Biomimicry Principles in Green Building Index Malaysia

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Many countries have initiated consciousness of environmental approaches in the planning and development of the built environment due to concerns about climate change and global warming. These are in the forms of energy rating system indexes, such as, LEED, Breeam, GBI, etc. to create more sustainable buildings and developments that are less harmful to the natural environment. Although good and novel, this paper contends that these ratings are remedying and alleviating whatever negative impacts that development create on the natural environment. The rating systems are seemingly lacking attempts to integrate and enhance the physical development together with the natural environment. On the other hand, Biomimicry is a discipline that explores nature and attempts to understand its bio-integration to allow for the establishment of sustainable products, processes and systems. This paper postulates that with the integration of Biomimicry's Life Principles (BLP) into the Green Building Index (GBI) Malaysia, a higher level of sustainability upon the natural environment could be achieved. The study utilized the content analysis method to explore the presence and the extent of the presence of Biomimicry frameworks in the existing GBI. This paper concludes that although the presence of BLP in the GBI is high, the extent or level of the presence is low. The paper also recommends the areas of concern that could be improved within the GBI for a more effective and sensitive rating system to make the built environment more sustainable.

Keywords: Green Building Index, Biomimicry Life's Principles, presence, extent of presence

Introduction and Problem Statement

Of late, there is a need to explore nature and to attempt to understand its bio-integration with the design of products, processes and systems for the establishment of sustainable built environments (Reap, 2009). 'Biomimicry' is one

such discipline that is gaining importance as a widespread movement in the design for sustainable development (Benyus, 1997; Zari, 2007). According to Hanafi & Naguib (2013), Biomimicry provides numerous inspirational lessons, and it offers examples of how “designing with nature" can help in designing sustainable or green buildings. It is also becoming clear that natural or ecological principles are capable of providing many benefits to green building design. Buildings have increasingly become more efficient and sustainable when these principles are applied. However, limited evidence exists on addressing the extent of the application of ecological or natural principles in green building design.

It is against this background that this paper explores the application of the principles of biomimicry in green building design activities, especially in the green building rating systems used. Therefore, this research attempts to investigate the integration of Biomimicry Life’s Principles (BLP) in the Green Building Index (GBI) system used in Malaysia. This study analysed the presence and the extent of the presence of BLP in the existing GBI to visualize the possible gaps in the future development of the built environment.

Aim & Objectives

The primary aim of this paper is to explore the bio-integration of BLP within the GBI. Thus, the study was conceptualised based on three objectives: The first is to explore the meaning and concept of biomimicry in the development of the built environment. Second is to analyse the presence and the extent of that presence or usage of BLP in the GBI system. Finally, after understanding how much or how little biomimicry evidence is in the building ratings, the integration of biomimicry into the existing green building rating systems for better sustainability are recommended.

Literature Review

What is Biomimicry?

The term Biomimicry comes from the Greek words bios, which means life, and mimesis, which means to imitate (Baumeister, 2012). This concept emerged in 1982 and was made famous by Janine Benyus in her book ‘Biomimicry: Innovation Inspired by Nature’ in 1997. Benyus defined biomimicry as the “new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems”. Biomimicry is a scientific approach that studies nature's lessons and methods, which are applied to the processes and designs to solve human problems. It seeks sustainable solutions by imitating Nature’s patterns and strategies (Zanowick, 2011). According to Gamage & Hyde (2012), biomimicry

could be called “strong ecological design” because it advocates using the same materials and processes applied by nature closely. Reap (2009) applied three verbs to define Biomimicry: ‘study, imitate and solve’. Reap studies the living systems with the intent of imitating it to solve technical problems. Additionally, a final evaluation was required to ensure that the product or design commensurate with the natural principles.

Biomimicry has achieved some innovative and efficient technologies in materials and product and has resulted in numerous innovations in fields such as transportation, material science, and medicine. It is also gaining recognition in the design professions such as architecture (Gamage & Hyde, 2012). Designers and architects are becoming more interested and aware of how much nature can offer to improve the way the systems function. However, El Ahmar et. al., (2013) among others, contended that biomimicry is a growing area of research in the field of architecture and engineering. However, it is still unrealized, largely in architecture as demonstrated by the small number of built case studies (El-Zeiny, 2012; Klein, 2009; McGovern, 2009). The paper suggests that biomimicry should be considered as an approach to increase the sustainability of a building project. The mimicking of general ecosystem principles should be integrated into the design at the earliest stage and utilized as an evaluative tool all over the design process (Zari, 2015).

