IMPACT OF GREEN BUILDING RATING SYSTEMS ON THE SUSTAINABILITY AND EFFICACY OF GREEN BUILDINGS

Case analysis of Green Building Index, Malaysia

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Abstract

Buildings are the dominant energy consumers in today's cities, accounting for 30 to 40 percent of total energy consumption, and 70 percent of total electricity consumption. The building sector therefore presents immense opportunities for reduction in energy consumption by through the adoption of energy efficient practices.

Green building construction can be largely driven by green building rating systems. The Green Building Index (GBI) is a first-generation rating tool for energy efficient buildings in Malaysia. Whether GBI is an efficient framework that can lead Malaysia towards its goal of creating more green buildings and ensuring a greener future for its buildings can be understood by analyzing the response of the building industry towards it. To assess its impact, the criteria laid out in the rating system were sorted into short-term and long-term impact criteria, depending on whether a given criterion helps keep a building green for its expected lifetime. In other words, the criteria that affect the energy and resource efficiency in buildings for a shorter duration have been listed as short-term impact criteria, and those that would continuously affect it for the expected lifetime of the building have been listed as long-term impact criteria.

The rated buildings tend to fulfilling the short-term criteria more than the long term. Some of the most effective criteria for energy efficiency have not been achieved by many rated buildings—and yet, these buildings still are called GBI-rated "green buildings." Data also shows that despite GBI, tropical climatic architectural features have not been made a mandatory part of energy-efficient building design. The current trend shown in the data from GBI shows a compromise in the sustainability of the green character of its rated buildings.

Some of the changes suggested in this paper—changes that are within the framework of GBI—can help bring substantial benefits, and create greener buildings with higher efficiency in Malaysia. In such cases, GBI can become a guiding tool for buildings in Malaysia to sustain their energy efficiency throughout their life span.

Introduction

In this era of intermittent energy crises and anticipated growth in demand for energy in the future, it is critically important to take steps to reduce the use of conventional energy. Around 40 percent of the global energy use demand comes from the construction and operation of buildings (Environmental Leader, 2009). Given that building construction is an essential part of development, energy efficiency in buildings—especially in the developing world—is an important area for policy.

Green buildings, also known as sustainable buildings, are structures that are environmentally responsible and resource-efficient throughout their life cycle. An efficiently designed green building can produce energy savings of between 30 percent and 60 percent of the energy that is consumed by a conventional building—i.e., one that does not apply and follow green building parameters during its design, construction, and operation phases (www.worldgbc.org). Because Malaysia is a progressive country, with the ambitious target of joining the ranks of the developed countries by the year 2020, it has made sustainable development one of its primary objectives. To realize this goal, the Malaysian government has undertaken numerous initiatives in various sectors to encourage energy efficient practices across the country. In order to incentivize energy-efficient construction and promote sustainable development, it has developed a suite of related policies, including the Development of Malaysian standard MS:1525 (2001), Energy Audit on Government Buildings (2002), Energy Efficient Building demonstration Projects (2004), Green Building Index (2009), and the Energy Audit and Retrofit in selected government buildings (2014) (Umar 2011).

Malaysia has also established organizations like the Malaysia Green Building Confederation and Green Building Association to promote green construction in the country, and has also introduced green financing schemes to support the efforts of such organizations. This paper focuses on the Green Building Index (GBI), a rating system created by the Malaysian building industry to rate and certify the construction of green buildings in Malaysia. Specifically, we ask:

Has the introduction of GBI been sufficient to promote energy efficient building design and construction practices in Malaysia? How do architects, designers, and builders respond to GBI? Does GBI ensure mandatory use of energy efficient building design, material, and construction technology? Does the present framework of GBI provide a sustainable approach for achieving energy efficiency in buildings?

Green building evaluation is an important tool to encourage sustainable development in the building sector. Many green building evaluation systems have been developed around the world. Sustainable building evaluation systems have led to the emergence of a new environmental building design paradigm (Mateus and Bragança, 2011). Green building rating systems are transforming the construction industry by focusing on high-performance, energy-efficient, economical and environmentally friendly buildings (Gowri 2004). With globalization, there is a trend to standardize these rating systems and to make them interchangeable for the wider green building market.

Research is needed to identify potential barriers and possible solutions to support this green building revolution (Zhonghua Gau 2014). Rating systems provide an effective framework for assessing building environmental performance and integrating sustainable development into building and construction processes. They can be used as a design tool by setting sustainable design priorities and goals, developing appropriate sustainable design strategies; and determining performance measures to guide the sustainable design and decision-making processes. They can also be used as a management tool to organize and structure environmental concerns during the design, construction, and operational phases. For all of these reasons and more, understanding the green building rating systems is of great importance for urban planning and design (Retzlaff, 2008).

