Lowland Technology International 2018; 20 (3): 321-330
International Association of Lowland Technology (IALT): ISSN 1344-9656

Research Paper

The development of green building in China and an analysis of the corresponding incremental cost: A case study of Zhejiang Province

J. Ge[1], J.T. Weng[2], K. Zhao[3], X.C. Gui[4], P. Li[5] and M.M. Lin[6]

ARTICLE INFORMATION

Article history:

Received: 03 October, 2017
Received in revised form: 21 May, 2018
Accepted: 03 June, 2018
Publish on: 07 Dec, 2018

Keywords:

Green building
Technology application
Incremental cost
Case study

ABSTRACT

With a focus on the survey of the green building development in China as well as the evaluation of the corresponding incremental cost, this paper selects 276 green building projects in Zhejiang Province and obtains comprehensive data, based on which the development of green buildings in the province is analysed. The results are then compared with the national data in such aspects as the certification grade, building type, geographical distribution and application frequency of green building technologies. Statistical analyses are also conducted on the technology application frequency and the incremental cost, which conclude that different types of green buildings would apply significantly different technologies considering factors like energy saving, material saving, indoor environment quality and operational management. According to the sample data, the incremental cost of green building technologies is found to make up less than 2% of the total building costs; and it increases with the upgrading of certification grade. When the floor area exceeds 100,000 square meters, the incremental cost would remain less than 60 yuan per square meters. Costs for water-saving and energy-saving technologies account for over 80% of the total incremental cost. This study would provide guidance for the selection of green building technologies.

1. Introduction

Energy consumption has already become a thorny issue for global development. With the acceleration of urbanization, energy used for building construction and operation has accounted for 20% of the total energy consumption of China; the number grew from 300 million tce in 2001 to 857 million tce in 2015, which has increased by more than 2.86-fold (China Association of Building Energy Efficiency, 2017). Therefore, a sustainable development within the building industry is imminent.

Green buildings were first introduced to China in the 1990s. The first standards related to the accreditation of green buildings in China, *Assessment Standard for Green Building* (ASGB), was issued in 2006 and revised in 2014, which specified the direction of green buildings development of China. As of December 2015, the total area of buildings in China approximated 64.76 billion square meters (Ning et al., 2016). Although the area of

[1] Professor & IALT member, Department of Architecture, Zhejiang University, CHINA, gejian1@zju.edu.cn
[2] PhD student, Department of Architecture, Zhejiang University, CHINA, arc_wjt@163.com
[3] Assistant Professor, Department of Architecture, Zhejiang University, CHINA, zhaok@zju.edu.cn
[4] Master student, Department of Architecture, Zhejiang University, CHINA, guixuechun@126.com
[5] Professor of Engineering, Zhejiang Province Construction Technology Promotion Center, CHINA, 88059869@sina.com
[6] Engineer, Zhejiang Province Construction Technology Promotion Center, CHINA, 57669820@qq.com
Note: Discussion on this paper is open until June 2019

China's green buildings had reached 472 million square meters by 2016 (Song et al., 2016), it accounted for less than 1% of the total building area of China. Currently, about 1.6 billion square-meter buildings are under construction in China each year, which accounts for about 40% of the world's total new buildings (Zhang et al., 2017). Green buildings in China still boast enormous potentials for further development.

Zhejiang Province is located on the southeast coast of China and in the hot summer and cold winter zone in terms of thermal environment. The mainland area of the province is 101.8 thousand square kilo-meters, taking up merely 1.06% of the total area of the country. As of December 2015, the population of the province had just grown to 55.39 million, accounting for only 4% of the nation's general population (Zhejiang Provincial Bureau of Statistics, 2016). However, the gross domestic product (GDP) of Zhejiang Province accounts for 6.3% of the national GDP, and its total GDP value and per capita GDP value rank the 4th and 5th at the national level respectively. At the same time, the energy resources of Zhejiang Province are relatively barren with the primary energy self-sufficiency rate of 5.3% in 2015 at best (Zhejiang provincial government's office, 2016). The majority of energy consumed in Zhejiang is either brought in from other provinces of China or imported. In face of the serious challenge of energy shortage, the provincial government of Zhejiang has proposed that all new real estate projects should obtain at least the one-star certification label for a green building and two-star projects should account for more than 10% of all new buildings by 2020.

The development of green buildings should not only pursue quantity expansion, but also focus on quality promotion. The buildings should be furnished with energy-efficient designs and advanced integrated technologies to reduce both the energy demand and consumption. For this purpose, the success of the current green building projects will be of directive significance. This paper takes Zhejiang Province as an example and conducts a comprehensive analysis of green building projects in China, which helps to understand the performance of existing rating system of green buildings and to give guidance for future applications. Besides, a calculation method of the incremental cost of green building is put forward; and the relationship between the incremental cost and building types is analysed. The findings of this study not only present a thorough understanding of green buildings in China, but also encourage participants to employ the green building technologies in a more reasonable way.