Biomimicry Design Lens

The ‘Biomimicry Design Lens’ is a guide that helps in understanding how biomimicry can be applied to any discipline or design scale. The Lens includes the Biomimicry Life’s Principles (BLP), and Biomimicry Thinking (Biomimicry 3.8, 2013). The Biomimicry Life’s Principles (BLP) represents “Nature’s strategy for sustainability” and they provide a lens to observe design strategies (Zanowick, 2011). According to Biomimicry 3.8 (2013), these principles also signify the main patterns found among the species living on Earth. The Design Lens or framework demonstrated six (6) main principles and twenty (20) sub-principles. The principles are all equally weighted, and they are (in no particular order): Adapt to Changing Conditions; Be Locally Attuned & Responsive; Use Life-Friendly Chemistry; Be Resource Efficient; Integrate Development with Growth and Evolve to Survive.

The BLP design lens was used as a guide in assessing the main aim in this paper is shown in Figure 1.

Figure 1: The Biomimicry Design Lens showing the main principles and sub-principles of BLP (Biomimicry 3.8, 2013)

Green Building and Green Building Rating Systems

The main motivation behind the green building movement is the sustainable development paradigm (Kibert, 2012). Green building is an outcome of applying sustainable construction approaches to providing a responsive built environment. According to Kibert (2012), the shift to the green building was pushed by three major forces: The first force, were the fast destruction of global ecosystems, changes in global biogeochemical cycles and massive rises in consumption and population. The second force was the rising in demand for natural resources and this issue caused a shortage and increasing the prices of products and materials. The third force was that green building movement coincided with similar alteration in other disciplines such as farming, manufacturing, medicine and others that have used several approaches to greening their activities.

The green building should be defined to understand green building movement. Then, a mean to evaluate these building should be provided to verify that a building follows the requirements of green building definition (Kibert, 2012). As a result, green building rating systems are developed to provide detailed criteria and grading systems to evaluate those buildings. In Malaysia, the Green Building Index (GBI) (Malaysia,

2009) is used, and the categories and the allocation points for various green aspects in the GBI define the green building in Malaysian marketplace.

GBI is made of six Parts including Energy Efficiency, Indoor Air Quality, Sustainable Site Planning and Management, Materials and Resources, Water Efficiency and Innovation. Under each of these Parts, there are in total fifty-one (51) evaluation criteria as to how the buildings are evaluated. (See GBI Design Reference Guide - Non-Residential New Construction (NRNC) V1.05.pdf)

This paper was incepted on the fact that most definitions of green buildings stated that ecology and ecological principles are the important factors for designing green buildings. However, some criticisms show that ecological or natural-based principles do not exist in a coherent manner in green buildings (Gamage et al., 2012; Kibert & Grosskopf, 2005). These critics reveal that most of the green buildings are based on performance-driven agendas or benchmarks rating systems and environmental policies (Gamage & Hyde, 2012). Another critic suggests that most green building designs operate as a collection of eco-technologies such as photovoltaic panels and eco materials (Yeang, 2006). This issue illustrated a lack of knowledge in understanding the significance of holistic integration (Gamage & Hyde, 2012). Kibert (2012) postulates that the progress of high-performance green building requires the ability of the design team to understand and apply ecology and its principles. In other words, the building should have “a synergistic relationship” with the natural environment surrounding it (Kibert, 2012). It is on this premise that the paper investigated how far the green building rating systems integrates the ecological principles.

Methodology

The methodology of this study is explorative in nature and the tool used is the content analysis (Elo & Kynga, 2007). The GBI document was explored in terms of the presence and extent of the presence of the BLP within the document through the validated Biomimicry Design Lens. The processes undertaken are summarized in the following stages:

Stages of Conducting the Content Analysis

Stage 1 is the Preparation stage where both documents (GBI & BLP) were analysed and the coding specified and assigned. The researcher decided to code for not only words or phrases but for themes and concepts as well, which were relevant or related to the predefined set of categories. Stage 2 is the Organization stage where the validated software Atlas.ti (Gibbs, 2007) was actively used in the coding process.

