# An Overview of the Green Building's Criteria: Non Residential New Construction

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**Abstract:** Designers and clients alike are now emphasising on how to make their buildings green. Currently a lot of green councils worldwide are dealing with innovative ways to implement energy efficient new buildings. They have adopted various criteria and rating systems in an endeavour to classify buildings that contribute to environment sustainability, efficiency and users health. The aim of the paper is to present an overview of the criteria adopted by selected green building councils. This paper discusses five of the rating systems available in terms of similarity and contrast and proposes a new framework based on the project life cycle for the development green building criteria. Criteria during the construction phase of the building is certainly lacking such as pollution control in terms of $CO_2$ emission, dust, and other pollutants.

**Keywords**: green building, criteria, rating system, framework, project life cycle

## 1. Introduction

Business organizations, governments and people around the globe have been implementing approaches to make our planet as 'green living'. They have replanted thousands of trees, control greenhouse gases, earth hour campaigns, and innovation adoption via hybrid cars, reuse materials, wind and solar energy exploitation. The broad definition of green living is any of human actions or activities that results in a positive impact, to any amount, on the environment and the Earth which can reduce their endurance to support future generations. The goal of green living is to preserve and improve the health of human being as well as the 'Earth' from the harmful environmental pollutants and emissions. People are now talking of how to make their buildings green. They want to have a place like a house or work in the building which has less negative impact to environment such as CO2 emissions and pollution. That is because buildings have a significant and continuously increasing the impact to the environment through CO2 releases (Montoya, 2010). They also created the most waste, use most of non-energy related resources, and as a source of major pollutions (sound, air and water). In the UK for example, in 2010, a survey have concluded that buildings contributed to about 50% of UK's CO2 emissions and another 7% due to new building construction (NBS, 2011). In addition, about 10% of the global economy involves the construction and operations of buildings which are using 17% to 50% of the world's natural resources that can cause the most extensive environmental damage (US Dept. of Energy, 2003). Hence, buildings and building construction are not only damaging to the environment but the people who live inside as well. For example, the building interiors subject the owners to indoor air quality environments that affect people's health, safety, welfare, and performance.

The selection of building materials also plays an important role for a more sustainable building. It is suggested that if buildings are made from precise woods for example, it will reduce almost 50% of CO2 emissions (Thomark, 2007). Thus, it becomes one of the important criteria for developing an efficient building where materials that easily contribute to CO2 emission can be controlled. Currently, a lot of green councils worldwide deal with an innovative ways in implementing energy efficient new buildings also known as green building. Among of them are LEED or Leadership in Energy and Environmental Design (U.S), Green Star (Australia), Green Mark (Singapore), KGBCC or Korea Green Building Certification Criteria (South Korea), CASBEE or Comprehensive Assessment System for Built Environment Efficiency (Japan), Green Ship (Indonesia) and Green Building Index (Malaysia).

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Green building is a set of practising human activities to increase the efficiency in which the buildings use and harvest energy, water, and materials. The goal is to reduce the building impacts on human health and condition as well as the environment, through a better positioning, design, construction, operation, maintenance, and the complete building life cycle. Generally, all green buildings are designed to save energy and resources, to use right and recycle materials, and to minimize the emission of toxic substances throughout its life cycle. A green building can also reduce the undesirable human impacts on the natural surroundings, building materials, building assets, and enhances human health and the natural environment (Okhovat *et al.*, 2009). All these can be achieved through several important stages;

- Resourcefully using energy - solar, electricity, water, lights, and other resources
- Shielding inhabitant fitness
- Improving workers' productivity
- Managing waste, pollution and environmental degradation

The study is to present an overview of criteria for green buildings rating systems (for Non Residential New Construction-NRNC) from five countries; Malaysia, Singapore, USA, Indonesia and South Korea. They were summarized into two categories; similarity and contrast. This study will propose new items for NRNC green buildings criteria. Currently, there is no common standard set of criteria for rating of green buildings for NRNC. Each country has its own rating system and the ways of implementation. Moreover, the criteria developed are mostly applicable to the current building in operation and not taking account the planning, design and construction considerations for criteria development. Thus, this paper is focussed to narrow down this gap by proposing new items for NRNC of green buildings criteria.

