, sustainability, building certification, green technology, operations management, policy support, future trends.

1 Introduction

1.1 Background and motivation for the study

With the rapid development of urbanization in China, public buildings play an increasingly important role in urban development and social progress, and green public

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and influence. On the one hand, green building is considered an effective way to reduce energy consumption, water utilization and carbon emissions, and on the other hand, it can improve the quality of indoor environment, thus creating a healthier and more sustainable urban life for people. However, there are a series of serious problems and challenges in the actual operation and management stage of green public buildings. This thesis aims to deeply analyze the existing problems in the operation and management of green public buildings, explore the root causes of these problems, and propose solutions to promote the sustainable development of green buildings.[1]

1.2 Purpose and importance

The main objective of the research in this paper is to identify and analyze the issues faced in the operation and management of green public buildings, which include aspects of energy management, water management, indoor environmental quality, and sustainable operation and maintenance. Meanwhile, this paper will delve into the aspects of best practice solutions, technological innovation routes, and policies and regulations for these issues.[2] By examining these issues in depth, we can better understand why green buildings fail to achieve their expected environmental and economic benefits in actual operation, and how to improve the operation and management of green public buildings to achieve sustainability goals.[3]

1.3 Introduction to the structure of the thesis

This paper is divided into five main parts. The first part mainly introduces the current necessity of dissecting the operation and management problems of green public buildings, which paves the way for the later analysis. The second part introduces the basic concepts of green public buildings, including definitions, concepts, green building certification systems and standards, and the advantages and impacts of green public buildings. Part III will discuss in detail the existing problems in the operation and management of green public buildings, including problems in energy management, water management, indoor environmental quality and sustainable operation and maintenance. Part IV will propose methods and strategies to address these issues, including best practice case studies, technological and innovative solutions, and policy and regulatory facilitation. Finally, Part V will summarize the findings and look into the future trends of green public building O&M and provide policy recommendations for further research.

2 Overview of green public buildings

2.1 Definitions and concepts

A green public building is a public building that takes full account of environmental sustainability in its design, construction and operation. Specifically, it refers to the life span of a public building, maximizing the conservation of resources, including water,

electricity, materials and energy saving, so as to protect the environment, reduce pollution, protect the health of employees, and provide people with suitable, healthy, safe and efficient use of space. Green public buildings are a kind of harmonious coexistence of man and nature, which aim to minimize the negative impact on the environment, and at the same time provide people with healthy, efficient, resource-saving and sustainable development space.[4]

2.2 Green Building Certification System and Standards

Green building certification systems and standards are a way of assessing the environmental friendliness and sustainability of a building, following the concept of sustainable development. The following are some of the common international green building certification systems and standards[5].

2.2.1. LEED (Leadership in Energy and Environmental Design):

LEED is a certification system led by the U.S. Green Building Council (USGBC) and is widely used around the world. LEED evaluates a building's sustainability, including energy efficiency, water management, indoor environmental quality, material selection and innovation. Buildings can be certified at different levels such as LEED Certified, Silver, Gold and Platinum. The advantage of this certification system is that it is internationally recognized and widely used worldwide. Comprehensive assessment, including energy efficiency, material selection, indoor environmental quality and other dimensions. However, the assessment process is complex and may require more time and resources. Some certification programs are more expensive.

2.2.2. BREEAM (Building Research Establishment Environmental Assessment Method):

BREEAM is a UK certification system that is also widely used worldwide. It assesses the sustainability performance of buildings in a number of areas including energy, water, land use, health and wellbeing, pollution, management etc. BREEAM also offers different levels of certification such as general, office, industrial etc. The BREEAM certification system has a rich pool of experience which helps in sharing best practices. Emphasis is placed on highlighting social sustainability factors. However, there is relatively little application on an international scale. Some of the assessment criteria may vary between countries.

2.2.3. WELL Building Standard:

Introduced by the U.S. Green Building Council (IWBI), the WELL Building Standard is a certification system that focuses on a building's indoor environment and human health. It focuses on improving indoor air quality, water quality, light, health promotion and comfort. Buildings can be WELL certified by meeting a range of health and comfort criteria to provide healthier environments for occupants and users. The WELL Building Standard places a greater emphasis on the indoor environment and

people's health than other system standards. This helps to improve the quality of life for employees and residents. However, it lacks a holistic approach and focuses mainly on the indoor environment, which is not as comprehensive as the other standards that cover the sustainability of the building.

2.2.4. Green Star:

Developed by the Green Building Council of Australia (GBCA), Green Star is one of the most important green building assessment systems in the southern hemisphere. It is based on factors such as energy use, carbon emissions, resource utilization, indoor environment, etc. Green Star emphasizes more on innovation and sustainability. Its advantage over other systems is that it can customize the assessment according to the characteristics of the project. However, its application is limited, and it is mainly used in Australia and New Zealand.