At the same time, the full potential of these rating systems rarely realized, due to a number of practical limitations (Ding, 2008). For example: rating systems can be overwhelmed by a prevailing environmental perspective, by technological concerns, and by an emphasis on meeting certificatory needs rather than exploring and experimenting in search of better solutions (Cole, 2005; Ding, 2008; Marsh et al., 2010). In the worst scenario, the green building certification is simply a box to be checked on a list and, possibly, a marketing asset, rather than a force in saving energy and protecting the environment (Straube 2006) (Emilia Conte 2012).

Background

Buildings and energy consumption

New infrastructure is indispensable to the growth and development of our society. In all developing countries, construction, real estate, and infrastructure development are the “sunrise sectors.” Buildings are the dominant energy consumers in the world. According to a report by World Green Building Council, buildings, globally account for between 30 and 40 percent of total energy consumption, and 70 percent of total electricity consumption (www.worldgbc.org).

Buildings use energy for lighting, space heating or cooling depending on climatic conditions of the place, active ventilation, air-conditioning of spaces, cooking, water heating and the use of other electronic and electrical appliances. An efficiently designed building can largely cut down the operational energy use in its lifetime as compared to a conventional building, which is not designed, keeping energy efficiency and conventional renewable energy use optimization in mind.

It is very important to adopt at least a 30- to 50-year timeframe before constructing a green building and expecting consistent performance in terms of efficient energy use, comfort, and sustainable resource management. If we fail to take the long view, we are likely to fall short of the goals we set for our greener future.

Green buildings

A green building may be defined as *a building whose construction and lifetime of operation assure the healthiest possible environment, while making the most efficient and the least disruptive use of land, water, energy and resources.*

Some of the major features that define a green building include a climate-responsive architectural design; passive design features and techniques for space heating, cooling, ventilation, and daylighting; the use of renewable sources of energy; efficient and environmentally friendly practices during construction; and, post occupancy, the use of vernacular materials and a focus on occupant health, safety, and comfort.

Around the world, the building construction industry today faces two major challenges. The first is the consumption of energy produced by conventional sources, which is increasingly expensive. The second is the kind of environmental damage that can occur as a result of building construction and operation—for example, air, water, and soil pollution; carbon emissions and other greenhouse-gas emissions; and damage to surrounding flora and other natural habitats.

There is increasing recognition, however, that green design can help builders respond to both of these challenges. It not only can make a positive impact on public health and the environment, it also can reduce operating costs, enhance building and organizational marketability, increase occupant productivity, and help create a sustainable community (Fowler and Rauch, 2006).

Green building rating systems

Green buildings can contribute substantially to reducing current and future energy demands. To achieve that important goal, regulations must be in place to promote, encourage, and enforce the construction of every building as a green building.

Green building rating systems play a very important role in supporting this transition. There are various green building rating systems that have been developed and are being followed in different parts of the world. For example, Leadership in Energy and Environment Design (LEED) in United States, BRE Environmental Assessment Method (BREEAM) in Europe, Comprehensive Assessment System for Built Environmental Efficiency (CASBEE) in Japan, Green Mark in Singapore, and Green Star and Green Rating for Integrated Habitat Assessment (GRIHA) in India.

Green building rating systems usually include global environmental impacts to indoor impacts (Burnett, 2007). The major categories that are included in most green building rating systems are: sustainable site, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality, and innovation in design. Most rating systems assess buildings on a 100 or more point system, with the number of points being different for different rating systems. The buildings are awarded points for the various criteria that they successfully meet under each category; collectively, the number of points determines the rating that the buildings receive under the framework of that particular system.

Rating systems have gained acceptance in part because they attempt to embody the concept of “total quality” (Berardi. U, 2012) with respect to sustainability. Nevertheless, there are various outstanding issues that need to be resolved, one of which is that the allocation of marks is essentially a qualitative approach that can lead to a lack of objectivity (S.R. Chandratilake 2013).

