Green vs. Sustainability Performance Assessment
A case study of an office building in Putrajaya, Malaysia

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ABSTRACT: Building performance assessment systems (BPASs) are emerging rapidly in many countries with different emphasis and scope of assessment. This paper seeks to find out whether a building design which scores high when assessed by an environmental-focused BPAS would also produce high scores if assessed by a BPAS which is based on a balanced and holistic concept of sustainability. Two BPASs were applied on a case study office building in Putrajaya, Malaysia, namely: 1) Singapore’s Green Mark Scheme, an existing environmental-focused BPAS actually used to rate the green performance of the case study building in reality; and 2) Malaysia Office Building Sustainability Assessment (MOBSA) framework, developed by the author in a three-year research as a means to assess the sustainability performance (environmentally, socially and economically) of office buildings in Malaysia. The study found that the building achieved a very high overall score in terms of its environmental design performance but scored lower when social- and economic-related criteria at the scale broader than the building itself were also taken into consideration and appropriately weighted. It appears that a more comprehensive BPAS, embracing the whole concept or three dimensions of sustainability, is crucial to be introduced and implemented in Malaysia, in priority to, or alongside with, single-dimensional BPASs.

Keywords: office, environmental performance, sustainability performance, building performance assessment system, emerging/developing countries, Malaysia

INTRODUCTION
One-tenth of the global economy is dedicated to constructing, operating and equipping buildings [1]. By contrast, the construction sector is responsible for huge solid waste generation, environmental damage and approximately a third global greenhouse gas emissions [2]. In Malaysia, the exploitation of resources, uncontrolled, and improperly planned development has resulted in the deterioration of the environment [3].

Knowledge about the negative impact of building construction is increasing and there is a growing field of new technologies aiming at minimizing negative environmental impacts. However, there is still no clear definition of what constitutes a sustainable building, nor there is any consensus regarding how to measure sustainability. One response to this has been the development of various building performance assessment systems (BPASs), which can be considered as one of the strategies in, and perceived as tools for, promoting and contributing to sustainable construction [4,5]. Many such BPASs have been developed in the form of rating systems that measure how well or poorly a building is performing, or is likely to perform, against a declared set of environmental or sustainability criteria. Examples of such BPASs include BREEAM in the U.K. [6], LEED in the U.S. [7], Green Star in Australia [8], SBTool (formerly known as GBTool) initiated in Canada [9], and many more.

However, most of the existing BPASs from developed countries have long been criticized for following a single-dimensional approach or being restricted to the environmental dimension of sustainability only, with limited ability to assess the broader social and economic dimensions of sustainability [10,11]. Hence, they are inadequate in addressing the complex concept of sustainability as well as many of the non-environmental priorities of emerging/developing countries. The key difference between an environmental-focused and a more-holistic BPAS is that the former is often being used to measure the ‘greenness’ of a building, whereas the latter is more relevant in the context of building sustainability.

The difference between ‘green’ and ‘sustainability’ has been clarified by various authors. For example, Cole [12] is of the opinion that the term ‘green’ has been used to describe “building design strategies that are less environmentally and ecologically damaging than typical practice”. ‘Sustainability’ on the other hand, “embraces notions other than environmental performance. It has social and economic dimensions, embraces all facets of human activity. Lutzkendorf and Lorenz [13] elaborated
this point further by suggesting that a green building is meant to be a building that does not fulfil all the requirements attributed to sustainable building, but which exhibits energy efficiency, resource depletion, impacts on the environment, and protection of health and environment. Additional requirements for a sustainable building are “minimization of life cycle cost; protection and/or increase of capital values; protection of health, comfort and safety of workers, occupants, users, visitors and neighbours, and (if applicable) to the preservation of cultural values and heritage” [13].