Atlas.ti is the software for qualitative data analysis. This software is helpful in working through the texts, underlying, writing comments and applying codes to a highlighted or selected text. The GBI, in pdf. file, was firstly uploaded into the software. Then, the list of codes of the BLP was generated. After which, the text from the GBI that is related to the code was then highlighted and the appropriate codes were dragged and dropped onto the highlighted text. This process is repeated until both GBI texts and BLP codes were exhausted. In the end the Atlas.ti generated a categorization table, as shown on the right side of Figure 2. (More information can be found in: http://atlasti.com/video-tutorials/)

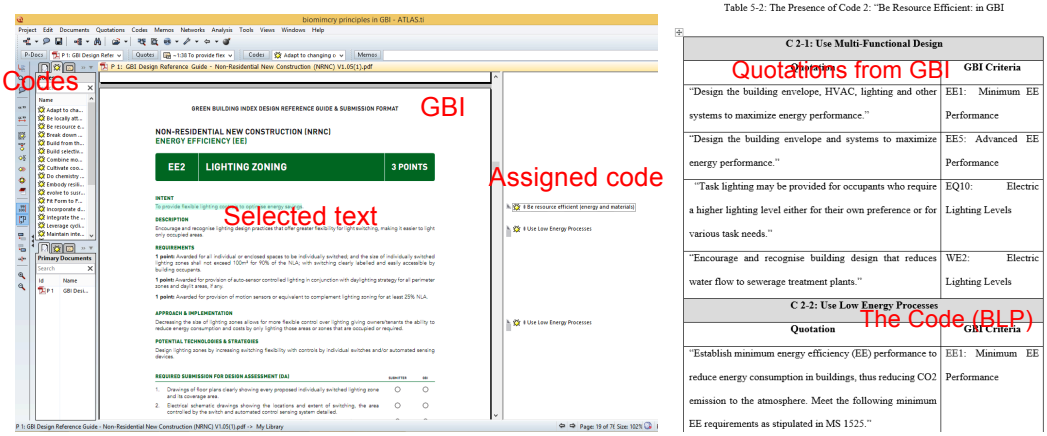

Table 5-2: The Presence of Code 2: "Be Resource Efficient: in GBI

C 2-1: Use Multi-Functional Design	
Quotation	GBI Criteria
"Design the building envelope, HVAC, lighting and other systems to maximize energy performance."	EE1: Minimum EE Performance
"Design the building envelope and systems to maximize energy performance."	EE5: Advanced EE Performance
"Task lighting may be provided for occupants who require a higher lighting level either for their own preference or for various task needs."	EQ10: Electric Lighting Levels
"Encourage and recognise building design that reduces water flow to sewerage treatment plants."	WE2: Electric Lighting Levels
C 2-2: Use Low Energy Processes	
Quotation	**GBI Criteria**
"Establish minimum energy efficiency (EE) performance to reduce energy consumption in buildings, thus reducing CO2 emission to the atmosphere. Meet the following minimum EE requirements as stipulated in MS 1525."	EE1: Minimum EE Performance

Figure 2: Left: Atlas.ti user interface. Right: The categorization table

The aim is to search for the existence of assigned words and concepts according to the codes specified in the GBI document. The codes were then organized into categories, using the Biomimicry Lens as a guide. The outcome of this is shown in Stage 3, the Reporting stage. This stage reports the results found from Stage 2 and were presented in tables and charts for clarity of reporting.

Analysis

The analyses of the presence of the BLP in GBI were conducted in three levels. The Biomimicry Design Lens was used at each level of the analyses. The first level analysed the presence of BLP in the GBI as a whole while at the second level each Part (6 Parts altogether) of the GBI was assessed. At the final level, the lens went deeper to assess all 51 criteria of the 6 Parts of the GBI. The same scrutiny was conducted for the extent of the presence as well. The results are reported in the next two sections. It is important to note that the scope of this study is concerned with the presence of the BLP and not on the application of it to physical developments.

Results

i. The Presence of BLP in GBI

When looking at the GBI as a whole, the level of presence of the BLP is a promising 65%. This means that much of the contents of the GBI include the themes and concepts as coded and categorized from the BLP. The total number of presences equate to the number of sub-principles found in the whole GBI document. Further analysis showed that 13 BLP sub-principles out of a total of 20 were present but in the different Parts of the GBI. Figure 3 illustrates the summary of the results of the three levels of analyses on the presence of the BLP in the GBI.