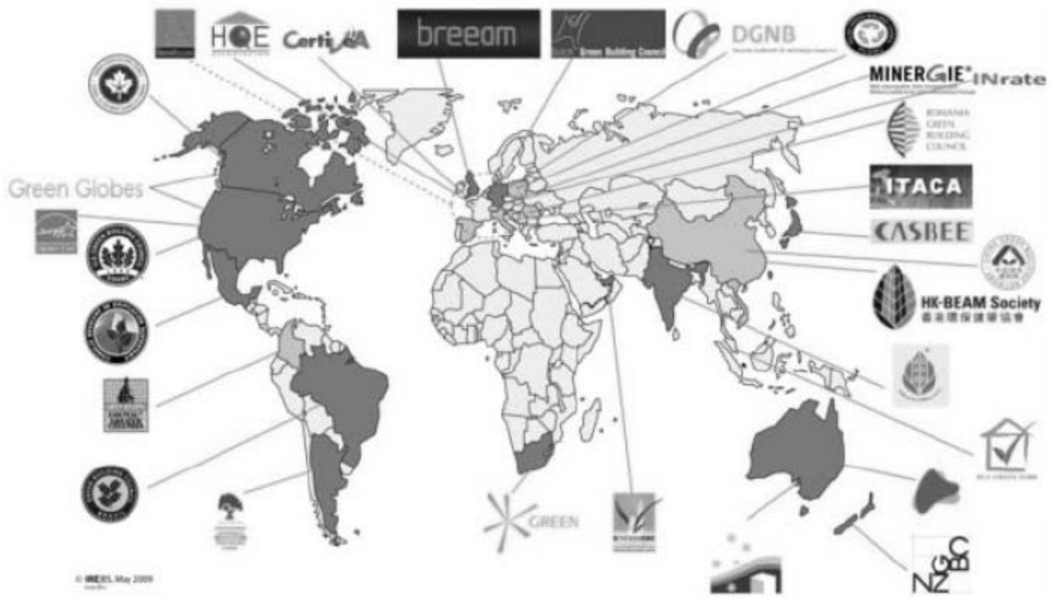


Figure 1. Various green building rating systems used around the world (Richard Reed 2009)

Green Building Index, Malaysia

The Green Building Index (GBI) is a green building rating system developed by Pertubuhan Arkitek Malaysia/Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM). GBI was launched in 2009, and over the past five years, has successfully rated buildings totaling some 100 million square feet.[i] GBI and the Malaysian Green Building Council have successfully increased awareness about the importance of green buildings among all the major stakeholders, including building owners, architects, engineers, and building developers.

GBI is a comprehensive rating system for evaluating the environment design and performance of buildings based on the following six main criteria[ii]:

- energy efficiency (EE)
- indoor environmental quality (EQ)
- sustainable site planning & management (SM)
- material and resources (MR)
- water efficiency (WE)
- innovation (IN)

GBI considers buildings in the following seven categories, each of which may have distinctive sub-criteria under the six main criteria listed just above:

- residential new construction (RNC)
- non-residential new construction (NRNC)[iii]
- non-residential existing building (NREB)
- township
- industrial new construction (INC)
- industrial existing building (IEB)
- interiors (ID)

GBI certifies buildings under each of these classifications, according the number of points achieved by the buildings on a 100-point scale, as shown in Table 1:

POINTS	GBI RATING
86+ points	Platinum
76 to 85 points	Gold
66 to 85 points	Silver
50 to 65 points	Certified

Table 1. GBI rating classification[IV]

Scope of research

GBI has rated around 300 buildings since 2009. Our study focused on the Non-Residential New Construction category (hereafter "NRNC"). The study sample includes 112 buildings, which are all the GBI rated buildings in the NRNC category from 2009-2013. Table 2 shows the list of the criteria and sub-criteria for the NRNC category:

PART	CRITERIA	ITEM	POINTS	TOTAL
1	EE	ENERGY EFFICIENCY		35
	EE1	Minimum EE Performance	1	
	EE2	Lighting Zoning	3	
	EE3	Electrical Sub-metering	1	
	EE4	Renewable Energy	5	
	EE5	Advanced EE Performance—BEI	15	
	EE6	Enhanced Commissioning	3	
	EE7	Post-Occupancy Commissioning	2	
	EE8	EE Verification	2	
	EE9	Sustainable Maintenance	3	
2	EQ	INDOOR ENVIRONMENTAL QUALITY		21

	EQ1	Minimum IAQ Performance	1	
	EQ2	Environmental Tobacco Smoke (ETS) Control	1	
	EQ3	Carbon Dioxide Monitoring and Control	1	
	EQ4	Indoor Air Pollutants	2	
	EQ5	Mould Prevention	1	
	EQ6	Thermal Comfort: Design & Controllability of Systems	2	
	EQ7	Air Change Effectiveness	1	
	EQ8	Daylighting	2	
	EQ9	Daylight Glare Control	1	
	EQ10	Electric Lighting Levels	1	
	EQ11	High Frequency Ballasts	1	
	EQ12	External Views	2	
	EQ13	Internal Noise Levels	1	
	EQ14	IAQ Before & During Occupancy	2	
	EQ15	Post Occupancy Comfort Survey: Verification	2	
3	SM	SUSTAINABLE SITE PLANNING AND MANAGEMENT		16
	SM1	Site Selection	1	
	SM2	Brownfield Redevelopment	1	
	SM3	Development Density & Community Connectivity	2	
	SM4	Environment Management	2	
	SM5	Earthworks—Construction Activity Pollution Control	1	
	SM6	QLASSIC	1	
	SM7	Workers' Site Amenities	1	
	SM8	Public Transportation Access	1	
	SM9	Green Vehicle Priority	1	
	SM10	Parking Capacity	1	
	SM11	Stormwater Design—Quantity & Quality Control 1	1	
	SM12	Greenery & Roof	2	
	SM13	Building User Manual	1	
4	MR	MATERIALS AND RESOURCES		11
	MR1	Materials reuse and selection	2	
	MR2	Recycled content materials	2	
	MR3	Regional Materials	1	

