A BUILDING SUSTAINABILITY RATING INDEX (BSRI) FOR BUILDING CONSTRUCTION

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Abstract

This research aims to deliver a building sustainability rating system which will easy to apply and will focus on macro as well as micro levels of building construction. Also this system will be focused on owner’s sustainability perspective. The criteria’s and indices in BSRI will be well defined in order to reduce confusion and misunderstandings. Also this research will be focused on helping the designers during the design stage itself minimizing assessment procedures.

Keywords: building construction, Green Buildings, Sustainability Assessments, Weighted Point system,
1. Introduction:

There is a growing concern among the stakeholders on how to improve construction practices to minimize their detrimental effects on the natural environment (Cole, 1999; Holmes and Hudson, 2000). The environmental impact of construction, green buildings, designing for recycling, waste reduction, dematerialization, de-construction and eco-labeling of building materials are some of the initiatives among other that have captured the attention of building professionals across the world (Johnson, 1993; Cole, 1998; Crawley and Aho, 1999; Rees, 1999). Building performance, evidenced by the building commissioning movement is now a major concern of professionals in the building industry (Crawley and Aho, 1999) and environmental building performance assessment has emerged as one of the major issues in sustainable construction (Cole, 1998; Cooper, 1999; Holmes and Hudson, 2000). According to Cole (1998), the definition of building performance varies according to the different interest of parties involved in building development. For instance, a building owner may wish his building to perform well from a financial point-of-view, whereas the occupants may be more concerned about indoor air quality, comfort, health and safety issues. Using a single method to assess a building’s environmental performance and to satisfy all needs of users is no easy task. Therefore, an ideal environmental building assessment will include a correct and complete set of requirements of the different parties involved in the development. The phrase built environment refers to the man-made surroundings that provide the setting for human activity, ranging from the large-scale civic surroundings to the personal places. The built environment has a profound impact on our natural environment, economy, health, and productivity. Green building has been defined as the practice of increasing the efficiency with which buildings use resources — energy, water, and materials — while reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal — the complete building life cycle.

Building designers and occupants have long been concerned about building performance (Cooper, 1999; Kohler, 1999, Finnveden and Moberg, 2005). Considerable work has gone into developing systems to measure a building’s environmental performance over its life. They have been developed to evaluate how successful any development is with regards to balancing energy, environment and ecology, taking into account both the social and technology aspects of projects (Clements-Croome, 2004). Separate indicators, or benchmarks based on a single criterion, have been developed to monitor specific aspects of environmental building performance such as air quality and indoor comfort. However, these benchmarks serve to emphasis the need for a comprehensive assessment tool to provide a thorough evaluation of building performance against a broad spectrum of environmental criteria.
The Building Research Establishment Environmental Assessment Method (BREEAM) in 1990 was the first such comprehensive building performance assessment method. BREEAM was the first environmental building assessment method and it remains the most widely used (Larsson, 1998). The Building Research Establishment developed the system in 1990 in collaboration with private developers in the UK. It was launched as a credit award system for new office buildings. A certificate of the assessment result is awarded to the individual building based on a single rating scheme of fair, good, very good or excellent. The purpose of this system is to set a list of environmental criteria against which building performances are checked and evaluated. This assessment can be carried out as early as at the initial stages of a project. The results of the investigation can be fed into the design development stage of buildings and changes can be made accordingly to satisfy pre-designed criteria (Johnson, 1993). Since 1990, the BREEAM system has been constantly updated and extended to include assessment of such buildings as existing offices, supermarkets, new homes and light industrial buildings (Yates and Baldwin, 1994).