The significance of these issues had prompted research into developing an assessment framework that enables sustainability to be addressed and incorporated in office building development, relevant to emerging/developing countries, particularly the Malaysian context. This paper can be regarded as the final result of the author’s research activities in the area. It is planned to demonstrate that a building which scores high on the green or environmental performance might not necessarily so if assessed holistically based on sustainable development principles. The study is important to justify the need of introducing and implementing a more comprehensive BPAS in Malaysia, in priority to, or alongside with, single-dimensional BPAS. It is argued that if a market was not provided with the opportunity to use more comprehensive and holistic BPASs, buildings which take into account broader than environmental criteria might not be awarded accordingly to reflect their sustainability performance in their assessment results.

The paper first explains the methodology of the study. It then presents the study objects, namely the selected case study building and both of the BPASs that are applied on the case study building. Based on this, it then presents, discusses and compares the assessment results between the two BPASs before concluding the paper.

**METHODOLOGY**

In order to achieve the aforementioned objective, this paper examines and compares a selected case study building’s assessment results between an environmental-focused or single-dimensional BPAS and a more-comprehensive-and-holistic or multiple-dimensional BPAS. Both types of BPASs were applied on the case study building by running an assessment of the project using archival data available at the end of the design stage, including tender/contract documents and drawings, and reports related to the building design. To a certain extent, inputs from four key project stakeholders were sought; hence, any difficulties in obtaining input data to complete the assessment could be identified. In addition, the MOBSA Framework could be further refined based on empirical data. These include the client’s project manager, architect, energy manager, and mechanical and electrical engineer.

Their inputs were for assessing the qualitative criteria such as those related to management, process, and communication were applied, e.g. maintenance management, skills and knowledge, participation and inter-disciplinary work. They were particularly requested to select the appropriate points that should be awarded for the criteria under their investigation, including any supporting documents or a brief explanation for the suggestions made. In doing so, any performance benchmarks that needs adjustment or suffer with unavailable of data could be identified. In addition, they also received a few quantitative criteria assessed and scored by the researcher for verifications and comments.

**THE STUDY OBJECTS**

**The Case Study Building**

The Energy Commission Diamond Building [14] which was completed and occupied in the middle of 2010 is located in Putrajaya, the federal administrative centre of Malaysia. It is claimed to be the first showcase sustainable and energy efficient building in Putrajaya [15], which is the main reason for the project to being selected for the study. At the early design stage, the Energy Commission had set a high goal for the project, inspiring the design to team to aim for the highest rating of the Singapore’s BCA Green Mark Version NRB/3.0, i.e. Green Mark Platinum [15]. The Diamond Building is an eight-storey office building with a total gross floor area of 14229 square metre, consisting of a one-storey podium of commercial, office, and gallery spaces; and a seven-storey office spaces as well as two storeys of basement parking (Figure 1-2). The design concept evolved from early design decisions to be slanted downwards and inwards derived from a contemporary interpretation of the distinctive diamond form.

The building has incorporated essential green features and strategies under the following five categories, namely: 1) sustainable site; 2) energy efficiency; 3) indoor environmental quality; 4) materials and resources; and 5) water efficiency. It is worth noting that the building has incorporated technologies that are considered the ‘first’ in Malaysia, i.e. shower heat recovery system; grey water recycling system; and advanced automatic control of blinds in atrium for daylighting. As the project is fairly new, it is acknowledged that this summary was derived from two main sources, namely: 1) the researcher’s personal visit to the building on the 28th of January 2010, guided by the key consultants of the project; and 2) archival data i.e. tender/contract documents, Green Mark assessment
reports, and drawings of the project provided by the client.

Figure 1: The Energy Commission Diamond Building: North & East facades.

Figure 2: Section of the building with an atrium in the middle

Building Performance Assessment Systems
The first BPAS used to assess the aforementioned case study building was the Malaysian Office Building Sustainable Assessment (MOBSA) Framework for the Design Phase which is a subset of the Comprehensive MOBSA Framework, developed to be applicable to all phases of assessment. MOBSA Framework was developed by the first author in a three-year research based on the argument that most of existing BPASs are single-dimensional in their framework structure; hence, inadequate in addressing the complex concept of sustainability as well as many of the non-environmental priorities of emerging/developing countries, particularly Malaysia.