2. Literature Review

There are currently a number of green building rating systems around the globe. *Leadership in Energy and Environmental Design* (LEED), developed by the United States, is one of the most popular assessment methods, which focuses on the design of green buildings. *Building Research Establishment Environmental Assessment Method* (BREEAM) and *Comprehensive Assessment System for Built Environment Efficiency* (CASBEE), promoted by Britain and Japan respectively, are two frequently-used assessment systems that are similar to each other. Many studies have been conducted to make a comparison of the different building rating systems (Chen and Lee, 2010, Zhu et al., 2015 and Zhang et al., 2017). Due to different national conditions and understandings of the concept of green buildings, the functional structure of each country's evaluation standards varies, and the focus of evaluation index items and subdivision items also differs. For example, the most widely-used green building standard in China, ASGB 2014, comprises the following seven index items: land saving, energy saving, water saving, material saving, indoor environment quality, construction management and operation management. Each item consists of prerequisites and methods for scoring. According to the total score, green buildings would be granted one of the three grades, i.e. the one-star, two-star and three-star grades. Additionally, two types of certification labels, that is, the design label and the operation label, will be also granted. Construction management and operation management are not considered as the index item for the grant of design label, while the grant of the operation label takes all the above-mentioned seven index items into account.

Many studies have been conducted on technologies adopted by green building projects. Silva and Ruwanpura (2009) put forward a set of credit frequency indicators to depict the occurrence of a certain grade within an assessment category, which helped to better understand the features of the application of green building technologies by such projects. Darko et al. (2017) conducted a questionnaire survey of green building experts, the results of which indicated that energy-efficiency, reduced environmental impacts, water-efficiency, the health, comfort and satisfaction of the occupants, and the company image are the top five driving forces for the implementation of the green building technologies. Wu et al. (2017) have investigated 3416 LEED-certified projects since 2009 and found that at the national level, green building projects perform significantly different in terms of water efficiency, energy and atmosphere, and material and resources as well as indoor environmental quality. Lu et al. (2016) made an analysis on the green technology system and LCA CO_2 emission reduction of a two-star green building project. However, analyses on the application of green building technologies are still in the minority in China.

The incremental cost caused during the design and construction of green building is a paramount obstacle for the construction of green buildings (Yudelson, 2008; Hwang and Tan, 2012). Some studies have shown that there is little difference between green buildings and conventional buildings on incremental costs (Morris, 2007 and Mapp et al., 2011). Kats (2003) gathered the cost data of 33 LEED projects, including 25 office buildings and 8 school buildings, and made analyses based on the modelling and detailed cost estimates. The results showed that the minimal increases in upfront costs was approximately by 2% so as to support the construction of green buildings, which would, on average, bring out 30% energy saving in the whole life cycle of the building. Through an analysis examining 14 public projects and 25 residential projects, Sun and Shao (2010) put forward a method to calculate the incremental cost of China's green building projects. However, such a method was derived based on the *Assessment Standard for Green Building* (ASGB) issued on 2006, and green building technologies change constantly. Liu (2014) used a formula to calculate the incremental cost of the energy-efficient scheme for green buildings based on the investment index estimation method (Ke. 2012). Kim et al. (2014) made a comparative cost analysis of a green residential building, and found that the incorporation of green systems had caused the construction costs to increase by 10.77% compared with that for the construction of a traditional building. In a case study of the green buildings of the Indian government office, Vyas and Jha (2018) outlined the potential benefits of such buildings, and used bills of quality to compare the costs of green buildings with that of the non-green ones. Findings of this study showed that the cost of green buildings increased by 3.10% on average for those with three stars in rating and by 9.37% for those with five stars in rating. The incremental cost is relevant to the local codes and green building rating systems. There are no unified and normative calculations to determine the incremental cost of green buildings at present. Therefore, no definite conclusion is available as whether or not the construction cost of green buildings would exceed that of conventional buildings (Dwaikat and Ali, 2016). Despite the above-mentioned researches, large-scale data of the incremental cost of green buildings is still in scarce need.

The construction of green buildings could help to save energy, increase productivity and achieve a higher level of satisfaction of the occupants (Ries et al., 2006 and GSA Public Buildings Service, 2008). Yet hesitance still prevails in the real estate industry about green buildings projects, which is due to the unpredictable incremental costs of such buildings and little construction experience gathered. Hence, it is necessary to summarize the current situation of green buildings construction and reveal the detailed incremental costs, thus the development of green buildings in China could be promoted.

