9th International Symposium on Heating, Ventilation and Air Conditioning (ISHVAC) and the 3rd International Conference on Building Energy and Environment (COBEE)

Analysis of the Present Situation of Public Institution Buildings Green Transformation in Shenyang based on Investigation and Survey

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Abstract

Public institution buildings green transformation is an important measure to promote national strategy of “energy conservation and emission reduction”. And it is the key to promoting green building transformation. [1]This paper introduces the buildings of investigation results of 6 buildings in Shenyang, including the buildings of government, agencies, research institutes and other public institution buildings that have been transformed, on the basis of investigation questionnaire, meeting interview and on-site visit. Through the investigation, we understand the way of reformation, building equipment update status before and after reformation. What’s more, we have also collected data of energy consumption in recent years. Through the analysis based on collected information, the benefit of energy saving at the present stage on public building green reformation has been excavated, while the disadvantage of public building green reformation such as single, limitations and one sidedness has come clear and definite. Put forward to establishing the evaluation system of green public building transformation mechanism, combined with advanced evaluation methods both domestic and foreign to lay a solid foundation.

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Peer-review under responsibility of the organizing committee of ISHVAC-COBEE 2015

Keywords: Public institution building; green transformation; analysis of the situation

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Peer-review under responsibility of the organizing committee of ISHVAC-COBEE 2015
doi:10.1016/j.proeng.2015.09.070
1. Introduction

In order to establish a green transformation technology system and evaluation index for public institution building comprehensive effect evaluation of application with the purpose of realizing green energy saving and sustainable development of public institutions and reducing building energy consumption, cutting waste resource, reducing the cost and saving state funds.[2,3] With these purposes, we choose six public institution buildings in Shenyang carrying on with on-spot investigation, research questionnaire, meeting interview and field visit. We have acquired the reconstruction method, equipment condition before and after the reformat ion and energy consumption data of recent years. At the same time, we also confirmed the primary means that affect building renovation which become a crucial role for the establishment of relations between public institutions building evaluation index and weight lifting. It also provides the data basis and practical basis for public institutions reform constitute green building evaluation method and make evaluation method more accurate with greater pertinence.

2. Methods

The purpose of the research on public institutions of government agencies and enterprises green reformation is to grasp the main method of reformation, the emphases, the difference before and after reformation and energy consumption effect. Therefore we make three kinds of survey form including green reformation (to be / have been renovated buildings) and construction equipment status questionnaire survey to understand the basic information, information of building green reformation, and information of building energy consumption.[4,5] In order to improve the authenticity and accuracy of the research information, we also assist with meeting interview and on-site visit to make the information of building reformation clear. Specific informatics are shown in figure 1.

![Table 1. The green transformation status questionnaire of public institution buildings (has been modified) in Liaoning province.](image)

3. Results

Sorting the information, we can find that the proportion of investment in existing public building major in the basic reformation. And in the basic reformation of buildings, the reformation method is mainly around building envelope, building energy-saving appliances, building heating, air conditioning system and the new energy application. Analysis of main building reformation is shown in table 1.

![Table 1. The main modification information of buildings.](image)
The research of the six public buildings is restricted by environmental impact and geographical location, building environment and corresponding public facilities has not been improved yet. The information that we collected is established after it has been built, there is no corresponding reformation methods in the subsequent reformation, specific feelings and related situation of facilities as listed in Table 2.

