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Cost and Financial Benefits of Achieving Green Building: An Overall Overview

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Abstract

Green buildings are one of the key strategies to reduce environmental pollution and create a healthier environment inside and outside of buildings and, generally, the materials used are harmless. Green buildings provide optimal utilization of valuable energy sources such as wind, water, sun and etc. Today the costs of green buildings implementation of green buildings are one of the challenges matters in several countries and this research will helps to find a suitable answer for the following questions. Are green buildings more expensive than conventional buildings or not? And if the answer is yes, how much is the costs increasehow much is the increase in costs? And whatWhat benefits can wecould be achieved? And And is the implementation of green buildings being economically feasible? This study has reviewed the results of recently published literatures about comparing the costs and benefits of green and conventional buildings. According to the results in more than 90% of studies, the incremental cost of green buildings is more than conventional buildings and less than 10% of them, indicate that there aren't significant cost differences between green and conventional buildings. About Regarding the benefits of green buildings, despite the reduction from 25 up 60% in energy consumption unfortunately, unfortunately, there isn't considerable support from investors and contractors by governments.

Keywords: *green building, conventional building, cost, and benefit, energy consumption*

1. Introduction

Energy is one of the biggest problems in the 21st century and the consumption of fossil fuels is increased. In recent years, wasting energy and destroying natural resources have made air pollution and environmental destruction. Green buildings are proposed with the aim of developing a green approach and adaptability of human activity with the environment. Green buildings are the strategic solution for achieving sustainable buildings, saving energy and environmental conservation. Currently, about 20 to 50% of energy consumed in residential buildings, offices and commercial buildings (Kim and Greene, 2014, Lee and Kim, 2013, Chen and Cheng, 2011, Luay and Kheran, 2016) that are main part of energy consumption and also produce more than 40% of solid waste (Luay and Kheran, 2016). Green buildings have been proposed as the ideal solution to reduce the use of fossil fuels, reducing carbon dioxide emissions, increase and improve efficiency, safety, environmental and economic performance. Despite there is wide agreement among researchers about the benefits of green buildings but about the percentage and amount of incremental costs of green buildings, opinions are different. (Yingxin, Lin and Yuan, 2010, Hwang and Tan, 2012).

Most investors currently do not know much about green buildings, especially the cost of construction and its benefits, and think that green buildings need high investment. Therefore, this article can greatly help in raising public awareness, especially investors, by evaluating and comparing the costs and benefits of green buildings.

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Now many countries are dealing with the standardization of green building assessment it can be noted that such $BREEM^1$ of Great Britain, $CASBEE^2$ of Japan, $GBTOOL^3$ of Multinational, $LEED^4$ of the United State, $ESGB^5$ of China, GS^6 of Australia, GBI^7 of Malaysia and etc (Ming Shan, Bon-gang Hwang, 2018) Which are purely administrative instructions and have not spoken about the costs of implementing green buildings although standard economic measure GBTOOL suggestions about the overall structure of the proposed green building (Liu, Guo, and Hu, 20140).

Calculating the cost-benefit of green buildings is a very difficult subject and researchers, according to regional prices and without correct logic, usually estimate them and costs calculated on some articles in addition to the economic, environmental and social costs are also included.

1) Building Research Establishment Environmental Assessment
2) Comprehensive Assessment System for Building Environment Efficiency
3) Sustainable Building Tool
4) Leadership in Energy and Environmental Design
5) Evaluation Standard for Green Building
6) Green Star
7) Green Building Initiative

2. Research Methodology

In this study, a preliminary search was conducted on the economic issues of green buildings. But because of the diverse topics, the results were not satisfactory and consistent the purpose of the study. In the following, and in the subsequent search for a goal, the costs and benefits of implementing green buildings in the headline and keywords of the articles were investigated and researched.

In this study, 105 articles from 37 different journals were extracted and reviewed. Finally, after summarizing, the results and outputs of 42 articles, from 2003 to 2019, were used in this study. Articles range from 2003 to 2019 and are extracted from journals such as Energy and Building, Building and Environment, Journal of Green Building, Sustainability, Journal of Building Engineering, Journal of Cleaner Production and etc.

2.1. An Overview of Green Buildings:

In recent years, economic development has caused many problems in the environmental sector and has brought about various environmental pollution and changes, which is one of the major problems of today's societies (Zhang and Yang, 2019). There is often a misconception about green buildings and it is thought that green buildings should be equipped with high technology and need high investment (Yingxin, Lin and Yuan, 2010)**.** Green development means the proper and efficient use of resources that leads to quality growth and community well-being. The United States Environmental Protection Agency (EPA) defines green buildings as approaches to employ creative structure and processes that are environmentally responsible and effective throughout the yard-based cycle, design, construction, maintenance, reconstruction, and demolition. This approach complements and develops the classical buildings design that are economical and functional. Also to achieve urban sustainability, we need to go beyond the visible situation to look for other improvements that will lead to greater overall output (Qian et al., 2015).