Therefore, it was intended for the MOBSA Framework to reflect the context of emerging/developing countries particularly the Malaysian construction industry by not only evaluating stakeholders’ decisions in building and construction processes, but also promoting participation, and enhancing their knowledge and awareness in supporting sustainability throughout the life cycle of their project. It was developed using a mix-methods research approach, particularly using the exploratory sequential design i.e. a qualitative followed by a quantitative phase. The goal of the quantitative phase was to discover the most essential performance criteria, conducted in three stages: 1) wide-ranging literature review; 2) in-depth, semi-structured, open-ended interviews; and 3) focus groups discussion. Data collections in the second and third stage were conducted with experts from various backgrounds of the Malaysian construction industry. The performance criteria identified from the qualitative phase were then brought into the quantitative phase for the purpose of assigning their relative importance or weighting levels. This phase involved a cross-sectional questionnaire survey participated by more than 200 local office building stakeholders. The research then defined the appropriate performance benchmarks for each criterion by recalling qualitative findings obtained from the focus groups discussion and interviews conducted earlier and reviewing additional literature. The assessment framework developed at this stage was then brought into a validation process involving nine experts in the local construction industry. The validated framework was then embedded with a proposed scoring system in order to enable the application of the framework in real life. This was done by recalling the weighting levels based on the quantitative results and further adjusted according to expert opinions.

To be specific, the MOBSA Framework is structured hierarchically in three levels with the higher level logically derived from the lower ones: 3 sustainability Issues (i.e. Environment, Social and Economic), 17 Sub-issues and 86 criteria (a mixture of quantitative and qualitative types). 16% of the criteria assess aspects at the scale broader than the site level i.e. global and community/regional levels. This hierarchical structure can be seen in the next section when the assessment results are explained. Based on the research findings, all the 3 sustainability Issues were given almost equal weightings, meaning that in the study, the stakeholders value each of these issues as important as the others. For detail information on the MOBSA Framework, refer to Shari [16].

The second BPAS used was an environmental-focused Singapore’s Green Mark Version Non-Residential Building (NRB)/3.0 [17]. As mentioned earlier, Green Mark was actually used to rate the green performance of the selected case study building in reality, explaining its selection for the purpose of this study. Green Mark scheme was developed by the Building and Construction Authority (BCA) Singapore in 2005 by using U.S. LEED and Australia’s Green Star as the basis [18]. The assessment structure consists of two levels of hierarchy. The highest level is the five categories within which are a number of criteria where points are assigned. These five categories are: 1) energy efficiency; 2) water efficiency; 3) environmental
protection; 4) indoor environmental quality; and 5) other green features. By offering 100 as the maximum score of an assessment, a building will be awarded one of the following four ratings: Certified (50 to points), Gold (75 to 84 points), Gold\textsuperscript{Plus} (85 to 89 points), and Platinum (90 or more points).

ASSESSMENT RESULTS & DISCUSSION

Building Performance Scores

The summary of the assessment results of MOBSA Framework for the Design Phase and the proposed score calculation are shown in Table 1. It indicates that the case study building performs poorly on two Environmental Sub-Issues, namely: ‘Support Resource Management’ and ‘Land Use and Impacts of Ecology’, with less than 50\% points achieved. Most of the criteria within these sub-issues aim to limit natural resource consumption and to reduce the production of solid wastes. The poor performance of these criteria is unsurprising because the construction and demolition waste treatment and recovery have yet to be commonly practiced in the Malaysian construction industry, and disposing unseparated and usable wastes in landfills is a common on-going practice [19,20]. The reasons for these are: high cost; poor practice of sorting, salvaging and recycling of construction and demolition waste, explaining the lack of availability; constant demand for new materials among clients; and inexistence of green labelling system for building materials and components.