	MR4	Sustainable Timber	1	
	MR5	Storage & Collection of recyclables	1	
	MR6	Construction waste management	2	
	MR7	Refrigerants & Clean Agents	2	
5	WE	WATER EFFICIENCY		10
	WE1	Rainwater Harvesting	2	
	WE2	Water Recycling	2	
	WE3	Water Efficient-Irrigation/Landscaping	2	
	WE4	Water-Efficient Fittings	2	
	WE5	Metering & Leak Detection System	2	
6	IN	INNOVATION		7
	IN1	Innovation in Design & Environmental Design Initiatives	6	
	IN2	Green Building Index Accredited Facilitator	1	

Table 2. List of criteria for NRNC category under GBI[v]

Methodology

As noted, this study focuses on the NRNC code of the Green Building Index. The 100-point rating system was studied to understand the qualities and characteristics of rated buildings in this category. We accomplished this by identifying two groups of criteria:

- those that affect the energy and resource efficiency in a building for the expected lifetime of the building (long-term impact criteria), and
- those that affect the building for a shorter duration (short-term impact criteria)

See Table 3, which present both groups of criteria in separate lists.

We further analyzed the criteria fulfilled by GBI-rated buildings light the primary criteria achieved by the buildings, and helps identify (1) the key areas within the rating system, and (2) areas that appear to need improvement.

Long-term Impact criteria are mostly part of the physical structure and design of the building itself—for example, thermal comfort design, daylighting, air-change effectiveness, standard of construction (QLASSIC), and material used. These are characteristics that are integrated into the initial building design and specifications, and therefore tend to remain permanently with the building. Their energy and environmental benefits can be gained year after year.

Short-term Impact criteria, by contrast, are not integral to the building for the most part, and as a result are unlikely to ensure effective energy efficiency and environmental gain on the part of the building in the future. This is an important distinction. These criteria are certainly significant from the environmental protection and building maintenance point of view. Our point, however, is that they do not address the building's larger energy-efficiency goals. For example, workers' site amenities and construction waste management are very important during the construction phase, but do not help the building stay "green" during the operational phase of the building's life. Buildings today have an average age of 30 to 50 years. Hence, we argue that the features that remain intact for the whole life of the building are effectively the ones that will determine if the building remains green and energy efficient throughout its functional life—and only through the impact of these long-term characteristics will the "green" status of the building remain valid.

We concluded that out of total 100 points in the rating system, 57 points are available for long-term impact criteria, and 43 points are available for short-term impact criteria. We then studied how many long-term vs. short-term impact criteria were achieved by the rated buildings in the sample set. We also identified the criteria that were most often and least often achieved by the buildings. This was intended to help us determine if any long-term impact criteria were being consistently neglected by the applicants, or if there were any easy-to-achieve short-term impact criteria that might be being fulfilled simply for the purpose of receiving certification. Again, this struck us as an important focus: in either of these circumstances, the optimal energy efficiency of the building in the long run was very likely to be compromised, and yet, these buildings were still being called "green." And finally, based on the criteria that were achieved by the buildings in the sample set, we looked at the "Green" buildings currently on the drawing boards, with an eye toward assessing whether those buildings would remain energy- and resource-efficient for the next 30 to 50 years.

LONG TERM IMPACT CRITERIA POINTS		**SHORT TERM IMPACT CRITERIA POINTS**	
EE1	Minimum EE (energy efficiency) Performance	EE6	Enhanced Commissioning
EE2	Lighting Zoning	EE7	Post Occupancy Commissioning
EE3	Electrical Sub-metering	EE8	EE (energy efficiency) Verification

EE4	Renewable Energy	EE9	Sustainable Maintenance
EE5	Advanced EE Performance – BEI (building energy index)	EQ2	Environmental Tobacco Smoke (ETS) Control
EQ1	Minimum IAQ Performance	EQ4	Indoor Air Pollutants
EQ3	Carbon Dioxide Monitoring and Control	EQ5	Mould Prevention
EQ6	Thermal Comfort: Design & Controllability of Systems	EQ10	Electric Lighting Levels
EQ7	Air Change Effectiveness	EQ11	High Frequency Ballasts
EQ8	Daylighting	EQ12	External Views
EQ9	Daylight Glare Control	EQ14	IAQ Before & During Occupancy
EQ13	Internal Noise Levels	EQ15	Post Occupancy Comfort Survey: Verification
SM4	Environment Management	SM1	Site Selection
SM5	Earthworks - Construction Activity Pollution Control	SM2	Brownfield Redevelopment
SM6	QLASSIC (standard of construction)	SM3	Development Density & Community Connectivity
SM8	Public Transportation Access	SM7	Workers' Site Amenities
SM9	Green Vehicle Priority	SM10	Parking Capacity
SM11	Stormwater Design – Quantity & Quality Control 1	SM13	Building User Manual
SM12	Greenery & Roof	MR4	Sustainable Timber
MR1	Materials reuse and selection	MR5	Storage & Collection of recyclables
MR2	Recycled content materials	MR6	Construction waste management
MR3	Regional Materials	MR7	Refrigerants & Clean Agents
WE1	Rainwater Harvesting	WE4	Water Efficient Fittings
WE2	Water Recycling	WE5	Metering & Leak Detection System
WE3	Water Efficient - Irrigation/Landscaping	IN2	Green Building Index Accredited Facilitator
IN1	Innovation in Design & Environmental Design Initiatives		