Green construction is getting more attention globally. Recognizing the concept of green building development around the world, the idea of green construction has become increasingly popular in Chinese academic circles (Qifa, 2013).

2.2. Evaluation of Green Buildings:

Green buildings are evaluated from three perspectives that continue as follows: 1) Green building benefits. 2) Green building cost. 3) Analyze and compare the benefit and cost

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2.2.1. Green Building Benefits:

The results of special project in china says that the implementation of green buildings reduces energy consumption by at least 25%, The quality of the interior of the home increases, respiratory diseases (allergies, asthma and etc.) reduces between 9 to 50 % and dependence on electricity has fallen from 139078 to 14350 units per year (almost 90% reduction) and it also produces carbon dioxide emissions by 90 tons per year has fallen (Pandharinath et al., 2015). In an overview of three classified projects of residential buildings in South Korea, the results showed a 33.96% to 50.16% reduction in energy consumption and also reduced CO2 emissions from 1269 to 1873 tons per year (Lee and Kim, 2013). Green buildings can reduce electricity, water and gas consumption by an average of 38%, 34% and 35%, respectively, which is a direct advantage of green building implementation (Chen and Cheng, 2011).

In a study by comparing two green and non-green residential buildings, the results show that the annual direct benefits of these two buildings are similar but the high demand for green buildings has justified the investment in green buildings over conventional buildings (Qifa, 2013). In another study in China, the attention has been paid to the design of green architecture and it was indicated that actual energy consumption in green buildings is 40% less than typical similar buildings as well as 20% less than the local standard (Yingxin, Lin and Yuan, 2010). The economic benefits of green buildings are expressed as follows: 60% reduction in water and energy consumption, 1 to 25% productivity improvement, at least 14% higher rate of return on investment, 10% increase of market capitalization and 5 to 10% increase in rental rates of buildings (Madew, 2008). Another opinion believes that Green buildings reduce operating costs by about 9% and increase building value by 7.5% and return on investment by 6.6%. (ROI) (Kassim et al., 2013).

In Turkey, a study has been conducted on the cost-benefits of green buildings, the results show that buildings with a green platinum and gold certificate represent 40% and 31% respectively of annual energy savings compared to conventional buildings (Latif and Nese, 2017). Another article has reviewed recent studies on the benefits of developing green buildings (2007-2016) and the results show that green buildings are an environmentally friendly and economic, social and environmental benefit and economically reduces project lifetime costs, more energy savings, tax benefits, and markets. Green buildings also provide better indoor environments, better indoor air quality, better thermal comfort, clean water, more efficient lighting and more effective noise levels (Huo and Yu, 2016). In Japan, 4 green buildings and 3 reconstructed green buildings, according to the CASBEE standard have been studied, the results show that reducing energy consumption in green and reconstructed buildings is 33% and 26% lower than conventional buildings and the carbon dioxide emission rate is 38% and 32% lower respectively (Balaban et al., 2016). In Israel, some of the benefits of green buildings have been investigated and the results indicate that electricity and water consumption in green buildings are 23% and 24% lower than conventional buildings, respectively (Meron and Meir, 2017). Researchers have studied the benefits of green buildings in New Zealand, and the results show that the maximum energy and water savings are 15% and 20%, respectively (Table1) (Rehm and Ade, 2014).

Table1. Energy and Water Benefits in Green Building [Rehm and Ade, 2014]

Green Building Level	Energy Saving	Water-Saving
Unclassified	0~6 %	Under 10 %
Bronze	6~10 %	10 %
Silver	10~13 %	12 %
Gold	13~15 %	18 %
Platinum	15 %	20 %

Green buildings have advantages such as higher thermal comfort, better air quality, higher audio satisfaction, higher lighting satisfaction and higher daylight satisfaction (Tatcher and Milner, 2016). Energy consumption in green buildings is between 19% and 39% lower than conventional buildings. Other benefits include increased comfort, residents' health and productivity, increase the

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reputation of the building, increase market value (Li Zhang et al., 2018). In Iran, the implementation of green roofs in buildings has reduced energy consumption by 17% (Ebadati and Ehyaei, 2018). Green buildings have the following benefits: Material loss reduction: 30%, Water consumption reduction: 30%, Energy consumption reduction: 10%, Efficient land use: 90% also, dust control, light pollution control, sewage control, sound control, construction waste control (Zhou and Huang, 2018). Green buildings have an economic justification and are recommended for use in light of the many benefits such as rainwater harvesting, the use of renewable energy and environmentally friendly materials (Khot et al., 2019). The results of the case study in Malaysia show that green buildings consume 71.1% of basic building energy (Luay and Kherun, 2018). The summary of the results of the benefits of green buildings is presented in Table 2.