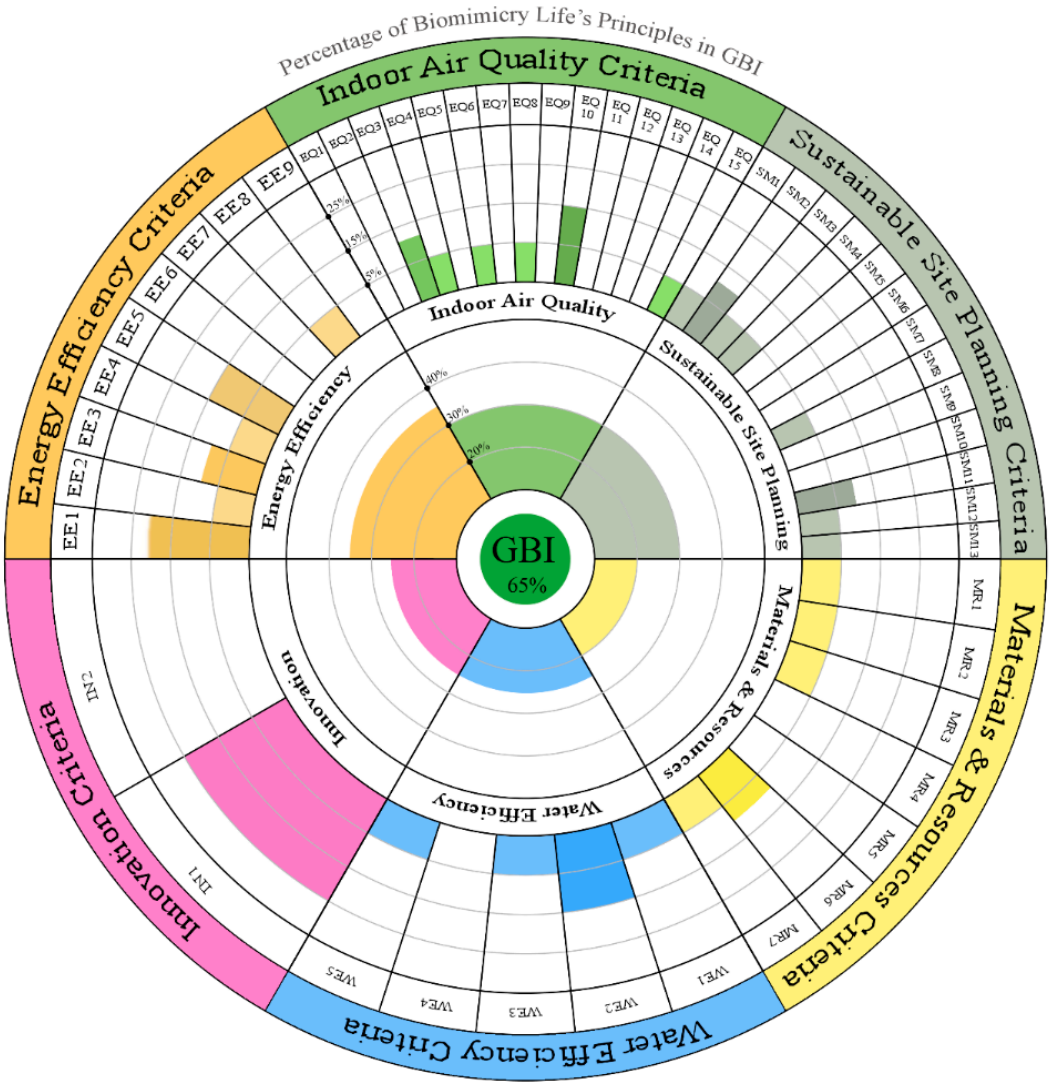

Figure 3: Summary of the Presence of Biomimicry Life Principles in GBI

Figure 3 demonstrates that all 6 Parts of the GBI are highlighted with the different levels of BLP presences. The innermost circle (Level 1) shows the total presence of BLP in GBI, which is 65%. The next circle (Level 2) indicates the magnitude of the percentages of the presence of the BLP in each part of the GBI. The outer circle

(Level 3) displays the breakdown percentage of the presence of the BLP in each criterion of the Parts of the GBI.

Starting from the outer ring, the results indicated the existences of BLP within each criterion of the GBI. All Parts of the GBI are represented, but not all criteria have the presence of the BLP. For example, in the Innovation (IN) Part (in pink), which consisted of only two criteria (IN1 & IN2), BLP is only found in one criterion. However, the level of the fulfilment of BLP is the highest (25%) amongst all criteria. Another example is in the Indoor Air Quality (IAQ) Part (in green), where nine criteria out of fifteen do not have any BLP presence in them.