These green building certification systems and standards play an important role in assessing the sustainability and environmental friendliness of buildings, encouraging developers and designers to adopt sustainable building design and management practices that reduce negative impacts on the environment and provide a more comfortable and healthy built environment.

2.3 Advantages of green public buildings

Green public buildings offer many advantages, including the following[6].

2.3.1 Energy conservation:

The use of energy-efficient technologies and equipment in green public buildings can significantly reduce energy consumption. This not only helps to reduce energy costs, but also reduces the need for traditional energy resources, which in turn reduces greenhouse gas emissions and is friendlier to the environment.

2.3.2 Environmentally friendly materials:

Green public buildings choose to use environmentally friendly materials, such as recyclable materials, low-carbon materials and healthy and harmless materials, which reduces resource extraction and pollution. This helps protect natural resources and reduce environmental pollution.

2.3.3 Indoor environmental quality improvement:

Green public buildings focus on the design and management of the indoor environment to ensure air circulation, sufficient light, noise control and other aspects. This improves the working and living environments, enhances people's health and comfort, and helps to improve productivity and quality of life.

2.3.4 Water Resource Management:

Green public buildings achieve effective management and utilization of water resources through the application of water-saving equipment and systems, rainwater collection and utilization. This helps to reduce water consumption, alleviate water stress, and reduce waste of water resources.

2.3.5 Building Value Enhancement:

Green public buildings are characterized by environmental protection and sustainable development, and are therefore more popular in the market. These buildings usually have higher values and better leasing rates, bringing economic benefits to owners and investors.

3 Existing Problems in Operation and Management of Green Public Buildings

Green public buildings are widely recognized as a core element of sustainable urban development, aiming to reduce resource consumption, minimize environmental impacts and improve the quality of life of occupants. However, despite the adoption of various green technologies and standards at the design and construction stages, green public buildings still face a series of serious problems at the operation and management stage. These problems not only hinder the actual benefits of green buildings, but also affect the realization of urban sustainability.

3.1 Energy management issues

The design of green public buildings usually focuses on energy efficiency, but in actual operation, energy consumption is often higher than expected. This is because energy use patterns within the building may not match the design assumptions. For example, employees may use a large number of personal devices in the office, which was not taken into account in the design. In addition, the energy management system in the building may not be intelligent enough to adjust to actual demand, resulting in wasted energy. This mainly includes the following two aspects:

3.1.1 Renewable energy utilization.

Green buildings usually encourage the use of renewable energy, such as solar and wind energy, to reduce carbon emissions. However, many green public buildings fail to fully utilize these resources. Some reasons for this include the high cost of renewable energy systems, technical limitations and lack of policy support. This leads to buildings relying on conventional energy sources, increasing operating costs and reducing environmental benefits.

3.1.2 Energy Monitoring and Control Systems.

Green buildings are usually equipped with energy monitoring and control systems to monitor and manage energy use in real time. However, the monitoring systems in some buildings are not intelligent enough to automatically adjust energy supply according to demand. In addition, data collection and analysis are not sufficient to provide detailed information on energy use, making it difficult to identify energy saving opportunities.

3.2 Water management issues

Water is an important part of urban life, and green public buildings fail to minimize water consumption. Although green buildings often employ water-saving devices and technologies, water consumption remains higher than expected in actual operations. This may be due to the fact that the behavior of residents and employees does not adequately take into account water conservation, or that water-saving technologies are not properly maintained. In the process of green public building operation and management, there are two main aspects of water management problems:

3.2.1 Rainwater collection and utilization.

Rainwater harvesting is a key method to reduce urban drainage problems. However, many green public buildings fail to fully utilize rainwater. Reasons for this include the high cost and complexity of rainwater harvesting systems and a lack of understanding of relevant policies. This leads to a waste of rainwater resources while increasing the burden on urban drainage systems.

3.2.2 Water Recycling Systems.

Green buildings should promote the recycling and reuse of water resources. However, some buildings lack efficient water recycling systems, resulting in underutilization of available water resources. This includes inadequate wastewater treatment and recycling systems, as well as under-exploitation of the recycling potential of graywater (non-sewage wastewater).

3.3 Indoor environmental quality issues

The design of green buildings usually focuses on improving indoor air quality, including ventilation systems and material selection. However, in practice, the indoor air quality of some buildings fails to meet standards. This may be due to inadequate or poorly maintained ventilation systems and ineffective control of air pollution sources inside the building. Indoor environmental quality is evaluated through the following two main aspects:

3.3.1 Indoor comfort management.

Indoor comfort is an important concern for building users and includes factors such as temperature, humidity and light. However, some green buildings fail to adequately

consider these factors, resulting in reduced comfort for users. This may be because the diversity of indoor environments has not been adequately considered in the design, or because the monitoring and adjustment systems are not intelligent enough.