Table 2. Published Literature Related to the Benefits of Green Buildings

Author(s)	year	Finding
Khot et al.	2019	Green buildings have economic justification
Ebadati and Ehyaei	2018	17% reduction in energy consumption by implementing green roofs
Zhou and Huang	2018	Benefits of Green Buildings include Material Loss Reduction: 30%, Reduced Water Consumption: 30%, Reduced Energy Consumption: 10%
Luay and Kherun	2018	Green buildings consume 71.1% of basic building energy
Li Zhang et al.	2018	Energy consumption in green buildings is between 19% and 39% lower than conventional buildings
Latif and Nese	2017	Green Buildings with platinum and gold certificate represent 40% and 31% respectively of annual energy savings compared to conventional building
Meron and Meir	2017	Electricity and water consumption in green buildings are 23% and 24% lower than conventional buildings
Huo and Yu	2016	Green buildings have economic, tax, environmental and social benefits and save more energy
Balaban et al.	2016	Energy consumption in green and reconstructed buildings is 33% and 26% lower than conventional buildings and the carbon dioxide emission rate is 38% and 32% lower respectively
Tatcher and Milner	2016	Green buildings have better benefits and satisfaction in terms of thermal comfort, air quality, noise, indoor light, and daylight.
Priyanka et al.	2015	25% energy savings, 9-50% reduce sickness, 90% reduces electricity, Saving co2 emission(90Tonne/year)
Rehm and Ade	2014	Energy-saving: 0~15%, Water saving:10~20%
Lee and Kim	2013	Saving energy 34-50%, Saving co2 emission 1269˜1873(Tonne/year)
Qifa	2013	Higher demand price, Increase annual revenue, Higher rent, a Higher reputation
Kassim et al.	2013	The decrease in operating costs to 9%, 7.5% increase building values and increase investment return to 6.6%
Chen and Cheng	2011	Saving electricity about 38%, Water about34%, Gas about 35%
Yingxin et al.	2009	Energy and water-saving about 40% and introduce ideal design for land
Madew	2008	About 60% reduction in energy and water consumption, 1 to 25% increase in productivity, At least 14% higher return rate

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2.2.2. Green Building Costs:

Researchers' opinions on incremental costs of green buildings vary depending on the method of calculation, type of project and buildings area. Despite the multiple benefits of green buildings, the high initial cost is the biggest barrier to the implementation and the rapid expansion of green buildings (Chen and Cheng, 2016, Hwang and Tan, 2012. Issa, 2011). The green buildings cost is 10.77% more than conventional buildings (Keem and Grene, 2014), but two different solutions based on Israeli Standard (IS 5281) showed firstly the incremental cost of the green building with compliance of all items and earning at least 75 points is 4 up to 12% and then, earning the same score with no obligation of compliance with all provisions and finding the factors which have less cost, its incremental cost will be between 0.12 to 1.33% (Gabay et al., 2014). In another study, the calculated additional costs of 33 green buildings base on LEED standard was 1.84% (Kats et al., 2003). And the other study by the same author and with examining more than 170 green buildings in the United States and other countries, they found that the green buildings are more expensive than conventional buildings and their incremental cost is around about 0 up to 18% (Kats, 2010). Instead of expressing green costs, a mathematical formula is presented to calculate the green building costs; the high costs of the green buildings are the biggest barrier to implementing them (Chen and Cheng, 2011).

In China, the factors which have impression on the green costs based on the standard GBEES (energy efficiency design of the green buildings) have been studied as a case study and the significant results have been achieved and showed that the rising cost of implementation of the green buildings is more than 50% of the cost of the normal building (Liu, Guo, and Kim, 2013). In another study, the costs of the green buildings have not been mentioned directly, but it is believed that the cost of them is more than the conventional buildings and for higher costs, the government should ensure for the appropriate support to the implementation of the green buildings (Lee and Kim, Hu, 2014). The costs are divided into three parts, including initial costs, operating costs and cleaning costs. For a case study results about two similar buildings show that the initial cost for green buildings is approximately 10% higher than for non-green buildings but the costs of operation and cleaning are 10% and 40% less than conventional buildings (Qifa, 2013). In Turkey, two green buildings with gold and platinum certificates were compared with the conventional building (LEED standard) and showed the extra cost for gold and platinum is 9.43 and 7.43 percent respectively more than conventional buildings (Latif and Nese, 2017).