3. Methodology

3.1 Samples and Sampling Methods

The object of this study is to analyse 276 certified green building projects in Zhejiang Province, China, from 2008 to 2016. Hereinto, the detailed technology information of 98 certified projects is recorded, and the incremental cost of 67 certified projects are provided.

3.2 Data Collection

The data collected include three following aspects:

1) Basic information, including the certification date, floor area, location, plot ratio, developers, design drawings, function, etc.

2) Technology information, which includes energy savings, land savings, water savings, material savings, indoor environment quality and operation management, while the construction management data is unavailable.

3) Incremental cost information, which includes the following two aspects: (a) the incremental cost of additional technologies that are only applied in green buildings, such as permeable pavement, vertical greening, solar photovoltaic systems and rain water recycling use; (b) the incremental cost of promotion technology, such as high-performance envelope, the use of effective equipment, energy-efficient lighting and high-strength steel.

3.3 Method

The equation for the total GBT incremental cost is as follows:

$$Q_{incre} = \sum_{i=1}^{n} \left(Q_{gi} - Q_{bi} \right) \quad [1]$$

where Q_{incre} represents the total GBT incremental cost, Q_{gi} represents the cost of technology *i* applied for the green building and Q_{bi} represents the cost of technology *i* for traditional building.

The technology *i* is designed based on the GB/T50378-2014 Assessment Standard for Green Building, while the technology *i* for traditional building is based on the minimum requirements of the national and local compulsory standards.

The mutual impact of green building technologies (GBT) on the incremental cost are quite complicated, the analysis of which is therefore excluded from in this study. Information of the certified green building (e.g., the certified grade, certification date, and geographic information) is considered in this study. The application frequency of each GBT is calculated according to the building type. The sums and mean values of the GBT incremental cost of the samples are calculated. In addition, regression models are used to depict the relationship between the GBT incremental cost and the project floor area.

4. The Development of Green Buildings in Zhejiang

4.1 General Description

Since the first green building project in Zhejiang, Jindu Matrix, obtained the one-star label in 2008, a sharp growth has been seen for green building projects, as shown in **Fig. 1**. By the end of December 2016, 276 projects have obtained green building certificates in Zhejiang Province.

According to the certification date and the number of projects, the development of green buildings in Zhejiang province can be divided into three stages as follows:

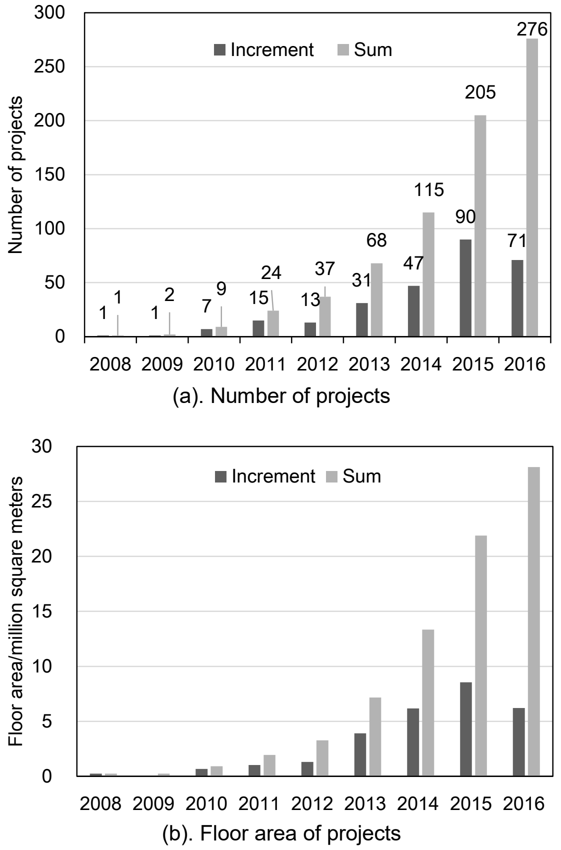

Fig. 1. Green building development in Zhejiang (2008-2016).

- The initial stage: 2008-2010;
- The quantitative growth stage: 2011-2015;
- The quality upgrading stage: 2016-present.

From 2008 to 2010, the increment cost of green building projects is quite small at the initial stage. From 2011 to 2015, with the incentive mechanism by the local government, green building projects increases exponentially. However, the growth of green building projects has slowed down since 2016.

4.2 Characteristics of Green Buildings in Zhejiang

Green building projects are divided into public, residential and industrial ones in terms of building types. Public building projects occupy the largest market share (60.5%), followed by residential projects (38.4%). The industrial projects represent quite a small percentage (1.1%).

According to the green building standard of China, GB/T 50378-2014 Assessment Standard for Green Building, green buildings would be classified into three grades, that is, one-star, two-star and three-star grades of certification. As shown in **Table 1**, the number of each level of green buildings adds up to 119, 112 and 45, respectively. With respect to the total amount of the projects, one-star and two-star projects make up the largest proportion, while the three-star projects manifest the smallest percentage (16.3%).