Table 3. Distinguishing between long- and short-term impact criteria

Findings

Out of the 112 buildings in our sample set (again, GBI-rated NRNC category buildings), 6 percent (6 out of total 112) received a Platinum rating, 32 percent (36 out of 112) received a Gold rating, 15 percent (18 out of 112) received a Silver rating, and 47 percent (52 out of 112) received a Certified rating.

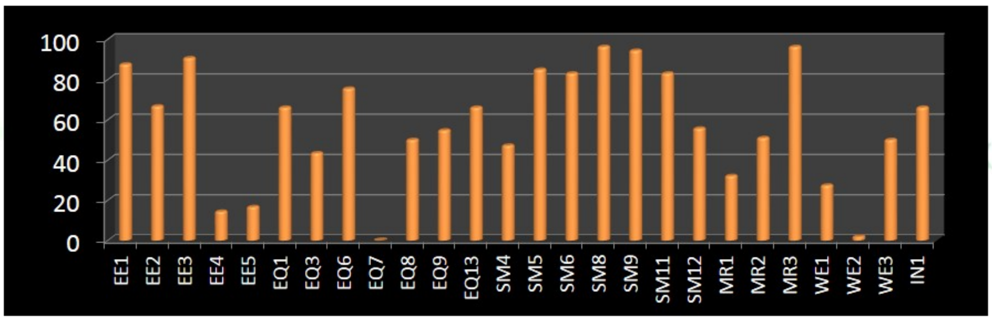
From these numbers, we see that the majority of the new buildings being built in Malaysia "earn" the lowest level of certification under GBI. Since most of the buildings receive this relatively low rating, it is important to understand the specifics of this category. A Certified rating requires the building to achieve only 50 points—and since we have identified 43 out of the 100 points as derived from short-term criteria, we can see that buildings that receive a Certified rating can earn 86 percent of their points from among those short-term impact criteria. This can largely affect the sustainability of the building's performance as an energy-efficient, green building during its expected lifetime.

Sample Building No.	Total Points Achieved	Long Term Impact Criteria points	Sample Building No.	Total Points Achieved	Long Term Impact Criteria points	Sample Building No.	Total Points Achieved	Long Term Impact Criteria points
1	50	23	18	53	18	35	53	30
2	54	28	19	51	23	36	51	22
3	50	21	20	52	27	37	53	25
4	63	29	21	57	26	38	50	19
5	62	36	22	54	26	39	57	29
6	50	23	23	51	21	40	51	23
7	57	25	24	50	22	41	51	29
8	57	27	25	59	34	42	60	29
9	58	28	26	56	24	43	55	26
10	62	36	27	51	24	44	55	26
11	57	32	28	58	31	45	53	25
12	56	24	29	53	29	46	60	29
13	60	29	30	56	29	47	52	25
14	51	21	31	54	26	48	52	22
15	56	24	32	54	23	49	53	28
16	56	24	33	55	22	50	55	29
17	51	17	34	55	27	51	55	24

Table 4. Number of points achieved by certified buildings (50−65 points) from the long-term impact criteria

Table 4 shows the number of points that the certified category green rated NRNC buildings acquire under the long-term impact criteria. Again, the buildings earn less than 50 percent of their points from the long-term impact criteria. This suggests that most (nearly 50 percent) of the buildings rated "green" will not be very different from a non-rated building during their life spans. In other words, the buildings may be called "green," but they will not have the hoped-for positive impact on energy use optimization in Malaysian cities.

PERCENTAGE OF CERTIFIED BUILDINGS ACQUIRING LONG TERM IMPACT CRITERIA POINTS



PERCENTAGE OF CERTIFIED BUILDINGS ACQUIRING SHORT TERM IMPACT CRITERIA POINTS

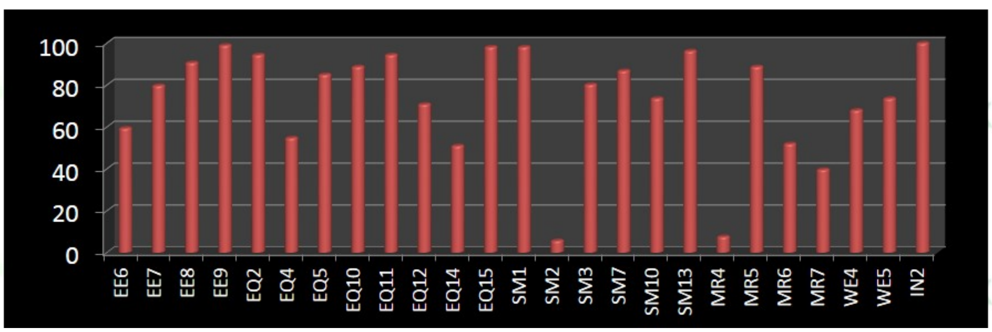


Figure 2. Percentage of certified buildings acquiring points under each criteria (x-axis = criteria code; y-axis = percentage of certified buildings)