In another study, 47 effective variables of costs were identified for the green residential building; then with the four categories of respondents through a questionnaire and by a fuzzy analysis model, finally eight influential factors were identified as follows: 1) Technology and Material Factor, 2) Residential Features Factor, 3) Social Expectation Factor, 4) Experience and Capacity Factor, 5) Policy Factor, 6) Awareness Factor for the Participants, 7) Relationship Factor, 8) Project Funding Factor (Ruan and Gu, 2012).

Another study concluded the green cost is about 17% higher than conventional building and the cost of greenest equipment is negligible and only three items, burnishing, fresh air supply and air conditioning system cover 63% of the cost of the green buildings and the effect of the other items is poor (Meron and Meir, 2017). In New Zealand, a study examines the cost of the green buildings and compares it with conventional costs based on the Green Star standard that the results are given in Figure 1 (Rehm and Ade, 2014).

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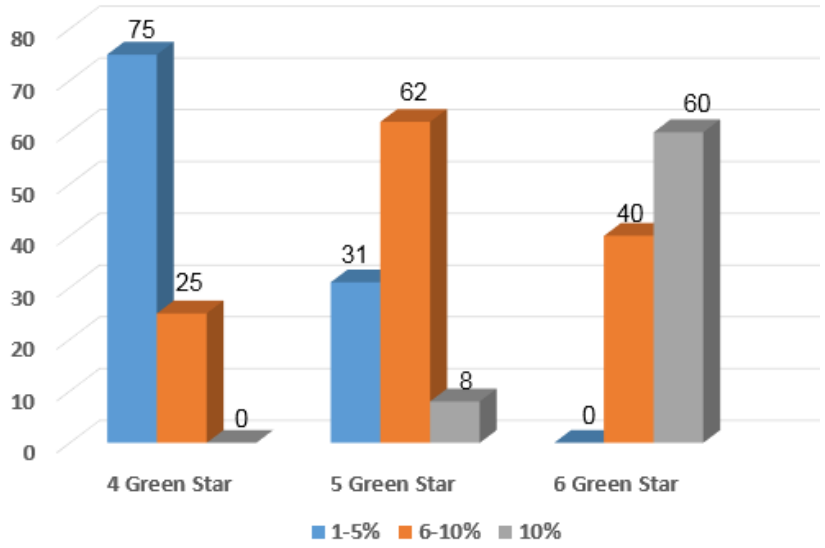

Figure 1. Perceived New Zealand green Building Cost Premium [Rehm and Ade, 2014]

In Hong Kong, a study was conducted based on expert interviews with policymakers, researchers and contractors on the cost of green buildings, and the obtained results indicated that the incremental cost of green buildings for bronze and silver certification was 1 to 3% and for gold and platinum was 5-10%. (Fan et al, 2018). In a case study in Malaysia, based on life cycle cost prediction and using inflation for 60 years, green building costs are calculated; the results are shown in Figure 2 (Loy and Crown, 2018).

Researchers in China have calculated the most important green building cost items, with the highest costs being natural ventilation and air conditioning (Xiaoling et al, 2011). Researchers compared the cost of green building with a conventional building based on four factors of materials, labor, design, and LEED costs. The results show that the cost of green building is $ 1,086,143, and $ 975,000 for non-green. In other words, green building costs are 11% higher than conventional buildings (Brian et al., 2006).

In an article reviewing past literature (2003–2015) about the rising cost of green building. The summary of the results shows that the average additional cost for green buildings compared to non-green buildings for high, medium and low standards are 9%, 5%, and 2%, respectively. (Li et al., 2018). In Taiwan, the cost of 37 green residential buildings has been calculated, which shows that these buildings do not require much cost and cost only 1.58% more than conventional buildings but for gold or diamond certification the cost is 6.7% and 9.3%, respectively (Yi Sun et al., 2019). Studies on green buildings have been conducted in India and the results show that the cost of 3-star buildings is 2-5% and for 5-star buildings is 5-17% (Vyas and Jha, 2018).

Summary results about the cost of green buildings are shown in Table 3.

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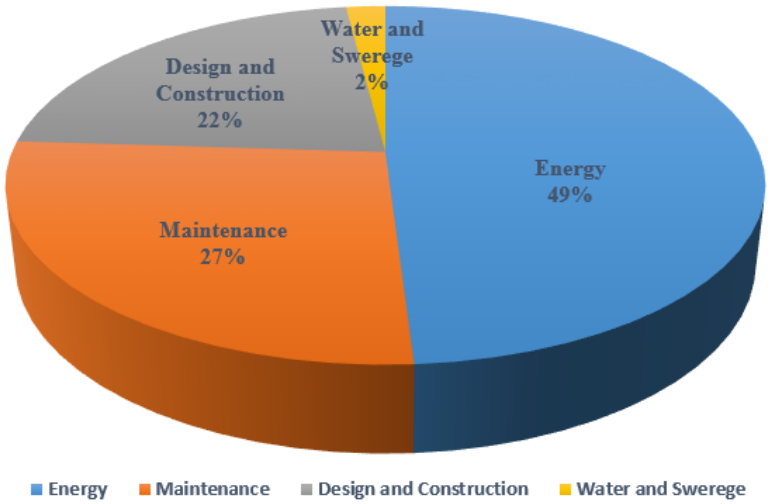