The paper findings are collected from a case study through face-to-face interviews. Three respondents are involved and they are coming from the buildings industry companies in Malaysia. Other data are also been collected as a secondary data. These data are coming from the webpages of each green building council from respective countries, for example, the GBI (http://www.greenbuildingindex.org/index.html). Other media printed materials are contributed from books, reports and journals. The paper is organized as follows; the introduction of green building, the definition, aim and the methodology. Later section is discussed the green building definition and the rating systems from five countries. Then the findings section will present the similarity and contrast of green building rating system and a new proposed framework. The paper is ended with some conclusions and recommendations.

## 2. Literature Review

This section presents the definition of green building and investigates green building criteria as adopted by major green building councils.

### 2.1 Definitions

The US Green Building Council (2003) defines 'Green Building' as:

"To significantly reduce or eliminate the negative impact of buildings on the environment and on the building occupants. Green building design and construction practices address: sustainable site planning, safeguarding water and water efficiency, energy efficiency, conservation of materials and resources, and indoor environmental quality".

Other definition is proposed by GBI (Malaysia) which states "*A Green building focuses on increasing the efficiency of resource use – energy, water, and materials – while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance, and removal.* Green Buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings." GBI focuses into six main criteria:

- Energy Efficiency
- Indoor Environment Quality
- Sustainable Site Planning & Management
- Materials & Resources
- Water Efficiency
- Innovation

Besides five major criteria cited by US Green Building Council, in addition, the element of innovation also can be important factor for green building construction. Thus, GBI has included it as one of the six main criteria for green building rating. For example, the using of Wind Jet Turbine can provide an electricity power of 1.5kW and up to 100kW (Preston, 2009). As a consequence, the wind energy provides an opportunity for electricity alternative which drive to reduce operation costs and creating healthier environment for residents to live and work in.

## 2.2 Green Building Councils – The criteria and rating systems

World Green Building Council (WGBC) is an alliance of 80 national Green Building Councils worldwide and serves as the largest international organizations that influence the green buildings marketplace. The mission is to facilitate the worldwide nations to transform from conventional of buildings construction into sustainability and renewable green energy (buildings construction) through market driven mechanisms. Two of the important global issues that they have addressed are related to the climate change and CO2 emissions. In addition, a WGBC function is to support the adoption of market-based green building through some criteria and rating systems. Some of the established criteria and rating systems around the world are: (i) LEED (US), (ii) Green Star (Australia and New Zealand), (iii) GBI (Malaysia), (iv) Green Mark (Singapore), (v) KGBCC (South Korea), (vi) CASBEE (Japan), and (vii) Green Ship (Indonesia). However this study will focus only on GBI, Green Mark, KGBCC, Greenship and LEED.

### 2.2.1 GBI (Green Building Index)

The GBI is officially launched on August 2008 and exclusively designed for tropical climate (hot and humid condition). The GBI Non-Residential Rating tool evaluates the sustainable aspects of buildings that are commercial, institutional and industrial in nature. This includes factories, offices, hospitals, universities, colleges, hotels and shopping complexes. In the GBI rating (*see* Table 1), more focus is placed on energy efficiency (35 points) and indoor environmental quality (21 points) as these have the greatest impact in the areas of energy use and well-being of the residents and users of the building. By improving on the efficiency of active systems through mechanical and electrical equipment plus with a proper sustainable maintenance administration, significant reductions in consumed energy can be realized. As examples, mechanical ventilation for roof and windows for fresh air intake and expel stale air and electrical usage can be reduced by selecting efficient appliances and lamps, and incorporating day-lighting strategies that reduce the need artificial light. Some of the equipment is photovoltaic components, automatic electricity cut-off systems and wind generator. This can lead to reduced CO2 emissions and increase long-term savings for the building owners. GBI looks into six main criteria as follows;

- Energy Efficiency
- Indoor Environment Quality
- Sustainable Site Planning & Management
- Materials & Resources
- Water Efficiency
- Innovation

The total points for all criteria is 100 and to achieve the points, building company will comply with necessary possessions so that the building will likely be more green environment-friendly. In addition, under the GBI assessment framework, some points will also be granted for achieving and integrating

environment-friendly features which are above current industry practice. Based on scoring, the building will be awarded Platinum, Gold, Silver or GBI Certified.