Figure 2 shows the percentage of certified buildings (acquiring 50-65 points) in the sample set that acquire points for each of the criteria listed in the NRNC code. The top graph shows the percentage of certified buildings meeting long-term impact criteria, and the bottom graph shows those meeting short-term impact criteria. Again, it is clear from the low density of the long-term impact criteria graph that the certified buildings tend to meet relatively fewer of the long-term impact criteria en route to their green rating.

Figure 3 identifies the criteria which are the most difficult and easiest to achieve by GBI rated buildings. Fewer than 20 percent of the rated buildings achieved the major criteria in the long-term impact category. These criteria have a higher weighting, and directly affect the comfort levels and the thermal and energy performance of the buildings influenced by the building design, envelope, and other physical attributes of the buildings (Fig.3). Therefore, the chances of achieving better performance in a building by renovation or retrofits become very few. It is interesting to see that these account for almost 25 points in the 100 point system. This shows that more than 80 percent of the buildings fail to earn half of the long-term impact criteria points.

The points achieved by more than 80 percent of the rated buildings have a substantial share of the short-term impact criteria. This again points towards the fact that it is easier for the buildings to acquire points which benefit energy consumption and environment protection for a very short period, and—as an indirect result—the energy-efficient character of the building cannot be sustained for long.

POINTS WITH HIGH ACHIEVABILITY
(achieved by more than 80% buildings)

IN2	Green Building Index Accredited Facilitator
EE9	Sustainable Maintenance
EQ15	Post Occupancy Comfort Survey: Verification
SM1	Site Selection
SM8	Public Transportation Access
MR3	Regional Materials
SM13	Building User Manual
SM9	Green Vehicle Priority
EQ2	Environmental Tobacco Smoke (ETS) Control
EQ11	High Frequency Ballasts
EE3	Electrical Sub-metering
EE8	EE Verification
EQ10	Electric Lighting Levels
MR5	Storage & Collection of recyclables
EE1	Minimum EE Performance
SM7	Workers' Site Amenities
SM5	Earthworks - Construction Activity Pollution Control
EQ5	Mould Prevention
SM6	QLASSIC
SM11	Stormwater Design – Quantity & Quality Control
SM3	Development Density & Community Connectivity

TOTAL POINTS – 26/100

POINTS WITH LOW ACHIEVABILITY
(achieved by less than 20% buildings)

EE5	Advanced EE Performance - BEI
EE4	Renewable Energy
MR4	Sustainable Timber
SM2	Brownfield Redevelopment
WE2	Water Recycling
EQ7	Air Change Effectiveness

TOTAL POINTS – 25/100

Long Term Impact Criterion
Short Term Impact Criterion

Figure 3. List of criteria with high and low achievability

Examples of Platinum, Gold, and Silver rated buildings show that it is possible to achieve better efficiency within the GBI framework. The Platinum rated buildings, even though fewer in number, provide promising examples of more energy efficient buildings in the GBI framework. These buildings have acquired the maximum points for the long-term criteria among the buildings in the sample set (Table 5). Six buildings out of 112 from the sample set have received Platinum rating, and have met 90 percent or more of the long-term impact criteria listed in the rating system.

Platinum Rated Buildings	**Points from long-term Impact criteria achieved (out of a total 57)**	**Points from short-term impact criteria achieved (out of a total 43)**	**Total points (out of a total 100)**
Building 1	53	33	86
Building 2	56	39	95
Building 3	51	37	88
Building 4	53	34	87
Building 5	52	37	89
Building 6	53	33	86

Table 5. Points achieved by Platinum rated buildings under NRNC code

It is also important to note that all of the platinum rated buildings have fulfilled two of the major criteria from the long-term impact category, which have been noted as criteria with low achievability (for certified buildings), accounting for a total of 20 points. Table 6 shows the details :

S.No.	**Criteria** (with low achievability)	**Points achieved by buildings**					
		Building 1	Building 2	Building 3	Building 4	Building 5	Building 6
EE4	Renewable Energy	5	5	5	5	5	5
EE5	Advanced EE Performance - BEI	15	15	12	15	10	15

Table 6: Two major criteria fulfilled by platinum rated buildings from the criteria with low achievability (accounts for 20 points under long-term impact criteria)

The GBI NRNC code allots six points for using innovative techniques for energy and resource efficiency and environment protection—but it does not specify *which* techniques can be used under this criterion. Table 7 shows the techniques that the rated buildings, included in the sample set, have used to acquire points under this criterion. The techniques that are most often embraced by the building developers are technology-oriented. They contribute to near-term resource conservation, but do not have much of an impact over the long run. Very few buildings have used passive architecture techniques or tropical architectural features to benefit the buildings over the long term.