Figure 2. The Most Important Cost of Green Building Items [Luay and Kherun, 2018]

Table 3. Published Literature Related to the Cost of Green Buildings

Author(s)	Year	Finding
Yi Sun et al.	2019	On average, green building costs in Taiwan are 1.58% higher than conventional buildings, but for gold or diamond certification the cost increase is 6.7% and 9.3%, respectively.
Vyas and Jha	2018	in India, the cost of 3-star buildings is 2-5% and that of 5-star buildings is 5-17%
Fan et al.	2018	Incremental costs between 1- 10%
Luay and Kherun	2018	The most important items of green building costs:1)Energy:48% 2)Building maintenance:27% 3)Design and construction cost:22%
Li Zhang et al.	2018	Review past studies on green building costs: for high standard about 9%, medium standard 5% and low standard 2% more than conventional building
Latif and Nese	2017	The extra cost for gold and platinum is 9.43 and 7.43 percent more than conventional buildings
Meron and Meir	2017	Green building costs an average of 17% more than conventional buildings
Rehm and Ade	2014	Incremental cost in New Zealand for 4Green star:1-5% , 5Green star:6-10%, 6Green star: more than 10%
Kim and Greene	2014	10.77% more than the traditional building
Gabay et al.	2014	-Optimum alternative: additional cost between 4-12% -Economical alternative: additional cost is only 0.12–1.33%.
Liu, Guo, and Hu	2014	The extra cost of green buildings is 50% more than conventional buildings
Qifa	2013	The initial cost of green building more than 10% and operation cost less than 40% of conventional building
Lee and Kim	2013	-Green buildings have a high initial construction cost -Presenting the proposed model of government guarantee for the cost increase
Ruan and Gu	2012	Identification of 47 variables affecting green residential costs and finally selecting 8 common factors with the help of fuzzy theory

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Xioling et al.	2011	The most important item of green building costs: Equipment and appliance for natural ventilation and air-conditioner
Chen and Cheng	2011	-The biggest obstacle to implementing green buildings is the high initial cost -The life-cycle cost of green buildings is described by mathematical equations
Kats	2010	-Green cost premium: about 0 – 18% -75% of the analyzed green buildings are the range from 0 – 4%
Brian et al.	2006	Green building costs are 11% higher than conventional buildings
Kats et al.	2003	The average cost of green buildings is 1.84% higher

2.2.3. Analyse and Compare the Benefit and Cost

Most of the researchers believe that although the initial costs of green buildings are more than conventional buildings, the ratio of benefits to costs is significant in the coming years (Kim and Greene, 2014, Lee and Kim, 2013, Liu et al, 2014, Gabay et al, 2014). A study was conducted in San Francisco regarding cost-benefit assessment methods for green buildings, the results indicate that NPV and IRR are the most important criteria for assessing green buildings (Gary, 2005). Another study compares the cost-benefit of implementing green vertical systems and concludes that in the event of tax cuts, green vertical systems are economically sustainable and net present value and internal rate of return are positive (Rosasco and Perini, 2018) .

A financial analysis was conducted comparing green and conventional building, NPV and the internal rate of return (IRR) have been calculated for a 10-year period. The results show that the NPV value is 29.8 (NPV≥0) and according to the discount rate (5.72%), the calculated IRR is 12% (IRR≥5.72%). Thus the results of NPV and IRR show that the implementation of green buildings is economically feasible (Brian et al, 2006). The life cycle costs (LCC) of green buildings have been investigated and concluded that most life cycle costs relate to the operation and maintenance of buildings (Chethana et al, 2019).

In another study, a residential building was converted to a green building and received a gold rating of 71 points based on the IGBC standard and the results show that the payback period for the water and energy seasons is 2.26 and 2.3 years, respectively (Patel and Thackter, 2019).

Some researchers surveyed the benefits of green building in the Israel residential buildings in two steps. In the first step, with optimum alternative, (standard IS5281) without limitation of initial cost and with maximum savings in the use of resources. For a realistic forecast, buildings have divided into small, medium and large sizes (1000, 4000, 10000 square meters) and with two medium and high standards. The results show that for example in buildings with medium standard and small size (optimum alternative), the benefits of green buildings over a 20-year period are more than 10 times their initial cost (Gabay et al, 2014). Further results of the other buildings are shown in Figure 3.