Table 1: Points achieved by the case study building and the proposed MOBSA Framework score calculation

<table>
<thead>
<tr>
<th>Sub-Issue</th>
<th>No. of Applicable Criteria</th>
<th>Points Achieved</th>
<th>Points Available</th>
<th>% of Points Achieved</th>
<th>Sub-Issue Weighting</th>
<th>Weighted Sub-Issue Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education &amp; Awareness</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>63%</td>
<td>0.197*</td>
<td>12.4</td>
</tr>
<tr>
<td>Support for Social Cohesion</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>100%</td>
<td>0.136*</td>
<td>13.6</td>
</tr>
<tr>
<td>Accessibility</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>73%</td>
<td>0.197*</td>
<td>14.3</td>
</tr>
<tr>
<td>Inclusiveness of Opportunities</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>57%</td>
<td>0.136*</td>
<td>7.8</td>
</tr>
<tr>
<td>Human Health &amp; Well-being</td>
<td>1</td>
<td>11</td>
<td>19</td>
<td>70%</td>
<td>0.197*</td>
<td>13.8</td>
</tr>
<tr>
<td>Cultural &amp; Heritage Aspects</td>
<td>0</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Local People &amp; Employment</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>83%</td>
<td>0.136*</td>
<td>11.3</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>50</td>
<td>68</td>
<td>74%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total weighted SOCIAL (S) score</th>
<th>Social weighting</th>
<th>Double-weighted S score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1.3</td>
<td>0.343</td>
<td>25.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total weighted ENVIRONMENTAL (EN) score</th>
<th>Environmental weighting</th>
<th>Double-weighted EN score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>67.7%</td>
<td>0.343</td>
<td>23.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total weighted ECONOMIC (EC) score</th>
<th>Economic weighting</th>
<th>Double-weighted EC score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>75.8%</td>
<td>0.314</td>
<td>23.8%</td>
</tr>
</tbody>
</table>

Total Building Sustainability Score: 72.1\% [Innovation Points Achieved: 2 (Max. 4)]

FINAL BUILDING SUSTAINABILITY SCORE: 74.1

Note:

*Weightings for Social Sub-Issues are adjusted according to the changes in Sub-Issues which remain active/applicable to the case study building. This is to ensure that the total weighting of all active/applicable Social Sub-Issues is 100\%.

Consequently, Environmental Issue obtained the least percentage of points achieved (71.6\%), as compared to Social with 74\% and Economic Issues 81.5\% which represents the highest percentage of points achieved (see Table 3). However, this ranking differs after individual issue is weighted. Table 3 shows that the double-weighted Environmental and Economic scores are comparatively similar (23.2\% and 23.8\% respectively), but these are smaller than the double-weighted Social score of 25.1\%. Despite the fact that Social score is the highest compared to Environmental and Economic scores, all issue scores seem to be comparatively
balanced. Overall, the total building sustainability score of the case study building is 74.1%.

Comparison with the Results of Green Mark Scheme

Given the building performance results above, it is considered valuable to compare them with those of Green Mark. Table 2 shows the summary of total number of social-, environmental-, and economic-related criteria addressed in either MOBSA Framework or Green Mark or both. This table also highlights the total number of criteria that are only addressed in MOBSA Framework of which relevant points are achieved, but are not addressed in the Green Mark scheme.

The result also shows that there are only 10 environmental-related criteria in the MOBSA Framework that are not addressed in Green Mark. However, the total number of environmental-related criteria addressed in the MOBSA Framework of which relevant points are achieved is comparable to those of Green Mark i.e. 23 and 20 respectively. This means that both MOBSA and Green Mark roughly cover the same scope of environmental-related criteria although their benchmarks are relatively different. By this, the environmental-related points achieved by the case study building in MOBSA could be deemed comparable to those of Green Mark.