Table 1. Certification grade and building type distribution of green building projects in Zhejiang Province

Certification grade	★	★★	★★★
Residential	61	29	16
Public	58	81	28
Industrial	0	2	1
Total	119	112	45

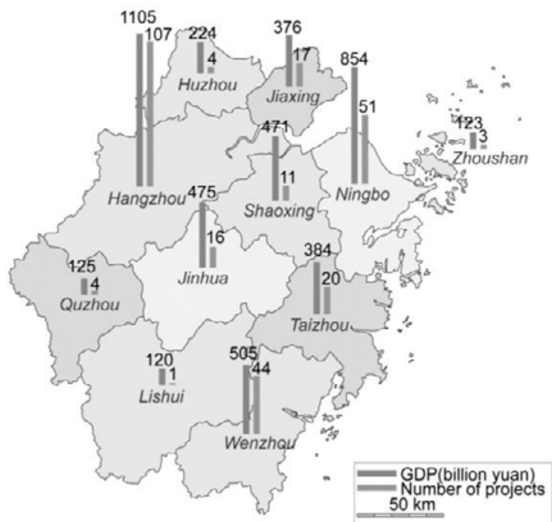

Fig. 2. Distribution of green building projects and GDP in 2016 in Zhejiang Province (base maps from http://d-maps.com/).

Table 2. Structural comparison of green buildings in Zhejiang Province and across the nation

Statistic content	Scope	Certification grade			Certification label	
		★	★★	★★★	Design	Operation
Number of projects	Zhejiang	43.48%	40.22%	16.30%	92.75%	7.25%
	National	40.68%	40.81%	18.51%	94.79%	5.21%
Floor area of projects	Zhejiang	56.05%	32.97%	10.98%	91.04%	8.96%
	National	44.41%	40.91%	14.68%	94.00%	6.00%

From the perspective of geographical location, all the 11 prefecture-level cities of Zhejiang Province boast their own green building projects. However the number of green buildings varies from city to city, as shown in **Fig. 2** (Zhejiang Provincial Bureau of Statistics, 2016). The certified projects are primarily centred in Hangzhou, Ningbo, and Wenzhou cities, accounting for 73.2% of the total. Hereinto, the certified projects in Hangzhou account for 53.0%. The number of green building projects in smaller cities such as Huzhou, Quzhou, Zhoushan, Lishui is less than 5. Such results show that the distribution of green building projects in Zhejiang Province is highly unbalanced. Cities with higher GDP tend to have more green building projects. The continued urbanization in less developed areas would facilitate its development of green buildings.

The comparison of the green buildings development in Zhejiang Province and that at the national level (Song et al., 2016) is shown in **Table 2**. In Zhejiang Province, one-star projects make up nearly half of its total green building projects, and correspondingly such buildings account for 56.05% of the total floor area, followed by two-star projects. Three-star projects are the least in number in Zhejiang Province. Projects with the label of operation certificate account for less than 10% of the total both in Zhejiang Province and at the national level. The average level of the grade certificate in Zhejiang is lower than that at the national level. The proportion of projects with the operation certificate is higher in Zhejiang than at the national level in both the total amount and the floor area. Since the operation label requires data of construction management and operation management over a period of one year, it is more difficult to acquire than the design one. With the development of green buildings, operators would benefit from energy saving and occupants tend to have a more comfortable indoor environment. The operation label has thus gained keener attention.

4.3 Frequency of GBT Application in Zhejiang Province

Among the 98 certified green building projects with detailed technology information available, 66 are for public purposes and 32 are residential green buildings. Based on the Standard, the technologies are classified into six categories as follows: land saving (LS), energy saving (ES), water saving (WS), material saving (MS), and indoor environment quality (IEQ) and operation management (OM), as shown in **Fig. 3**. Due to limitations on resources, construction management (CM) data is not available yet.

In general, the technologies applied in public green buildings are more diversified and common than those applied in residential projects. Different types of green buildings apply significantly different green building technologies in terms of ES, MS, IEQ and OM, yet these buildings are quite similar to each other in LS and WS. In terms of LS, the application frequency of permeable pavement, multi-storey planting and underground space are relatively higher, reaching more than 50% in both residential and public building projects. None of the selected residential projects applied the technology of vertical greening and rooftop planting, while one-third of public projects used roof greening. In general, there is little difference between residential and public projects in terms of LS.