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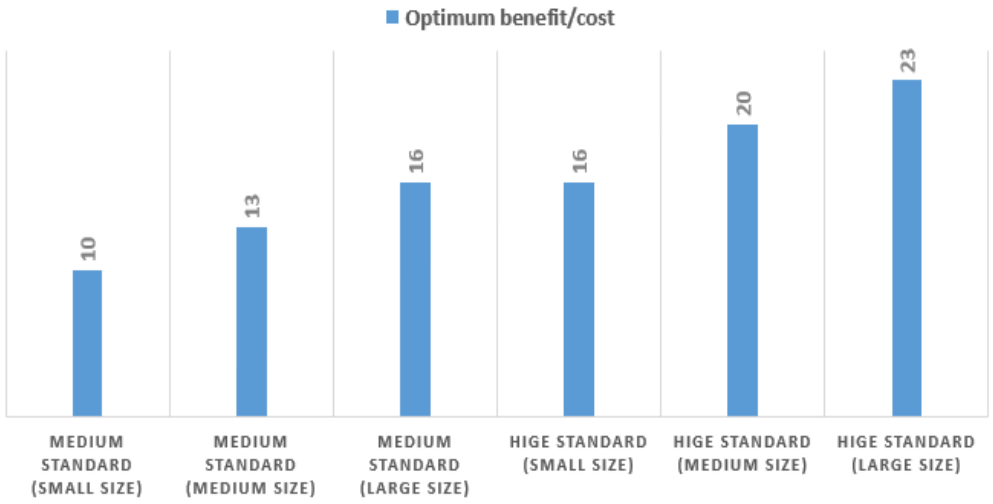

Figure 3. The Result of Benefit/Cost for 20 Years (Optimum Alternative) [Gabay et al, 2014]

But in the second step (economic alternative), with the lowest initial investment and minimum standard score, the benefit-to-cost ratio has increased dramatically (Figure 4).

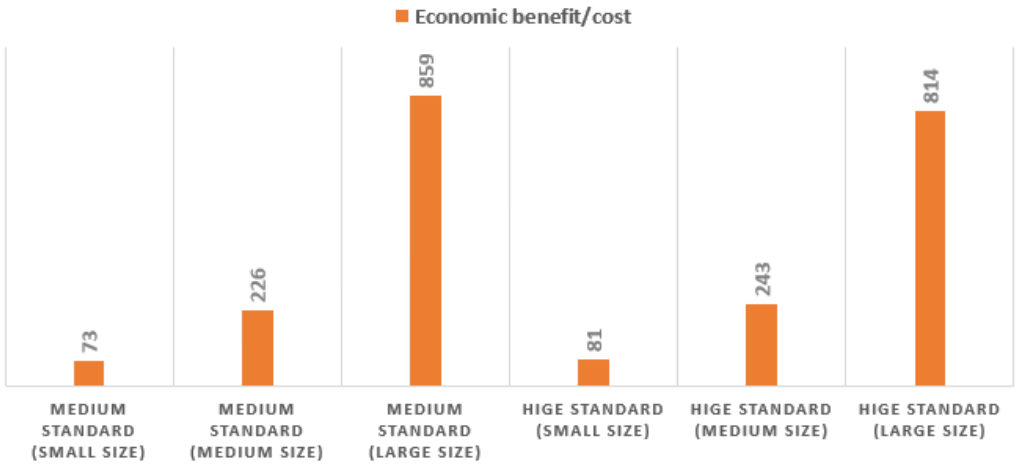

Figure 4. The Result of Benefit/Cost for 20 Years (Economic Alternative) [Gabay et al, 2014]

In another study, the cost and benefit of green buildings were investigated in both financial and economic analysis methods. The results show that in financial analysis the Return of capital is 14 years and the internal rate of return is 0.83%, but in the economic analysis method, the results are improved and respectively it reached 8.6 years and 7.89% (Liu et al., 2014).

In South Korea and in three case studies, the cost and benefit of green buildings are calculated based on three items of materials, equipment, and devices. The results show that the net present value (NPV) of all three projects is greater than zero and economically are justified (Lee and Kim, 2013). The costs and benefits of green buildings divided into three parts as shown in Equation 1 (Chen and Cheng, 2011):

$$\Delta = \sum_{t=0}^{t_1} (B_0 - C_0) \times PV_0 + \sum_{t=t_1}^{t_2} (B_1 - C_1) \times PV_1 + \sum_{t=t_2}^{T} (B_2 - C_2) \times PV \quad (1)$$

If $\Delta \geq 0$, a green building should be chosen, otherwise, choose the conventional project

PV= present value of costs or benefits in primary, construction and operation times

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t1=the time of before construction, t_2=the time of after construction, T= time at the end of the project life, B0 / C0: benefit and cost in primary time, B1 / C1: benefit and cost in construction time, B2 / C2: benefit and cost in operation and maintenance time.