3.3.2 Health and well-being impacts.

Green buildings often claim to improve the health and well-being of occupants. However, this claim has failed to be verified in actual operations. Some of the reasons for this include failure to change lifestyles and habits within the building, as well as insufficiently scientific and comprehensive methods for assessing health and well-being.

3.4 Sustainable operation and maintenance issues

Green buildings often include efficient equipment and systems, but these require regular maintenance to ensure performance. However, in practice, some buildings fail to carry out timely and effective equipment management and maintenance, leading to equipment failure and performance degradation.

3.4.1 Waste Management and Recycling.

Green buildings should encourage waste minimization and recycling. However, waste management systems in some buildings are not efficient enough, leading to wastage of resources. This may be due to a lack of waste sorting and recycling facilities or a lack of staff waste awareness

3.4.2 Sustainable procurement and supply chain management.

Green buildings should adopt sustainability measures in procurement and supply chain management, including the selection of environmentally friendly materials and products. However, some buildings fail to fully consider sustainable procurement policies, resulting in increased environmental impacts. This may be due to insufficiently stringent criteria for supplier selection or because of the high cost of sustainable procurement.

4 Solutions to Operation and Management Problems of Green Public Buildings

Sustainable operation and management of green public buildings is a key component in realizing sustainable urban development. Issues that may arise during the O&M phase have been detailed previously, including aspects of energy management, water management, indoor environmental quality and sustainable operations and maintenance. In order to address these issues, a comprehensive range of solutions are required, including best practice case studies, technological and innovative solutions, and policy

and regulatory enablers. This paper will explore these solutions in detail to achieve sustainable O&M in green public buildings.

4.1 Best practice case studies

"Bullitt Center", a green office building located in Seattle, USA, is called the greenest commercial building in the world, and is also regarded as a masterpiece of sustainable building, which provides a lot of inspiration for solving the problem of operation and management of green public buildings. This paper takes Bullitt Center as an example to analyze the problems of green public building operation and management.

Bullitt Center was awarded the "Best Sustainable Building" in 2013, and this paper will analyze the following five aspects:

4.1.1. Energy Management Best Practices:

One of the most notable features of the Bullitt Center is its zero net energy goal. The building utilizes large-scale solar panels to generate more electricity than the building itself requires. The building is also equipped with efficient lighting and ventilation systems to minimize energy waste. These systems, combined with an advanced energy monitoring system, allow the building to monitor and manage energy use in real time. As a result of these efforts, the Bullitt Center successfully achieved its zero net energy goal, generating more electricity than it consumes each year, with the excess fed back into the grid [7].

4.1.2. Water Management Best Practices:

The Bullitt Center also made significant breakthroughs in water management. The building implemented a rainwater harvesting system that stores rainwater in underground tanks for use in the water supply, irrigation, and cooling systems.[8] This system is innovative in that it allows the building to require little to no external water supply, effectively reducing urban water consumption. In addition, the building is equipped with efficient low-flow faucets and toilet flushing, further reducing water consumption.

4.1.3. Indoor Environmental Quality Best Practices:

The Bullitt Center focuses on improving the quality of the indoor environment to enhance employee comfort and productivity. The building utilizes extensive natural lighting and ventilation systems to reduce the need for artificial lighting and ventilation. In addition, non-toxic materials are used in the building to ensure the highest standards of indoor air quality. An indoor environment monitoring system regularly tests air quality and automatically adjusts ventilation as needed.

4.1.4. Sustainable Operations and Maintenance Best Practices:

The Bullitt Center employs a preventative maintenance strategy where equipment is regularly inspected and maintained to ensure proper operation. In addition, the building

has a highly efficient waste management system that employs waste sorting and recycling facilities to ensure waste minimization and resource recycling.

4.1.5. Policy and Regulatory Enablers:

To support sustainable buildings such as the Bullitt Center, the City of Seattle has developed a number of policies and regulations, including providing solar tax incentives, codes to reduce building energy use, and policies to support rainwater harvesting. These policies provide important support for sustainable buildings.

The Bullitt Center's success story demonstrates that sustainable buildings can be built through a combination of measures to achieve zero net energy, zero waste, quality indoor environments, and efficient operations management. In the future, we can expect more building owners and government agencies to be inspired by this case and adopt similar best practices to achieve more sustainable urban development goals.

In addition, with the continuous advancement of technology, we can look forward to smarter building management systems, more efficient use of energy and water resources, and more environmentally friendly materials and products. Government support for sustainable buildings will also continue to play a key role in driving more buildings towards a sustainable path by setting stricter standards and providing incentives.