| Criteria | Scoring | Total Score | Rating Award |
|---|---|---|---|
| Energy Efficiency | 35 | 86 and above | GBI Platinum |
| Indoor Environmental Quality | 21 | 76 to 85 | Gold |
| Sustainable Site Planning & Management | 16 | 66 to 75 | Silver |
| Material and Resources | 11 | 50 to 65 | Certified |
| Water Efficiency | 10 | | |
| Innovation | 7 | | |
| Total | 100 | | |

Table 1: GBI Scoring and Rating Award For
Non Residential-New Construction Building

### 2.2.2 Green Mark

The Green Mark is introduced in January 2005 by Singapore's Building Construction Authority. The objective is to establish the construction industry towards producing a more environment-friendly building. It is also to promote sustainability in the built environment and increase environmental responsiveness among developers, designers and builders. Among the benefits of Green Mark include:

- Facilitate reduction in water and energy bills,
- Reduce potential environmental impact,
- Improve indoor environmental quality for a healthy and productive workplace,
- Provide clear direction for continual improvement.

Green Mark is a green building rating system which evaluates a building for its environmental impact and performance. It provides a comprehensive framework for assessing the overall environmental performance of new and existing buildings. Under the assessment framework for new buildings, developers and design teams are encouraged to design and construct green, sustainable buildings which can promote energy savings, water savings, and healthier indoor environments. As for existing buildings, the building owners and operators are encouraged to meet their sustainable operations goals and to reduce adverse impacts of their buildings on the environment and occupant health over the entire building life cycle. The assessment criteria cover the five key areas:-

- Energy Efficiency
- Water Efficiency
- Environmental Protection
- Indoor Environmental Quality
- Other Green Features and Innovation

The assessment identifies the specific energy efficient and environment-friendly features and practices incorporated in the projects. Points are awarded for incorporating environment-friendly features which are better than normal practice. The total number of points (190) obtained will provide an indication of the environmental friendliness of the building design and operations. Depending on the overall assessment and point scoring, the building will be certified to have met the Green Mark Platinum, Gold$^{Plus}$, Gold or Certified rating (*see* Table 2).

| Criteria | Scoring | Total Score | Rating Award |
|---|---|---|---|
| Energy Efficiency | 116 | 90 and above | Green Mark Platinum |
| Water Efficiency | 17 | 85 to 90 | Gold$^{Plus}$ |
| Environmental Protection | 42 | 75 to 85 | Gold |
| Indoor Environmental Quality | 8 | 50 to 75 | Certified |
| Green Features and Innovation | 7 | | |
| Total | 190 | | |

Table 2: Green Mark Scoring and Rating Award For
Non Residential-New Construction Building

### 2.2.3 Green Ship

The participation of Indonesia in implementing green building principles mainly through public and private sectors, associations and academic institutions. Indonesia by practice focus on both newly-built and old building as well. The application of green building principles that been carried out have reflected some sort of benefits towards lower operating, lower energy and less waste. Basically through Green Building Council Indonesia (GBCI) having objectives in promoting the implementation of green building principles for all building sectors in their country, and one of the efforts is by developing a rating system "Greenship" kind of certification for buildings to achieve a green standard. The Greenship has been launched in 17$^{th}$ June 2010 and it is one of the kinds rating to establish and used to benchmark the environmental capability or performance of different buildings. By using a credit system in rating a wide range of green building attributes could be observable, but to assess attributes where the assessment is accountable for at a realistic cost. By engaging into building material assessment is a good example of where rating tools do not yet have the capacity to make a full impact assessment. The assessment criteria cover the six key areas:

- Appropriate Site Development,
- Energy Efficiency and Conservation,
- Water Conservation,
- Material Resource and Cycle,
- Indoor Health and Comfort,
- Building Environment Management