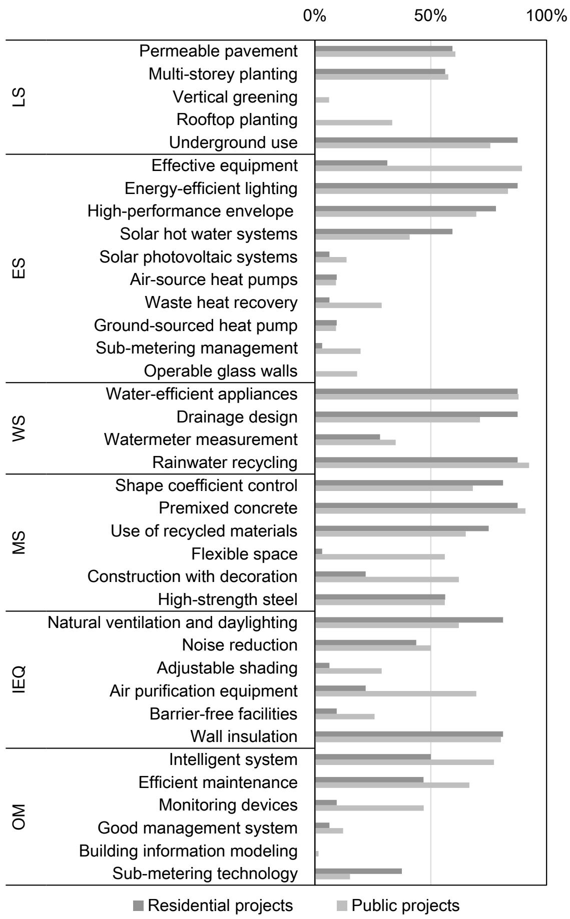

Fig. 3. Frequency of GBT application in Zhejiang.

Regarding ES, residential projects show the highest use of energy-efficient lighting, high-performance envelope and solar hot water systems, while few residential projects employed solar photovoltaic systems, waste heat recovery, ground-source heat pumps, sub-metering management and operable glass walls. The utilization rates of efficient equipment, energy-efficient lighting and high-performance envelope are all higher than 70%.

For WS, residential projects and public projects are quite similar. The application frequency of water-efficient appliances, drainage design, and rainwater recycling are all above 70% for both residential and public projects.

As for MS, the application rates of the shape coefficient control of building, premixed concrete, recycled material and high-strength steel are all above 50% for both residential and public projects. Regarding the flexible space and construction with decoration, the utilization rate of above technologies in public projects are significantly higher than that in residential projects, as public projects require more flexible space.

With regard to IEQ, the application frequency of natural ventilation and daylighting and wall insulation are higher than 60% in both residential and public projects. In the application of air purification, residential and public projects differ vastly from each other. Public projects use air purification much more frequently than the residential counterparts, which also employ noise reduction, adjustable shading and barrier-free facilities in a slightly more frequent way than the residential projects do.

In terms of OM, intelligent systems and efficient maintenance are two technologies most highly applied. In the meanwhile, monitoring devices, good management system and building information modelling account for less than 10% in terms of application frequency.

4.4 Comparison of Application Frequency in Zhejiang and that at the National Level

The application frequency of green building technologies in Zhejiang is compared with that at the national level, which is derived from the data of Song et al. (2016). Information of 716 residential projects and 792 public projects has been included in Song's research.

As shown in **Fig. 4**, the situation LS in Zhejiang is almost the same with that at the national level. With respect to ES, the application frequency of sub-metering management in Zhejiang is lower than that nationwide. For WS, the situation in Zhejiang is similar to that of the whole country. The utilization rates of water-efficient appliances and rainwater recycling both exceed 90% in Zhejiang as well as across the nation. For MS, premixed concrete and high-strength steel are relatively more frequently used than other green building technologies. Regarding IEQ, the utilization rate of natural ventilation and daylighting is higher in Zhejiang than that at the national level both for residential and public projects. For OM, intelligent systems and the sub-measurement technology are less used in Zhejiang than at the nationwide scale.

5. GBT Incremental Costs

5.1 Relationship between the GBT Incremental Cost and the Certification Types

67 green building projects have been chosen for analysis, as shown in **Table 3**, and the data of incremental costs have been collected. The corresponding incremental

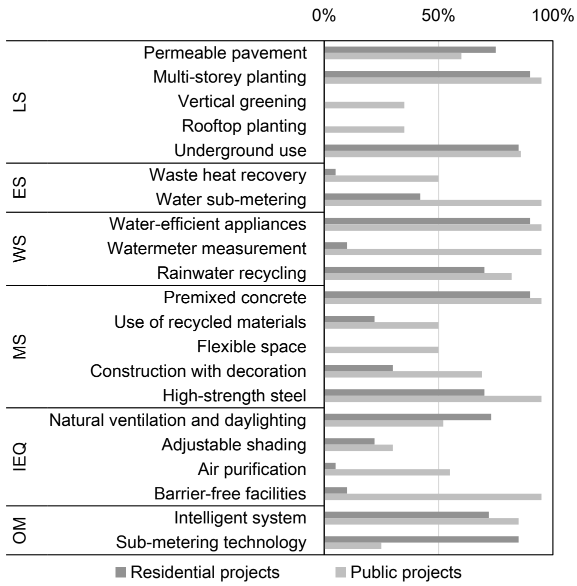

Fig. 4. Frequency of GBT application at the national level.