The Bullitt Center is an inspiring demonstration of how substantial sustainable progress can be made in construction. It is not just a building, it is a vision of a sustainable future, and we should continue to work to make sustainable buildings like this the norm for the future.

4.2 Technology and innovative solutions

4.2.1. Intelligent building management systems:

Intelligent building management systems use advanced sensors, data analysis and automation technologies to monitor energy use, indoor environmental quality and equipment status of buildings in real time. These systems can automatically adjust energy supply, improve indoor environment, and increase equipment efficiency, thereby reducing operating costs and environmental impact.

4.2.2. Intelligent Water Management Systems:

Intelligent water management systems can monitor and control the use of water resources in a building, including water use, wastewater treatment and rainwater recycling. These systems ensure optimal water utilization, reducing waste and costs.

4.2.3. Renewable Energy Technologies:

Renewable Energy Technologies (RETs) utilize renewable energy sources, such as solar and wind, which can provide clean energy to the building and reduce dependence on traditional energy sources. Buildings can install equipment such as solar panels and wind turbines to integrate renewable energy into their energy supply.

4.2.4. Sustainable materials and products:

The use of sustainable materials and products is a key step in reducing the environmental impact of buildings. Buildings can choose to use recycled materials, low carbon materials and environmentally friendly products to reduce resource consumption and waste generation.

4.3 Policy and regulatory push

4.3.1. Setting energy efficiency standards:

The government can set and enforce stricter energy efficiency standards that require green public buildings to achieve higher levels of energy efficiency. This can motivate the construction industry to adopt more advanced technologies and management practices.

4.3.2. Promote Green Building Certification and Incentive Programs:

The government can establish green building certification and incentive programs to encourage the construction industry to adopt green technologies and practices. This can be done by providing tax incentives, preferential loan interest rates or incentive payments.

4.3.3. Introduce environmentally friendly procurement policies:

Governments and organizations can establish environmentally friendly procurement policies that require the purchase of environmentally friendly products and services. This can motivate suppliers to provide greener products and promote the development of sustainable supply chains.

5 Conclusions and outlook

The problem of sustainable operation and management of green public buildings requires innovative and comprehensive solutions to cope with it. Thus, substantial progress has been made in building operation and management. However, this is only a starting point, and more work needs to be done in the future.

5.1 Summary of Existing Problems of Operation and Management of Green Public Buildings

First of all, we would like to emphasize the importance of solving the problems of operation and management of green public buildings. It is not only related to the effective utilization of resources and the control of operating costs, but also to the realization of urban sustainability, as well as our environment and health. Therefore, sustainable operation and management of green buildings must become a shared responsibility of the government, the industry and the community.

As can be seen from the best practice examples already available, intelligent building management systems, renewable energy technologies, intelligent water management systems and the adoption of sustainable materials are all key elements of green building O&M. These technologies and practices not only help reduce resource consumption and environmental impact, but also improve building performance and user comfort. We therefore encourage more building operators and government organizations to adopt these innovative solutions.

In addition, governments play a key role in promoting sustainable buildings. The formulation of more stringent energy efficiency standards, the establishment of green building certification and incentive schemes, and the implementation of environmentally friendly procurement policies are policies and regulations that can provide important support and incentives for sustainable buildings. Governments should also encourage research and innovation to facilitate the continuous advancement of green building technologies.[9]

5.2 Future Development Trends and Research Recommendations

In the future, we can foresee more innovations and improvements in green public building operations and management[10]. Here are some outlooks:

5.2.1. Smarter building management:

With the continuous development of IoT technology, building management systems will become smarter. We can expect more buildings to have real-time access to large amounts of data to better optimize energy use, indoor environments, and maintenance schedules.

5.2.2. Carbon Neutral Buildings:

In order to combat climate change, more and more buildings will be moving towards carbon neutrality. This means that buildings should not only reduce their own carbon emissions, but also actively participate in carbon offset and storage programs.

5.2.3. Eco-buildings:

Future buildings will focus more on the integration of ecosystems, such as the use of green roofs, vertical gardens and biodiversity maintenance, to increase the interaction between buildings and nature.

5.2.4. Broader government support:

The government will play a greater role in sustainable buildings by formulating more supportive policies as well as providing more financial and tax incentives to encourage the industry to adopt sustainable practices.

5.2.5. Increased Public Awareness:

Society's concern for sustainability is growing and public expectations will drive the construction industry in a more sustainable direction. Building operators need to respond positively to this trend and meet the public's needs.

Addressing green public building operations and management is a global challenge, but also an opportunity. Through continued collaboration, innovation and commitment, we can build more sustainable cities and create a better future for our children and grandchildren. Through continuous innovation and improvement, we can expect to see more green public buildings being built and a more sustainable future for the cities and societies of the future.

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