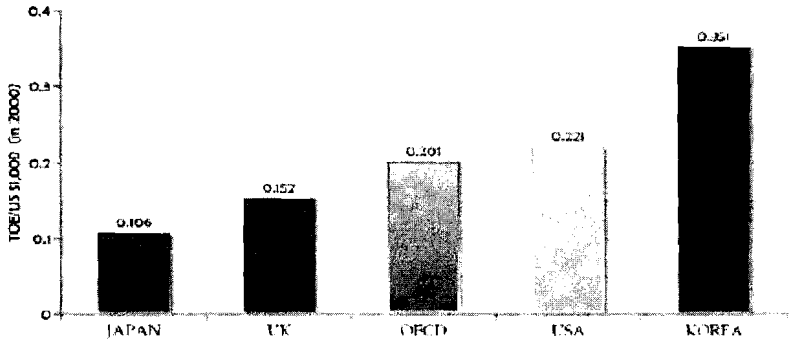
| Criteria | Scoring | Total Score | Rating Award |
|---|---|---|---|
| Energy Efficiency and Conservation | 26 | 80 and above | Greenship Platinum |
| Water Conservation | 21 | 60 to 79 | Gold |
| Appropriate Site Development | 17 | 50 to 59 | Silver |
| Material Resource and Cycle | 14 | 40 to 49 | Certified |
| Indoor Health and Comfort | 10 | | |
| Building Environmental Management | 13 | | |
| Total | 101 | | |

Table 3: Greenship Scoring and Rating Award For
Non Residential-New Construction Building

The total rating for the Greenship is 101 and most important criteria are energy efficiency and conservation which carry 26 points. Thus the building will be awarded Platinum, Gold, Silver or Certified depending on total points from those six criteria (*see* Table 3).

### 2.2.4 KGBCC

The first initiative of green building systems for office and residential buildings in South Korea had begun between years 1997 to 2000. Then in 2001, the system has enhanced into Green Building Certification Criteria (GBCC) by Korea Institute of Energy Research (KIER) which based on Green Building (BG) tool. Nowadays, the KGBCC has extended its areas to include the semi-residential buildings, office buildings (public and private), commercial buildings and re-modelled buildings. One of the main reasons why South Korea highlighting on GB, because the country has the lowest rate of energy efficiency consumption. They had 0.351 per US$1 as compared to Japan (0.106) and UK (0.152) (*see* Figure 1).




Sources: IEA, Energy Balances of OECD Countries (2005)

Fig 1: Comparison of Energy Efficiency

| Criteria | | Scoring | Total Score | Rating Award |
|---|---|---|---|---|
| Land Use & Commuter Transportation | Land Use | 7 | 85 and above | KGBCC Best |
| | Transportation | 5 | 65 to 84 | Excellent |
| Energy Resources Consumption & Environmental Loads | Energy | 23 | | |
| | Material Resources | 21 | | |
| | Water Resources | 14 | | |
| | Environmental Pollution Loads | 6 | | |
| | Management | 10 | | |
| Ecological Environment | Ecological Environment | 19 | | |
| Indoor Environmental Quality | Indoor Environmental Quality | 31 | | |
| Total | | 136 | | |

Table 4: KGBCC Scoring and Rating Award For Non Residential-New Construction Building

Currently, KGBCC focuses on four main criteria (*see* also Table 4):

- Land Use and Commuter Transportation
- Energy Resources Consumption and Environmental Loads
- Ecological Environment
- Indoor Environment Quality

All the criteria have been established for numerous types of buildings either for Non Residential New Building and Residential New Building. Two most important factors for the KGBCC are Energy Resources Consumption and Environmental Loads (64 points) and Indoor Environmental Quality (31 points). The total point for all criteria is 136 points and only two rating awards offered; 85 points above will be awarded KGBCC Best and between 65 to 84 points can be credited as Excellence.

### 2.2.5 LEED Green Building Rating System

LEED is a highly quantified and systematic approach to buildings of all types. Because it has accomplished so much and been so broadly accepted, LEED is becoming the standard by which many green buildings are measured. LEED quantifies a building's performance in the following major categories as shown in Table 5. LEED operates through the U.S. Green Building Council and takes a much broader "triple bottom line" approach considering people, planet and profit, not just energy use. The triple bottom line factors in the economic, environmental and social issues present throughout the entire building process from concept, design, development and future operation.

| Criteria | Scoring |
|---|---|
| Energy & Atmosphere | 17 |
| Water Efficiency | 5 |
| Sustainable Sites & Transportation | 14 |
| Indoor Environment Quality | 15 |
| Material & Resources | 13 |
| Innovation & Design Process | 5 |
| Total | 69 |

Table 5: LEED Scoring and Rating Award For
New Construction Building & Major Renovations

## 3.0 Findings

The results of this study can be summarised in Table 6 and Table 7 which shows the percentage utilisation of the green building criteria by various councils and a comparison of the green building criteria respectively. It is clear from Table 1 that Energy Efficiency, Water Efficiency and Indoor Environment Quality are the most vital elements (as they are being referred to by all the councils) to be considered in the green building criteria development by the councils under consideration, followed by Site Planning & Management, Materials & Resources, Environmental Protection and Innovation.