What have been said so far suggest that a significant portion of the Green Mark performance criteria addressed; hence, the final score achieved by the case study building, is due to its environmental performance. This result is echoed by argument developed by Soebarto and Ness [21] that Green Mark is among the BPASs which focuses particularly on rating the greenness of the building itself. In addition, Table 2 also indicates that there are only ten Green Mark criteria of which relevant points are achieved by the case study building but they are not addressed/applicable/achieved in MOBSA Framework. This number is much lower if compared to 37 MOBSA criteria of which points are achieved but are not addressed in Green Mark; but more importantly, this suggests that if a building could achieve a high portion of MOBSA points, the building would as well achieve a significant portion of Green Star points, but not necessarily the other way around.

For example, the design of the case study building aimed for, and subsequently achieved, the Green Mark Platinum rating; hence, the final score achieved was at least 90 out of 100. Further, Green Mark contains most criteria at the building and site levels and seems not to address any impacts on the community/regional scale. However, the building scores lower i.e. 74.1 when assessed using the MOBSA Framework which also contains criteria at the community/regional scale and above, and all parameters i.e. Issues, Sub-Issues and Criteria, are weighted. It is possible for the overall score difference between MOBSA Framework and Green Star to be one or two levels of ratings. Overall, it could be argued that a building design could score high when assess based on the ‘greenness’ of the building alone but not necessarily so if assessed in a balanced and holistic manner based on the concept of sustainability i.e. inclusion and equitability of the three dimensions of sustainable development within the assessment framework.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No. of criteria</th>
<th>SO</th>
<th>ENV</th>
<th>EC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A- Addressed in MOBSA and relevant points are achieved; however, they are not addressed in Green Mark</td>
<td>18</td>
<td>10</td>
<td>9</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>B- Addressed in Green Mark and relevant points are achieved; however, they are not addressed/applicable/achieved in MOBSA</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>C- Addressed in, and relevant points are achieved from, both MOBSA &amp; Green Mark</td>
<td>4</td>
<td>13</td>
<td>0</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL number of criteria addressed in MOBSA and relevant points achieved (A+C) | 22 | 23 | 9 |

TOTAL number of criteria addressed in Green Mark and relevant points achieved (B+C) | 7 | 20 | 0 |

Note: SO = Social-related; ENV = Environmental-related; EC = Economic-related

It can be inferred from this table that most of the social-related criteria (18 out of 22, or 82%) of which relevant points are achieved by the case study building, are not addressed in the Green Mark scheme. Contrasting, there are only three social-related criteria in the Green Mark that are not addressed/applicable/achieved in the MOBSA Framework. By the same token, there are a total of 22 social-related criteria addressed in MOBSA as compared to only 7 in the Green Mark of which points are achieved by the case study building. In respect of economic-related criteria, all those addressed in the MOBSA framework are not considered in the Green Mark scheme. In fact, there are no economic-related criteria measured, or points offered, in the Green Mark to the case study building. Therefore, it could be argued that the final Green Mark score achieved by the case study building only partly, if at all, based on its social and economic performance.
CONCLUSION
This paper has presented and compared the application results of two BPASs with different scope on a case study building. These BPASs are: 1) environmental-focused Green Mark Version NRB/3.0; and 2) more comprehensive BPAS i.e. MOBSA framework. It was found that the scores of all three issues i.e. Environmental, Social and Economic seem to be comparatively balanced. Overall, the total building sustainability score of the case study building is 74.1% after being appropriately weighted. However, the overall assessment result based on Green Mark Version NRB/3.0 revealed that the building achieved a significantly higher overall score. Putting it differently, the case study building achieved a very high overall score in terms of its environmental design performance (using Green Mark) but scored lower when social- and economic-related criteria at the scale broader than the building itself were also taken into consideration and appropriately weighted (using MOBSA Framework). This finding has implications for BPASs development and implementation in emerging/developing countries, particularly Malaysia. It appears that a more comprehensive BPAS, embracing the whole concept of three dimensions of sustainability, is crucial to be introduced and implemented in Malaysia, in priority to, or alongside with, single-dimensional BPASs.

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