	Number of Buildings Implementing the Technique				
INNOVATIVE CRITERIA TECHNIQUES	PLATINUM	GOLD	SILVER	CERTIFIED	TOTAL
Recycling of fire drill water	3	29	10	36	78
Condensate water recovery	5	26	12	23	66
Non-chemical water treatment	4	13	8	16	41
Heat wheel recovery	4	20	3	9	36
Composting	2	17	3	13	35
Regenerative lifts	1	12	1	15	29
Refrigerant leakage detection	1	10	1	6	18
Waterless urinals	0	5	4	9	18
Pressure independent control valve	0	12	1	3	16
Herbal garden	1	4	3	7	15
Charging station for electric cars	2	3	2	7	14
Vacuum degasser	0	12	0	1	13
Advanced air filtration technology	2	5	2	2	11
Environmental Awareness	1	2	3	5	11
LED façade lighting	0	2	2	7	11
Condensate water tube cleaner	3	2	2	3	10
External shading	0	0	2	6	8
Bicycle racks/lanes	0	1	0	5	6
Industrialized building system	1	2	0	3	6
Parking guidance system	0	0	1	4	5
Self-cleaning façade	0	0	1	4	5

Electrostatic precipitator	0	1	1	2	4
Heat pipe technology	0	1	2	1	4
LED/non-mercury lamps	0	3	0	1	4
Thermal energy storage system	0	0	2	2	4
Light shelves and fixed louvers	0	0	0	3	3
Solar water heating	0	1	0	2	3
Automatic waste collector	0	0	0	2	2
Central vacuum system	0	1	0	1	2
Community recycling center	0	0	1	1	2
Light pipes	0	0	0	2	2
Solar air conditioning system	1	0	1	0	2
Vertical green walls	0	1	0	1	2
Air conditioning break switch for rooms with windows	0	0	0	1	1
Air flow monitoring	0	0	1	0	1
Bike sharing (sustainable transport)	0	0	0	1	1
Heat pump	0	0	1	0	1
Integrated induced ventilation system	0	0	0	1	1
Motion sensors	0	0	0	1	1
Rainwater system	0	0	1	0	1
Solid waste management policy	0	0	0	1	1
Use of green certified material	0	0	0	1	1
West elevation sunscreen	0	0	0	1	1
Wetlands	0	0	0	1	1
Wind turbine ventilator	0	0	1	0	1
Bioswales	0	1	0	0	1

daylight trough	0	1	0	0	1
ENVI Façade	0	1	0	0	1
LCD Display	0	1	0	0	1
Centralized waste management system	1	0	0	0	1
Solar thermal cooling	1	0	0	0	1

Table 7. Techniques applied by rated buildings under innovation criteria

A number of energy-efficient buildings were built in Malaysia many years before GBI came into existence. They included tropical architectural features that are appropriate for the Malaysian climate, including solar buffer effect, solar shading devices, daylighting, terraced gardens, orientation-driven ventilation, and so on. We note that none of these features—that complement the context of the Malaysian climate—can be seen in the GBI innovation criteria.

Analysis

Again: it has been much easier for buildings to acquire points from among the short-term GBI impact criteria, and—not surprisingly—most developers have used that path to acquire a green certification. As a result, in the coming years, many buildings will lose their potential to positively impact the environment, because they do not fulfill many of the long-term impact criteria. Since more than half of the rated buildings do not achieve points for innovation and higher energy efficiency, a vast opportunity for energy conservation and optimization is going untapped.

Few of the examples of buildings that have acquired higher certification have shown that GBI framework can deliver buildings with higher performance in terms of energy efficiency and retain their green character for the larger part of their lifespans. For example, 18 out of 112 buildings acquired 10 or more points out of 15 for the Advanced EE performance criterion, which is one of the lowest or least achieved criteria across the sample set.

What is to be done? Heightening the awareness and motivation of building designers, as well as mandating features of the rating tool, can make the system more effective. Adjusting he GBI framework to promote the use of tropical architecture would make the buildings respond better to the climate of Malaysia, which would automatically reduce the usage of energy and electricity in the buildings.

Recommendations

Our research leads us to a number of specific recommendations.

Malaysian Standard MS:1525 compliance should be introduced as a pre-requisite for a GBI rating. MS:1525 is the Malaysian code of practice for energy efficiency and use of renewable energy for non-residential buildings. It provides guidelines for the design and construction of buildings in the Malaysian context, keeping climate factors and comfort conditions in mind. Making it mandatory to conform to this standard would help to establish a minimum threshold for green buildings in Malaysia.