Energy Efficiency encompasses design and performance, commissioning, monitoring, improvement & maintenance with a 38% maximum score for GBI, 61% for Green Mark, 26% for Greenship, 17% for KGBCC and 25% for LEED. Water Efficiency includes water harvesting and recycling with a 12% maximum score for GBI, 9% for Green Mark, 21% for Greenship, 10% for KGBCC and 7% for LEED. Indoor Environment Quality takes into account air quality, thermal, lighting, visual and acoustic comfort, and verification with a 21% maximum score for GBI, 4% for Green Mark, 10% for Greenship, 23% for KGBCC and 22% for LEED.

| CRITERIA | | | | | | |
|---|---|---|---|---|---|---|
| Energy Efficiency | Water Efficiency | Indoor Environment Quality | Site Planning & Management | Innovation | Materials & Resources | Environmental Protection |
| 100% | 100% | 100% | 80% | 60% | 80% | 60% |
| **CRITERIA** | | | | | | |
| Transport | Land Use | Ecological Environment | | | | |
| 20% | 20% | 20% | | | | |

Table 6: Percentage Utilisation of the Green Building Criteria

| Criteria | GBI | Green Mark | Green Ship | KGBCC | LEED | TOTAL |
|---|---|---|---|---|---|---|
| Energy Efficiency | √(38) | √(61) | √(26) | √(17) | √(25) | **33%** |
| Water Efficiency | √(12) | √(9) | √(21) | √(10) | √(7) | **12%** |
| Indoor Environment Quality | √(21) | √(4) | √(10) | √(23) | √(22) | **16%** |
| Site Planning & Management | √(10) | | √(17) | √(7) | √(20) | **11%** |
| Innovation | √(10) | √(4) | | | √(7) | **4%** |
| Materials & Resources | √(9) | | √(14) | √(15) | √(19) | **11%** |
| Environmental Protection | | √(22) | √(13) | √(4) | | **8%** |
| Transport | | | | √(4) | | **1%** |
| Land Use | | | | √(5) | | **1%** |
| Ecological Environment | | | | √(14) | | **3%** |
| **TOTAL** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

*Note: Numbers in brackets are percentages.*

Table 7: A Comparison of the Green Building Criteria by Various Green Building Councils

Materials & Resources include reused, recycled and sustainable materials and resources. This criterion also takes into account waste management and green products. GBI allocated a 9% score for these criteria with Greenship's score of 14% and KGBCC's score of 4%. Site Planning & Management criteria encompass facility management, transportation and the reduction of the heat island effect. GBI allocated a 10% score for these criteria with Greenship's and KGBCC's score of 17% and 7% respectively. These two criteria however is not applicable for Green Mark's assessment for green buildings. The distribution of scores for other criteria by the councils under study is illustrated in Table 2. It can be seen (from Table 2) that energy efficiency is the most influential criteria (33%) followed by indoor environment quality (16%) whilst transport and land use are the least influential (1% each) criteria for the assessment of green buildings as allocated by the councils under study.

GBI and LEED developed six (6) criteria that are similar but differ in emphasis (scores or points). GBI places more emphasis on Energy Efficiency, Water Efficiency and Innovation whereas LEED places more emphasis on Site Planning & Management, and Materials & Resources. Both GBI and LEED placed equal emphasis on Indoor Environment Quality. Green Mark opted out Materials & Resources and Site Planning & Management criteria (as noted previously) but included Environmental Protection (22%) which is only second in emphasis to Energy Efficiency (61%). Environmental Protection is also included in the Greenship and KGBCC assessment for green buildings but Innovation is not applicable. KGBCC introduces other criteria such as Transport, Land Use and Ecological Environment which are not considered by other councils in this study.

## 4.0 Discussions and Conclusions

The various criteria discussed for the assessment of green buildings however are mainly focussed on the actual completed building (operation and maintenance phase). No doubt these criteria are of utmost importance to the current building but consideration must also be given to the planning, design and construction phases that the building has gone through.