Table 3. The type distribution of sample buildings

Certification grade	★	★★	★★★
Public	10	26	6
Residential	12	8	5

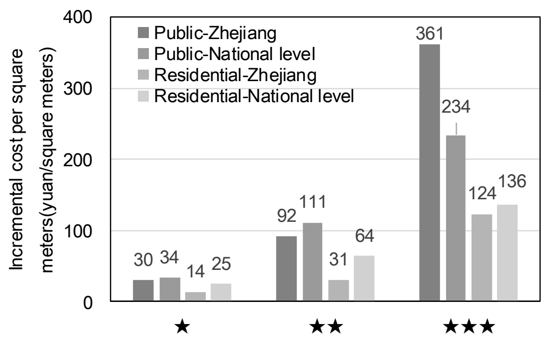

Fig. 5. A comparison of mean GBT incremental costs of Zhejiang and of the country

GBT cost is shown in **Fig. 5**. The data on the GBT incremental cost at the national level are cited from Song et al. (2016). The results show that the GBT incremental cost is directly related to the level of certification granted. The GBT incremental cost increases with the upgrading of the certified grade. The GBT incremental cost of public projects is approximately 2 to 3 times that of residential projects. The mean GBT incremental cost of one-star and two-star projects in Zhejiang is always lower than that at the national level. However, the mean GBT incremental cost of three-star public projects in Zhejiang is much higher than that at the national level.

From the perspective of certification date, the yearly GBT incremental cost of public and residential projects in Zhejiang is shown in **Fig. 6-7**. As shown in the diagrams, public and residential projects demonstrate different changes of GBT incremental costs. With respect to the public projects, the GBT incremental cost of two-star and three-star projects decreased from the peak in 2012, and that of one-star projects fluctuated between 28-42 yuan per square meters. The GBT incremental cost of residential projects increased year to year from 2010 to 2015 and then began to decline after 2015. Two major facts exert influence upon the above results. First, at the initial stage, green technologies used in green building projects were quite limited. Some developers directly adopted extremely expensive GBT copying successful projects in developed countries, which caused the GBT incremental cost to be generally large. Second, in the beginning, the green building technologies tend to be applied in small-sized projects. The large-scale application of GBT helps to reduce the GBT incremental cost at a later stage.

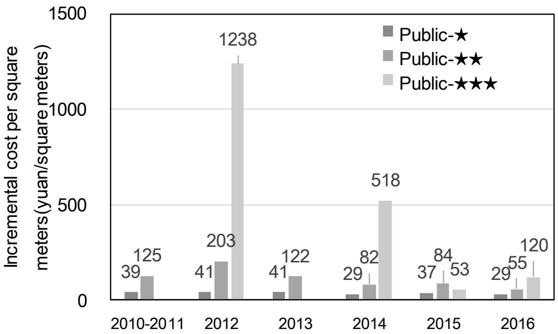

Fig. 6. Yearly GBT incremental costs of public projects in Zhejiang.

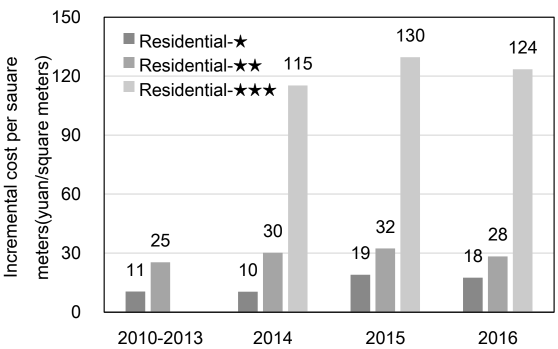

Fig. 7. Yearly GBT incremental costs of residential projects in Zhejiang.

5.2 *Relationship between the GBT Incremental Cost and Project Floor Area*

To analyse the relationship between the GBT incremental cost and the project floor area, the power function model is used. A curve regression model is set up by SPSS, as shown in **Fig. 8**. The formula is as follows:

$$y = 469.21x^{-0.669} \quad [2]$$

(R^2=0.4771, P-value=0.000<0.05)

where *y* represents the GBT incremental cost per unit area of and *x* represents the floor area of the project.