Going deeper to the inner ring, the result illustrates the magnitude of the presence of BLP in each GBI Part on the whole. Energy Efficiency (EE) (in orange) Part obtained the highest presence of BLP with 35%. On the other hand, Materials and Resources (M&R) Part (in yellow) has seven criteria but the lowest number of BLP with only 20% presence. The Innovation (IN) Part in GBI, which promotes the innovative strategies through building design, is the smallest with only two criteria. However, it is well represented in one criterion, IN1, with 25% presence of BLP.

ii. The Extent of the Presence of BLP in Parts of GBI

The definition of the extent of presence here means the level of frequency of the presences of the BLP in the GBI. This frequency was obtained through a categorization matrix where the presence of the BLP sub-principles was ticked against the criteria in the GBI when found. These occurrences may appear several times in some criteria/sub-principle matrix, while in some other matrix it may not appear at all. Although many of the BLP existed in GBI as a whole (13 out of 20), the extent (or level of frequency) of the presence is low, shown in Figure 4.

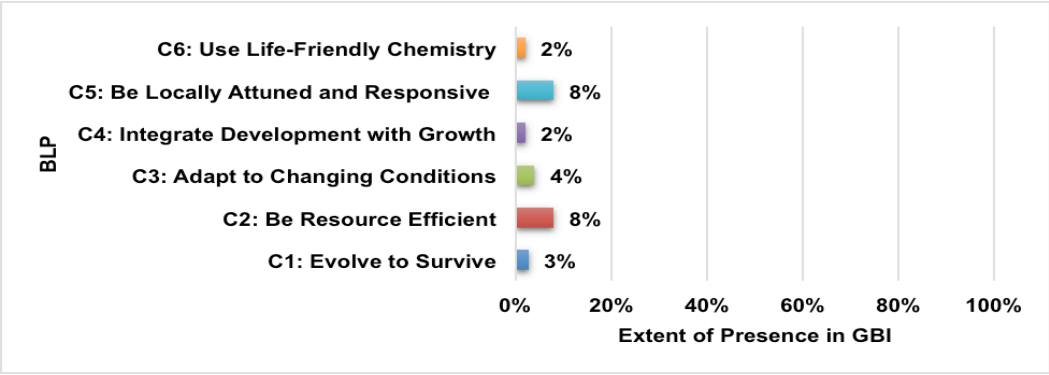

Figure 4: The extent of Presence of BLP in GBI

The results show the percentage of the extent of the presence of each main principle of BLP in the GBI. Overall, although the presence of the BLP is high (65%) in

the GBI, the extent of the presences is, however, quite low. The highest numbers of the frequency of presence (8%) in GBI are evident in two principles. They are “Be Locally Attuned and Responsive” and “Be Resource Efficient (Materials and Energy)”. The lowest extent of presence is by the “Use Life–Friendly Chemistry” and “Integrate Development with Growth” principle, where the extent is only 2% in the GBI criteria. This would infer that more efforts are required to increase the use of strategies employed and will enhance these principles in the GBI. On average, the total of the extent of the presence of BLP was calculated as 4.7% only in the whole GBI. This finding indicated poor bio-integration of ecological principles into the existing green building rating tool.

Conclusion

Green building design and biomimicry are two different evolving approaches to sustainability in the built environment. Green building design aims to achieve the sustainable development goals and principles. On the other hand, Biomimicry seeks to study nature’s models to solve all problems that humans face nowadays. In other words, biomimicry is based on the natural model while the green building is based on the man-made model. As demonstrated, nature is considered as a perfect paradigm of sustainability and, therefore, using the Biomimicry life’s principles in green building design could be very beneficial. The synergy between biomimicry and green building design can help in improving and further develop the green building rating tools that are widely used by building’s professionals to help them define and produce a sustainable building.

This research uses the Biomimicry Life’s Principles (BLP) framework or lens to analyse the GBI Malaysia rating tool. The whole GBI document was analysed in terms of the existence of Biomimicry principles in it. This study helped in highlighting the natural principles that exist in GBI and also indicating those that do not exist. Once the missing attributes were found, efforts can be made to enhance the content of the GBI document to achieve a higher level of sustainability. The study explicated the extent of the presence of BLP in GBI, which, in general, is a low. The findings inferred a need for more integration of the next generation of the GBI rating tool.

The future study would be to find out how the missing principles may be included in the existing GBI and how the other existing principles may be enhanced. An improved framework can be developed in which all the criteria are designed based on the natural principles where all criteria are working together to help professionals in producing the building that “create conditions conducive to life”.

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