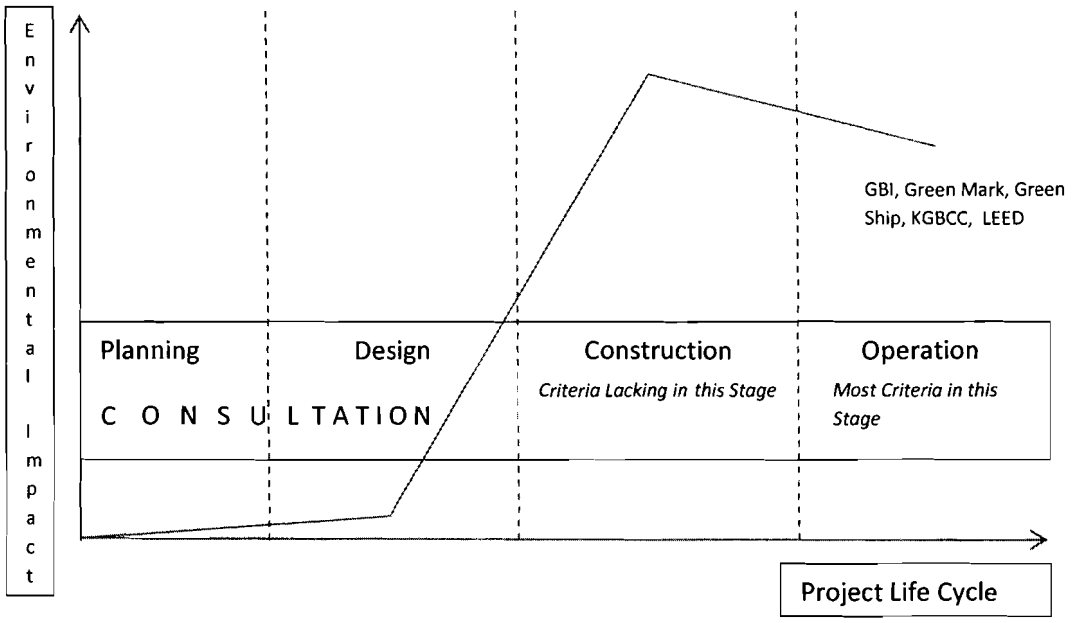



Fig 2: Environmental Impact & Criteria Development during the Project Life Cycle.

In other words, the assessment should also take into account whether the building has been subjected to green planning, design and construction or whether the building has gone through a green project life cycle. If criteria are to be developed for the planning, design and construction phases, the operation and maintenance phase of a building, however, will still carry the most weightage towards the assessment for a green building. Figure 2 shows the life cycle of a building and its environmental impact. The construction phase will no doubt contribute the highest intensity of impacts to the

environment, and this should be taken into account into the assessment of green buildings. The only criterion that has relevance to the pre-operational stage of a building is Materials and Resources where emphasis is on recycled, reused sustainable materials and green products during the construction phase. Sustainable purchasing policy and the storage and disposal of materials are also

part of the criteria which is mostly adopted by the councils under study. However the authors feel that more criteria should be developed for the planning, design and construction stages of a building life cycle in the assessment for green buildings. Criteria during the construction phase of the building, for example, is certainly lacking such as pollution control in terms of CO emission, dust and other pollutants. Figure 3 shows a framework based on the project life cycle where criteria are developed.

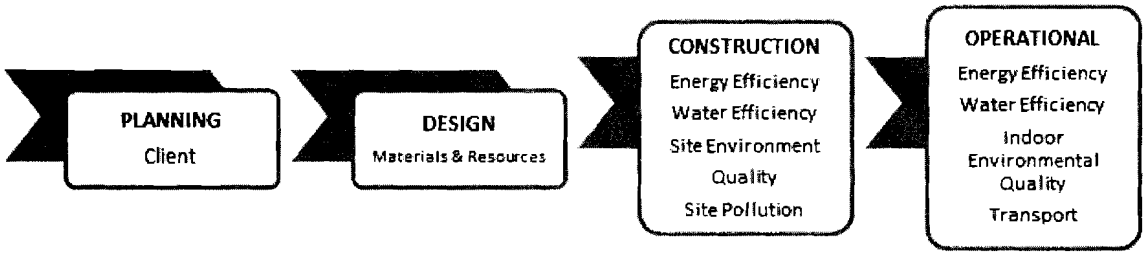



Fig 3: Criteria Development: The Green Building Criteria Framework

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