In China, two green and non-green buildings have been compared. for discount rate i= 6% and cost analysis for a period of 30 years, authors find that the present value of green buildings is less than zero (NPV≤0) and in addition, the internal rate of returns is less than the discount rate (IRR≤i) therefore not justified in economic terms (Qifa, 2013) (Table 4).

Table 4. Results of Two Green and Non-green Buildings [Qifa, 2013]

Building type	i	NPV	IRR
Green building	6	-0.81	5.97
Non-green building	6	4.73	6.22

Summary results about comparing the cost and benefit of green buildings are shown in Table 5.

Table 5. Published Literature Related to Comparing Costs-Benefits of Green Buildings

Author(s)	Year	Finding
Patel and Thackter	2019	In green buildings, the payback period for the water and energy seasons is 2.26 and 2.3 years, respectively
Chethana et al.	2019	In green buildings, most of the life cycle costs are related to the operation and maintenance of buildings.
Rosasco and Perini	2018	In the event of tax cuts, vertical green systems are economically sustainable and net present value and internal rate of return are positive.
Gabay et al.	2014	The benefit/cost of the economic option is at least 7 and up to 35 times higher than the benefit/cost ratio in the optimal option.
Liu et al	2014	Financial evaluation: IRR=0.83
Kim and Greene. Lee and Kim. Liu, Guo, and Hu.Gabay et al.	2013 2014	Although the initial costs of green buildings are more than conventional buildings the ratio of benefits to costs is significant in the coming years
Qifa	2013	For a case study for green building NPV≤0 and conventional building NPV≥0 Thus, the implementation of green buildings is not economic
Lee and Kim	2013	NPV for green buildings usually is greater than zero and is economically justified
Chen and Cheng	2011	Presenting a formula for comparing the cost-benefit of green buildings
Brian et al	2006	The result of the case study shows that NPV≥0, IRR≥5.72%. Thus the implementation of green buildings is economically feasible
Gary	2005	NPV and IRR are the best criteria for assessing green buildings

2.2.4. Advantages and Benefits of Using Green Buildings

Ordinary buildings consume many resources such as water, energy, wood and materials. The big reason companies are now looking to implement green buildings is because of their higher reputation, higher revenue, lower risks and lower operating costs (Yingxin Lin and Yuan, 2010. Kassim et al., 2013. Qifa, 2013). Benefits such as higher return on investment, high employment

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and market value, lower risk, significant reduction in water and energy consumption, reduced electricity and gas costs, reduced fossil fuel pollution, reduced building maintenance costs, benefits Social and environmental factors such as improving health and productivity have made investors more interested in investing in green buildings (Dwaikat and Kheran, 2016. Qifa, 2013. Eliasa and Khai Lin, 2015). Benefits of green buildings include enriching biodiversity and protecting the ecosystem, reducing greenhouse gas emissions, improving sanitation and increasing comfort for residents and increasing beauty (Chethana et al., 2019).

Green buildings are today being developed in the world because of the many benefits of these types of buildings. Green buildings are now well developed in some European countries, the US and Australia. In addition, some Asian countries such as China, Japan and Singapore have also used it to meet the needs and development of the community. The construction industry is evolving with green residential development. One of the important benchmarks of green housing is that the building can be transformed into a sustainable building by increasing energy efficiency, reducing energy costs significantly Also, using green technology can recycle rainwater and domestic sewage Used (Eliasa and Khai Lin, 2015).

Many countries are now trying to develop green building to slow down global warming due to greenhouse gas emissions (Azizi, Zainul Abidin and Raofuddin, 2015).

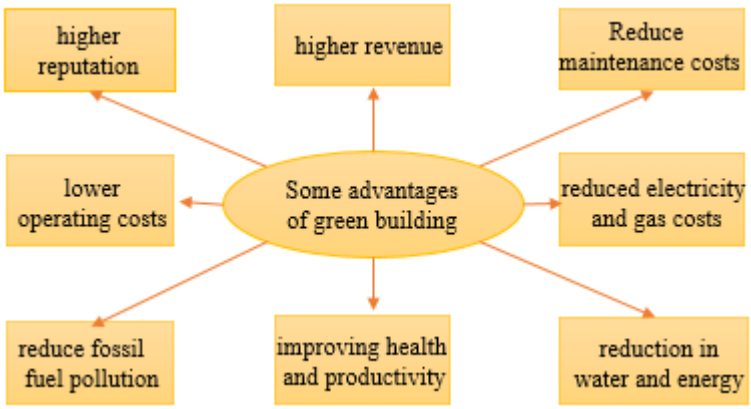

Figure 5. Some Advantages of Green Buildings

3. Discussion

Problems and weaknesses of previous studies on four key factors are summarized and discussed: (Figure 6)