The unit area of the GBT incremental cost shows a downward trend with the increase of the project floor area. If the floor area is less than 25 thousand square meters, the GBT incremental cost fluctuates considerably, from 10 to 420 yuan per square meters. However, if the floor area is more than 100 thousand square meters, the GBT incremental cost remains less than 60 yuan per square meters.

Fig. 9 shows the relationship between the ratio of total GBT incremental cost to the total building cost and the floor area of project. The GBT incremental cost accounts for less than 2% of the total building cost among 90% of the samples. It is close to the literature values by Kats (2003). In general, the GBT incremental cost ratio decreases with the increase of the total building cost.

5.3 *Composition of the GBT Incremental Cost*

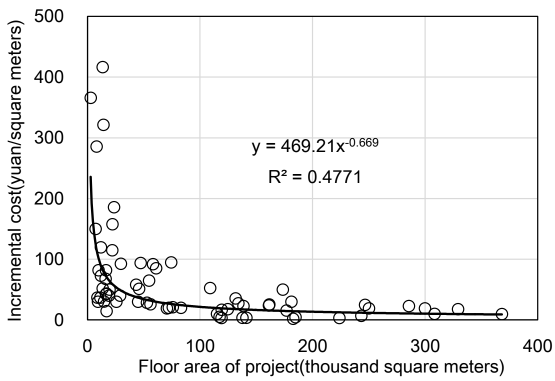

Fig. 8. Relationships between the GBT incremental cost and project floor area.

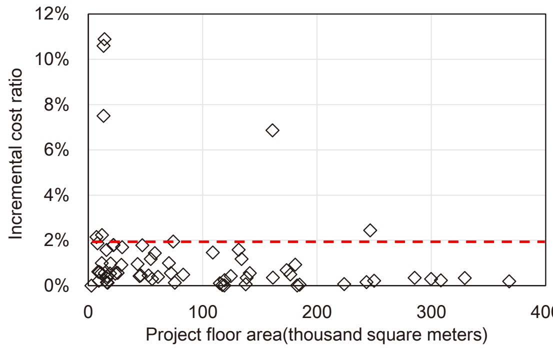

Fig. 9. Relationship between the ratio of total GBT incremental costs to the total building costs and project floor area.

In this study, the subentry GBT incremental cost of 67 green building projects is analysed; and the results are shown in **Fig.10-12**. For all projects, the incremental cost of ES makes up the largest proportion of the total GBT incremental cost, followed by WS, LS and OM; whereas the cost of MS and IEQ account for less than 1% of the total. Additionally, the cost of the MS, IEQ and OM adds up to account for less than 10% of the total.

As shown in **Fig.11-12**, when the certified grade is raised, the incremental cost of ES increases accordingly and the incremental cost of WS declines rapidly for residential projects. However, given the same circumstance, the incremental cost of ES would decline and that of WS would increase gradually for public projects. Such an eminent difference causes that the total incremental cost of residential projects is much lower than that of public projects, and that advanced technologies of ES cost more than those of WS.

5.4 Incremental Costs of Energy Saving and Water Saving

The incremental cost of ES and WS accounts for 80% of the total incremental cost according to the analytical results above. Here, equation (1) is used to calculate every GBT incremental cost in the 67 projects, and the mean value of every GBT incremental cost is computed. The results are shown in **Table 4**.

For residential projects, rainwater recycling and water-efficient appliances makes up the largest proportion of the total incremental cost of WS. The incremental cost of ES mainly comprises expenditures on the following three types of technologies: effective equipment, solar hot water systems and high-performance envelope. As for public projects, the incremental cost of WS is primarily caused by rainwater recycling. The incremental cost of ES mainly

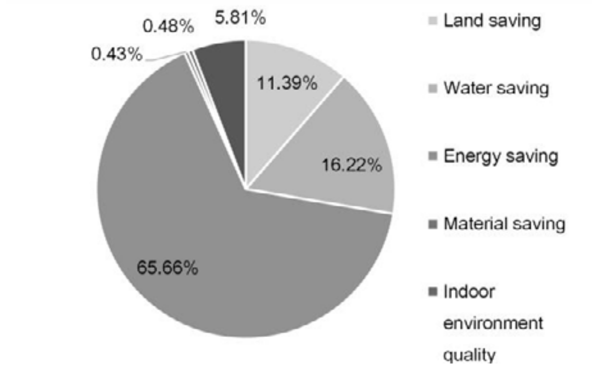

Fig. 10. Composition of GBT incremental costs in Zhejiang Province

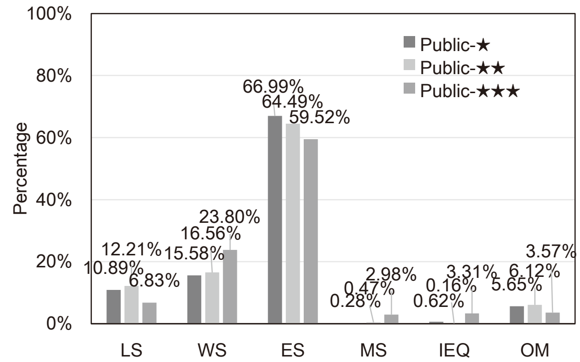

Fig. 11. Composition of GBT incremental costs for public projects in Zhejiang Province