### Table 2. Fundamental information of construction environment and public facilities.

<table>
<thead>
<tr>
<th>Original information</th>
<th>A building</th>
<th>B building</th>
<th>C building</th>
<th>D building</th>
<th>E building</th>
<th>F building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building wind environment</td>
<td>O</td>
<td>O</td>
<td>W</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Building sound environment</td>
<td>O</td>
<td>M</td>
<td>W</td>
<td>W</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Building light environment</td>
<td>O</td>
<td>W</td>
<td>W</td>
<td>O</td>
<td>W</td>
<td>O</td>
</tr>
<tr>
<td>Building greening</td>
<td>W</td>
<td>P</td>
<td>P</td>
<td>O</td>
<td>O</td>
<td>M</td>
</tr>
<tr>
<td>Building decoration</td>
<td>O</td>
<td>W</td>
<td>M</td>
<td>O</td>
<td>W</td>
<td>O</td>
</tr>
<tr>
<td>Fire control facilities</td>
<td>O</td>
<td>W</td>
<td>O</td>
<td>O</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Parking Spaces</td>
<td>O</td>
<td>M</td>
<td>W</td>
<td>O</td>
<td>W</td>
<td>O</td>
</tr>
<tr>
<td>Traffic facilities</td>
<td>W</td>
<td>W</td>
<td>O</td>
<td>W</td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td>Service facilities</td>
<td>O</td>
<td>M</td>
<td>M</td>
<td>O</td>
<td>W</td>
<td>O</td>
</tr>
<tr>
<td>Barrier-free design</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

- O = optimal
- W = well
- M = moderate
- P = poor
- Y = yes
- N = none
Take C and F buildings for example: C building carried on reformation of energy-saving lamps and energy-saving stoves in 2011, carried on reformation of water-saving appliances in 2012, we have made analysis and comparison of detailed data in four years before and after reformation. Detailed data are shown in Table 3.

Table 3. The amount of energy consumption in C building between 2010 and 2013.

<table>
<thead>
<tr>
<th>Time</th>
<th>Water (L)</th>
<th>Electricity (KW/h)</th>
<th>Gas (m³)</th>
<th>People (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2.88×10⁴</td>
<td>4.45×10⁵</td>
<td>5117</td>
<td>198</td>
</tr>
<tr>
<td>2011</td>
<td>2.40×10⁴</td>
<td>4.07×10⁵</td>
<td>4580</td>
<td>203</td>
</tr>
<tr>
<td>2012</td>
<td>1.14×10⁴</td>
<td>3.94×10⁵</td>
<td>4747</td>
<td>217</td>
</tr>
<tr>
<td>2013</td>
<td>1.45×10⁴</td>
<td>4.25×10⁵</td>
<td>5551</td>
<td>262</td>
</tr>
</tbody>
</table>

F building carried on reformation of envelope and energy-saving lamps in 2008, carried out reformation of water-saving appliances in 2009, we made analysis and comparison on retrofitting energy consumption data of the four years before and after reformation, detailed data are shown in Table 4.

Table 4. The amount of energy consumption in F building between 2007 and 2010.

<table>
<thead>
<tr>
<th>Time</th>
<th>Water (L)</th>
<th>Electricity (KW/h)</th>
<th>Coal (t)</th>
<th>People (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>2.63×10⁴</td>
<td>4.63×10⁶</td>
<td>303</td>
<td>422</td>
</tr>
<tr>
<td>2008</td>
<td>2.62×10⁴</td>
<td>4.12×10⁶</td>
<td>143</td>
<td>456</td>
</tr>
<tr>
<td>2009</td>
<td>1.96×10⁴</td>
<td>4.27×10⁶</td>
<td>143</td>
<td>486</td>
</tr>
<tr>
<td>2010</td>
<td>1.44×10⁴</td>
<td>4.01×10⁶</td>
<td>148</td>
<td>502</td>
</tr>
</tbody>
</table>
Through the processing and analysis of the energy consumption data before and after reformation, those energy-saving renovation project presents downtrend rather than with the number of the staff increased, the consumption of water, power, coal and gas has also increase rapidly. It is easily to find the renovation effect of water-saving appliances, energy-saving lighting, building envelope, etc. from the Figure 3.