1-Analysis and calculations without green standard, 2-The lack of specified time interval for Cost-Benefit analysis, 3- Ignoring the time value of money 4-Fixed energy prices in different years

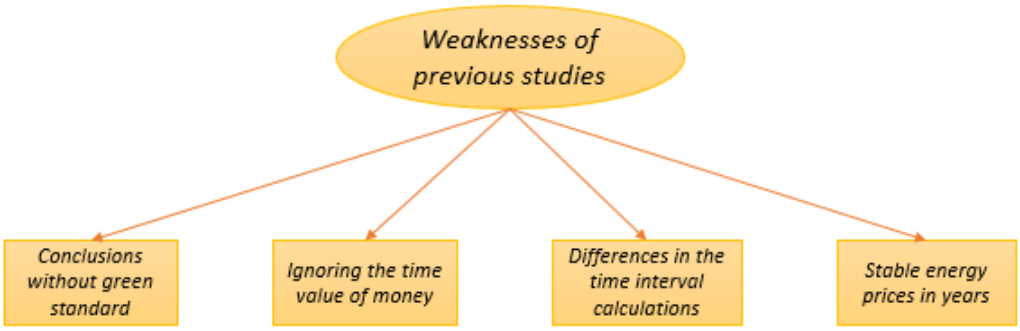

Figure 6. Weaknesses of Previous Studies

3.1. Analysis and Calculations without Green Standard

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A review of past studies shows that some researchers judge and compare the benefits and costs of green buildings without specifying the type of green standard. The results of this method cannot be documented and reliable. Therefore, in each case the comparison of the cost and benefit of green buildings must first identify the standard type such as LEED, BREEM, ESGB, GBTOOL, CASBEE and then conclude and judge.

3.2. Ignoring the time value of money:

One of the most important problem in previous studies is that the time value of money in calculating cost/benefit is not considered and the results have been surveyed from accounting aspect while it is clear that the value of money in the first year is not the same as the year after that, it drops depending on the discount rate and unfortunately, in the past articles, little attention has been paid to this issue. Therefore, it is recommended to use the time factor as a critical factor in all financial analysis and we can use some economic indexes such as Internal Rate of Return (IRR), Net Present Value (NPV) and Return on investment (ROI).

3.3. The Lack of Specified Time Interval for Cost-Benefit Analysis

Sometimes the different views of scientists in evaluating green buildings can create many problems and the results of comparison costs/benefits in similar buildings usually are unreasonable and with major differences. Lake of instructions and regulations for making these problems are very effective. Some researchers analyze since buying land until usually after 20 years of operation (primary studies, construction, operation, maintenance) but others survey only the results in construction stage and short time period after operation. These cases illustrate that there is not same way among the researchers. For example, in a paper the incremental cost for green building is 1% and in another paper with similar condition the amount is more than 50%.

3.4. Fixed Energy Prices in Different Years

The fixed annual price of energy is one of the big mistakes in calculation the cost-benefit of green building in most of previous studies and it is obvious that energy prices are rising in different countries and for example the current energy prices is not the same as next year.

Unfortunately, in numerous articles some energy items such as gas, water, electricity and other factors have been fixed for different years and this is the biggest computational error. Therefore, the results aren't reliable and predict of the annual increasing energy prices are essential.

4. Conclusions

This paper has reviewed the literature about the costs and benefits of achieving green buildings that the most important results are as follows:

a) According to the results, most of the researchers in this paper believe that the initial cost of the green buildings is more than conventional buildings however, green buildings have higher rental rates because of higher demand.

b) According to the outcome, minimum and maximum of incremental cost of green buildings is between 0.12 up to 50%, But most of the results show an average cost increase of 10%.

c) Depending on the use and location of the building, Green buildings can save energy about 25 up to 60%, Reduction in water, gas and electricity consumption, reduction respiratory diseases, reduction CO2 emission and making better environment are some of the implementation benefits of the green buildings.

d) Despite of widespread advantages of green buildings, unfortunately there is not enough support and appropriate facilities from the governments' side and usually most of the rules such as

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taxes and insurance are same for the investors and this matter is the biggest barrier for the implementation of the green buildings especially in the developing countries.

e) The main factors in economic evaluation of green buildings are Net Present Value (NPV) and Internal Rate of Return (IRR). If NPV≥0 and IRR≥ Discount Rate, the results will be acceptable and the green buildings are economically justified otherwise, it is unacceptable.

f) The direct benefits of green buildings implementation are computable and we can estimate them but about indirect benefits, it is not easy and most times we don't have specific basis for calculating them.

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