Crawley and Aho (1999) suggest that the system is successfully alerting building owners and professionals to the importance of environmental issues in construction. BREEAM has made an impact worldwide, with Canada, Australia, Hong Kong and other countries using the BREEAM methodology in developing their own environmental building assessment methods. Following the launch of BREEAM in the UK many other assessment methods have been developed around the world to undertake environmental building assessment. Table 1 summarized the old and new environmental building assessment methods used in different countries. Most of the environmental building assessment tools cover the building level and based on some form of life-cycle assessment database (Seo et al., 2006). There are two categories of tools that the industry uses: assessment and rating tools. Assessment tools provide quantitative performance indicators for design alternatives whilst rating tools determine the performance level of a building in a graphic (stars) or quantitative systems. Furthermore these tools are created and maintained by government or private agencies. EMGB, NABERS and BASIX are operated by the government while the others (such as LEED) have a private, voluntary and contractual origin and are guidance type only. They essentially aim at showing those involved in the building process the potential for improvement. Most building evaluation methods are concerned with a single criterion such as energy use, indoor comfort or air quality to indicate the overall performance of a building (Cooper, 1999; Kohler, 1999). As environmental issues become more urgent, more comprehensive building assessment methods are required to assess building performance across a broader range of environmental considerations. An environmental building assessment method reflects the significance of the concept of sustainability in the context of building design and subsequent construction work on site. The primary role of an
environmental building assessment method is to provide a comprehensive assessment of the environmental characteristics of a building (Cole, 1999) using a common and verifiable set of criteria and targets for building owners and designers to achieve higher environmental standards. It also enhances the environmental awareness of building practices and lays down the fundamental direction for the building industry to move towards environmental protection and achieving the goal of sustainability. It provides a way of structuring environmental information, an objective assessment of building performance, and a measure of progress towards sustainability.
<table>
<thead>
<tr>
<th>Assessment Method</th>
<th>Origin</th>
<th>Characteristic</th>
<th>Reference</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>- Star rating on the scale of 1 to 5</td>
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<td></td>
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<td>- National approach to benchmarking</td>
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<tr>
<td></td>
<td></td>
<td>- Based on 12 months of energy consumption</td>
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<tr>
<td>BASIX- Building and Sustainability Index</td>
<td>Department of Infrastructure, Planning and Natural Resources, 2004</td>
<td>- Web-based planning tool for residential development</td>
<td>Seo et al. (2006)</td>
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<td></td>
<td></td>
<td>- To assess the water and energy efficiency of new residential developments</td>
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<td></td>
<td></td>
<td>- NatHERS and AccuRate are simulation packages used to assess energy performance</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- It is mandatory for all new residential development and a BASIX certificate is required for development approval</td>
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<td>BREEAM- BRE Environmental Assessment Method</td>
<td>United Kingdom, Building Research Establishment.</td>
<td>- First environmental assessment system used internationally</td>
<td>Shakoorian, A.</td>
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<tr>
<td></td>
<td></td>
<td>- Used four levels of ratings-excellent, very good, good and pass.</td>
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<tr>
<td></td>
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<td>- Sustainability assessment system</td>
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<td></td>
<td></td>
<td>- Each criterion weighted based on its importance.</td>
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<td>CASBEE- Comprehensive Assessment System for Building Environmental Efficiency</td>
<td>Japan, 2004 A co-operative project between industry and government</td>
<td>- Applicable in accordance with the stages of a development in pre-design, new construction, existing building and renovation</td>
<td>Cole (2005), Yau et al. (2006), Seo et al. (2006)</td>
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<td></td>
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<td>- It is based on the concept of closed ecosystems to determine the environmental capacities</td>
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<td>- Consideration for regional character</td>
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<td></td>
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<td>- Absolute performance indicators to complement the relative scores</td>
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<td>- More than 90 individual performance assessment</td>
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<td></td>
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<td>- Four levels of weighting</td>
<td></td>
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<tr>
<td>Method</td>
<td>Overview</td>
<td>References</td>
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</tr>
<tr>
<td>LEED- Leadership in Energy and Environmental Design</td>
<td>USA, 2000. Developed by the US Green Building Council - A certification process developed to create an industrial standard - Self-assessing system awards rating of certified, silver, gold and platinum - Use simple checklist format to rate building performance - For new and existing commercial, institutional, high-rise residential &amp; major renovation - Comprises 5 areas of sustainability - A voluntary tool</td>
<td>Rohracher (2001), Todd et al. (2001), Yau et al. (2006), Seo et al. (2006), Shakoorian, A.</td>
<td></td>
</tr>
<tr>
<td>SpeAR- Sustainable Project Appraisal Routine</td>
<td>ARUP, Developed by private architectural firm, ARUP. - A project assessment methodology within Ove Arup’s consulting projects - To enable a rapid review of project sustainability - Use a graphical format to present sustainable design</td>
<td>Crawley and Aho (1999), Larsson (1999), Yau et al. (2006), Seo et al. (2006)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1
2. Problem Statement:
The purpose of this research is to develop a building sustainability rating index (BSRI).