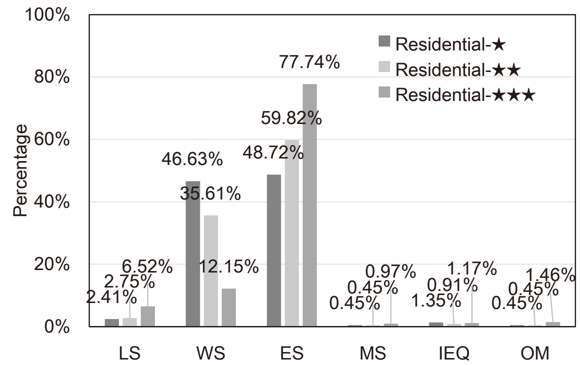

Fig. 12. Composition of GBT incremental costs for residential projects in Zhejiang Province

Table 4. Mean values of subentry GBT incremental costs of WS and ES (yuan per square meters)

	Building type	Residential projects			Public projects		
GBT	Subentry GBT	★	★★	★★★	★	★★	★★★
Water saving	Rain water recycling use	4.25	4.35	9.16	3.75	12.38	14.38
	Water-efficient appliances	2.36	6.01	5.55	0.36	/	/
Energy saving	Energy-efficient lighting	1.20	2.84	4.26	5.12	10.45	15.26
	Effective equipment	15.26	35.46	70.25	8.66	22.36	35.26
	Solar hot water systems	9.28	10.38	11.28	2.69	7.12	12.94
	High performance envelope	21.26	26.40	32.61	26.25	45.26	55.26
	Solar photovoltaic systems	/	/	/	2.94	21.32	33.76

consists of expenses on high-performance envelope, effective equipment and solar photovoltaic systems. Apart from water-efficient appliances in residential projects, costs of other subentry GBTs increase in accordance with the upgrading of certification grades.

The subentry GBT cost on ES differs greatly among projects of different types and with different certification grades. For two-star and three-star projects, in the aspect of WS, the rainwater recycling in public projects costs much more than that in residential ones. Water-efficient appliances are used more frequently in residential projects. For ES, the subentry incremental costs vary among with different certified grades. For residential projects, the cost of effective equipment if they are with a three-star certified grade reach 70.25 yuan per square meters, which are nearly two times those with a two-star grade. Solar photovoltaic systems are only adopted in public projects, and the incremental cost of two-star and three-star public projects on such systems is 7-10 times that of one-star projects.

6. Conclusions

This paper presents a detailed analysis of green building projects in China, taking Zhejiang Province as an example. One major contribution of this article is to provide a critical, global perspective on the study of green buildings and the GBT application situation. Another contribution is that it assesses the GBT incremental cost by floor area, certification level and building types.

Overall, a fast growth in the number of green buildings was achieved in Zhejiang Province from 2008 to 2016. A total of 276 projects have obtained certification labels and the total floor area has reached 28.12 million square meters. The geographical distribution of green building projects in Zhejiang is highly unbalanced.

The GBT application frequency is influenced by project types as well as the certified grade. The total GBT incremental cost of public projects is approximately 2-3 times that of residential projects with the same certified grade. The GBT incremental cost accounts for less than 2% of the total building costs among 90% of the samples.

The incremental cost of energy saving and water saving account for 80% of the total incremental cost. The subentry GBT cost in energy saving diffesr significantly among projects of different types and with different certification grades.

This study shows a data analysis of GBT incremental cost based on 276 certified projects in Zhejiang Province. However, the GBT application varies from project to project and the mutual impacts of GBTs are quite complicated. Changes occur during construction, which leads to a broad gap in the operation performance. In the future study, the data describing the operating performance of green buildings should be collected to evaluate the benefits of GBT in a comprehensive way and also to guide the GBT application.

Acknowledgements

The authors appreciate the support from the China National Key R&D Program (No. 2016YFC0700100), the National Natural Science Foundation of China (No. 51708489), the Zhejiang Provincial Natural Science Foundation of China (No. LQ17E080009) and Zhejiang New talent program.

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Symbols and abbreviations

i	Technology number
Q_{incre}	Total GBT incremental cost
Q_{gi}	Cost of technology i applied for the green building
Q_{bi}	Cost of technology i for contrast
x	Floor area of the project
y	The GBT incremental cost per unit area