Combining with Table 1 and the data analysis form above-mentioned, the energy efficiency of public building green reformation in Shenyang at this stage is mainly derived from water-saving appliances, energy-saving lamps, envelope (walls, windows, roof) and some new energy-saving equipment applications. Specific analysis is as follows:

- The reason of reformation on saving appliances and energy-saving lamps is mainly because that public building power consumption and expenditure patterns is mainly sanitary water and electricity for lighting at this stage. There are many disadvantages on traditional sanitary ware such as not timely switch, volume flow per unit time, which leading to excessive water consumption. There are also many disadvantages on traditional lighting such as high illumination per unit area and low power efficiency. At the same time, relatively low cost and significant reformation benefit has been primary reason for reformation.

- The reformation of the envelope in terms of the level of direct influence is mainly because the heat transfer performance of the building envelope heat source in the form of buildings and energy level, and airtight doors also occupy a large part of the energy consumption of the building. Therefore, the strengthening of structural alteration envelope has become an important part of the green reformation of public institutions.

- In terms of the use of some energy-saving equipment, such as the energy-saving stoves used in C building. From the point of total use of gas, it did not make significant effect as water-saving appliances and energy-saving lamps. From the point of per capita, coupled with large population and low cost of reformation, its value to community energy saving becomes evident.

4. Discussion

The public institution building for now basically has the three following problems:

The present content of public institutions buildings green transformation in Shenyang is relatively monotony. The main content of green transformation focus on retaining structure, water-saving appliances and energy saving lamps and lanterns are not enough. We should strengthen the public institutions buildings in energy-saving elevator, the peak valley electric energy storage, energy information administration, the rainwater recycling, prefabricated using, the use of renewable materials and renewable energy, etc. But we also should avoid the phenomenon of pure technology accumulation, and focus on the real application effect to realize the sustainable development model of adjusts measures to local conditions.

With the increase of office equipment and the growing number of employees, the original artificial environment has been unable to meet the demand of people's comfort in some public institution building. According to the report, a comfortable artificial environment has a great influence on the efficiency of work. If we can increase the artificial environment comfort by 3%—25%, there will bring another 10%—40% of the work efficiency. [6] However, restricted by the geographical position and the limit of construction site, most of the public institution buildings are unable to improve the artificial environment effectively. Therefore, we should pay more attention to improvement of the artificial environment and develop some new greening and supporting modes.

There was no significant difference on the weight of each project of the existing evaluation standards. There were also no significant targeted and no significant renovation points for the public institution building green transformation. We should innovate the discriminated method of the weight, emphasize the item that place a high value on it. Provide a clear direction to public institution building green transformation and solve the phenomenon of blind reconstruction. And in order to satisfy the complex reality transformation with the established evaluation methods. Combined with the new evaluation methods, the professional evaluators should be trained and a monitoring system should be established. And establish a professional ratings agency to provide the technical
assistance or evaluation for the implementation of public institution buildings green transformation.

5. Conclusions

- In recent years, the energy-saving of public institution buildings in Shenyang has made an obvious effect on the saving of water, electricity, coal and gas. With the progress of energy saving reconstruction, public institution buildings had an obvious decrease on per capita energy consumption level. Implement energy saving behavior and reduce the energy consumption. In terms of heating and air conditioning system realize both adjust measures to local conditions and optimum transformation.

- The three aspects of water-saving appliances, energy-saving lamps and retaining structure of public institution buildings green transformation in Shenyang just some basic requirements. There must strengthen the transformation of building environment and public facilities in the future of public institution building. Using the methods such as office equipment concentrated management and some new greening mode to improve the work environment. Appropriately use the new energy-saving equipment according to the characteristics of buildings to expand architectural energy saving effect and architectural energy saving types.

- Public institution buildings green transformation is short of a scientific evaluation system and a complete evaluation method that needs to strengthen the study of evaluation system and evaluation method and then to complete an instruction manual. Which will be significant for promoting the public institution buildings green transformation and provide targeted technical assistant or guidance to maximize the energy conserving potential of the building and avoid the blind reconstruction of building.

Acknowledgements

This research was supported by National Twelfth Five-year Plan for Science and Technology (NO.2013BAJ15B06-02).

References