3. Sub-problems:
1. To categorize various types of buildings and identify critical processes for each project type.
2. To assess weighted score for the sustainability of each process.
3. To determine Sustainability index for respective category of the building.

4. Delimitations-
1. The scope of this study is limited to building construction.

5. Literature review-
Literature review indicates that the task of understanding and translating strategic sustainability objectives into concrete action at project level has become a very challenging task for construction professionals (Viitaniemi & Haapio, 2007). The process has been exacerbated by the multi-dimensional perspectives of sustainability such as economy, society, environment, combined with a lack of structured methodology and information at various levels. Also, while discussing environmental issues in the building sector, the use of terms is not well established. This inconsistent use of terms may cause confusions and misunderstandings (Viitaniemi & Haapio, 2007). Over the past few years, the increased concern over the deterioration of our environment has motivated the development of various sustainability assessment systems across the globe. Although most of them are based on the concept of life cycle assessment, they have been basically focused on the evaluation of the environmental performance during building operation (Cole, 2000). The limited attention given to the onsite construction impacts is a consequence of the perceived relatively lower significance of construction impacts compared with the lifecycle impacts associated with building design and management.

The environmental assessment methods all have limitations that may hamper their future usefulness and effectiveness (Ding & K.C., 2007). According to Ding (2007), current assessment methods do not adequately and readily consider environmental effects in a single tool and therefore do not assist in the overall assessment of sustainable development. Also the inflexibility, complexity and lack of consideration of weighing system are still major obstacles to the acceptance of sustainability assessment methods. Use of a sustainability index should simplify the measurement of sustainability and therefore should make a significant contribution to the identification of optimum design solutions and facility operations. (Ding & K.C., 2007)

In several countries “rating” schemes 2 have been introduced that do provide this additional information for assessing energy-efficiency compared to an arch-type building. These schemes have a variety of objectives forming either part of the requirements for building=planning code compliance or part of a
scheme to market energy-efficient environmentally responsible buildings (V.I. Soebarto, 2001). Despite claims to the contrary, most of these assessment programs are not design-orientated. They are constructed to give endorsement to a completed design rather than to assist the designer during the design process. (V.I. Soebarto, 2001)

Hence in future the rating systems developed should ideally assist designers during the design process, they should be clear with the definitions of its indicators in order to avoid confusion, they should be developed with the help of trend analysis or equivalent to remove future uselessness.

6. Proposed methodology:

The objective of this research is to develop a rating system which will have an ability to satisfy present as well as future requirements of sustainability. The most significant problem facing everyone who attempts to study the future is how to sift effectively through the myriad of information sources and pull out those trends worthy of future study and tracking. Researchers use number of techniques to think about and sketch out future opportunities. Trend Analysis is one of those techniques used by researchers which give reliable outputs. Trend analysis is nothing but collecting and analyzing local, regional or global conditions. Researchers can develop forecasts of future conditions through simple exploration by collected data. (Wallace, 2005)

The proposed methodology for the development of BSRI consists of the following important concepts:

Figure: 6.1

Indicators

An actor in the field of building construction needs tools and system to improve sustainability practices. These tools are based on Sustainability indicators and criteria’s. According to Appu
Haapio, 2007; indicators are measures which can show the direction of change while criteria are characteristics that are considered important and by which success or failure is judged. Indicators provide crucial guidance for decision-making in a variety of ways. They can translate physical and social science knowledge into manageable units of information that can facilitate the decision-making process. They help to measure and calibrate progress towards sustainable development goals. They can provide an early warning, sounding the alarm in time to prevent economic, social and environmental damage.

One of the salient features of BSRI is its easy to use index with well defined list of indicators. The BSRI research team will conduct a survey with a combination of structured interviews with industry professionals, academicians and policy makers in Green Building Industry. This process will help the team to establish clear set of definition with appropriate weights from professionals. Following chart shows some of the key sustainability indicators:

After reviewing published literature and following above stated aspects, the research will move ahead with development of a matrix comprising of various activities that affects the sustainability of the

8\textsuperscript{th} International Post Graduate Research Conference, Prague, The Czech Republic, June 25-28, 2008
buildings at the most (Prototype). This list will be then sent to various organizations such as owners, contractors, sustainability certifying professionals as well as to academicians for their review. They will be asked to rate each activity from 0-5 (0=doesn’t affect sustainability, 5= affects sustainability the most)

Figure 6.3- Proposed adaptive weighted scoring system for BSRI

After receiving the reviews, next step in this research is to reorganize the matrix as per the review results and furnish it for the sustainability assessment stage.
In assessment stage, we will select 3 sets, each with 3 ongoing building construction projects for assessment purpose as follows -

![Figure 6.4]

BSRI will be applied with these three sets and the results will be prepared for the next stage, which is the validation stage. Validation of the BSRI will be carried out through the workshops and surveys. In those, the BSRI results will be reviewed and analyzed by industry experts.

It is very important to set benchmarks during the development of any system. The benchmarks will be set for each activity with the evaluation of its impact on the buildings sustainability. Benchmarking will define limits for each level as well as it will give us the standard for the type of building. Following table shows conceptual project benchmarking for BSRI:

<table>
<thead>
<tr>
<th>SR NO.</th>
<th>PROJECT</th>
<th>TYPE</th>
<th>LOCATION</th>
<th>BSRI SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reed Arena Expansion</td>
<td>Sports Complex</td>
<td>College Station, TX</td>
<td>650</td>
</tr>
<tr>
<td>2</td>
<td>Agriculture Program State Headquarters</td>
<td>Educational</td>
<td>Oklahoma City, OK</td>
<td>890</td>
</tr>
<tr>
<td>3</td>
<td>Interdisciplinary Life Sciences Building</td>
<td>Educational</td>
<td>Milwaukee, WI</td>
<td>750</td>
</tr>
<tr>
<td>4</td>
<td>New Campus Housing</td>
<td>Residential</td>
<td>College Station, TX</td>
<td>530</td>
</tr>
<tr>
<td>5</td>
<td>Mitchell Buildings</td>
<td>Commercial</td>
<td>Austin, TX</td>
<td>320</td>
</tr>
</tbody>
</table>

Figure 6.5- Project Benchmarking Model
Figure 6.6: Proposed Methodology for BSRI
7. Significance of proposed study:

This research aims to deliver a building sustainability rating system which will be
- Easy to apply and will focus on macro as well as micro levels of building construction.
- Also this system will be focused on owner’s sustainability perspective.
- The criteria’s and indicators in BSRI will be well defined in order to reduce confusion and misunderstandings.
- The system will use adaptive weighted scoring system.
- Also BSRI will be an open system.

Figure 7.1- Salient features of BSRI
REFERENCES:


Shakoorian, A. A comparative study of LEED, BREEAM and GBTOOL.


(Soebarto & Williamson, 2001)