Among the points achieved by buildings for any certification, the percentage requirement for Long Term Impact Criteria points should be specified. This will ensure that the buildings achieve a reasonable balance of long-term and short-term impact criteria. Out of the total number of points achieved by the buildings, irrespective of the level of certification, the ratio of Long-Term Impact Criteria and Short-Term Impact Criteria points should be fixed at 60-40 or 70-30, with the higher percentage being the long-term criteria points. This will ensure that no building can acquire most of it points from among the short-term criteria, and thereby lose its effectiveness and green character after a short time.

A minimum number of Long-Term Impact Criteria points should be required to apply for Silver, Gold, and Platinum certification. This is important to raise the bar and maintain the quality standards of the buildings in various certification classifications. Each higher classification should show substantial energy benefits compared to a lower classification. This would encourage developers and architects to put more effort into achieving energy efficiency.

The identified criteria listed in Figure 4 are vital for human health, comfort, safety, and environmental protection. It is suggested that these be made mandatory in order to receive any GBI certification.

EQ6	Thermal Comfort: Design & Controllability of Systems	3
EE8	EE Verification	2
EQ14	IAQ Before & During Occupancy	2
MR5	Storage & Collection of recyclables	1
MR6	Construction waste management	2
SM7	Workers' Site Amenities	1
SM13	Building User Manual	1

TOTAL POINTS - 12

Long Term Impact Criterion

Short Term Impact Criterion

Figure 4. List of points suggested as mandatory requirements

These should be treated as basic rules and responsibilities of the developer. If these points were mandatory, it would also free up some of the points in the existing 100-point system—and thereby allow the more effective weighting of long-term impact criteria. To prevent buildings from acquiring certification by relying mostly on short-term impact criteria points, increasing the weighting of the long-term impact criteria would indirectly enforce acquisition of long-term impact criteria for certification.

The number of points allotted for innovation criterion should be increased. This will encourage designers to be creative and make proper analysis of the behavior of their designs. Every building project is different, due to variations among such parameters as climate, site, location, resources, building function, and so on. Every building, therefore, ought to have the benefit of unique design solutions to address its unique issues. This needs to be encouraged by the rating systems as an integral part of the tool, so that the onus lies on the designer to use his/her expertise to bring about efficient solutions with tangible results.

Innovation should be encouraged in building design, rather than being limited to technology. This could include, for example, incorporation of passive heating or cooling design features, or the more efficient use of daylighting by incorporating skylights and efficiently designed shading devices.

This can be done by equally dividing innovation points among building design features and technology incorporation. This will allow the system to recognize the importance of developing creative solutions at the beginning of the conceptual design stage.

Learning lessons from examples of environmentally sensitive buildings can be one of the most effective ways of applying innovative ideas. Some examples in Malaysia include Menara Mesiniaga and Central Plaza Tower in Kuala Lumpur, and Umno Tower in Penang. These buildings have been designed and built for the Malaysian climate using tropical architectural features that are appropriate for the Malaysian context. With features like solar buffer effect, solar shading devices daylighting, terraced gardens, and orientation-driven ventilation, these are justifiably celebrated examples of environmentally sensitive Malaysian buildings. We can and should learn from them.

Conclusion

In a developing country like Malaysia, the construction industry needs to develop and grow rapidly in the coming decades. In this era of real and anticipated energy crises, as the building sector continues to be one of the largest consumers of energy, it is extremely important that we optimize energy usage by buildings, all around the world.

Green building rating systems can play a significant role in promoting this shift toward energy efficiency. But unlike the technologies called upon in other fields of endeavor, the technology needed to create energy efficient buildings demands indigenous knowledge, and different set of solutions in different parts of the world.

Any green building rating system must strike a balance between the dynamics of user response, vernacular requirement, positive awareness, and the goal of large-scale energy saving. GBI as a rating system has a long way to go before it can become sufficiently successful in pushing building developers and architects to make efforts towards creating sustainable green buildings. It needs to reassess its structural framework, in light of users' response to it.

With the changes and alterations recommended in this paper, GBI can help ensure that the longevity of the green character of the buildings rated by it is sustained. It can prod architects and builders to meet more long-term impact criteria for getting their buildings rated.

A building constructed today will either be optimally using energy or inefficiently performing for at least the next 30 years. Therefore, we must ensure that our rating systems are robust enough to encourage and enforce the design and construction of energy-efficient buildings. If we do so, GBI can become a powerful guiding tool for buildings in Malaysia—one that will help them sustain their energy-efficient character throughout their life span.

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[24] http://www.epa.gov/oaintrnt/projects/

[25] http://buildingsdatabook.eren.doe.gov/

[26] n.d. *www.worldgbc.org.*

[27] http://environment-ecology.com/environment-and-architecture/80-green-building.html

NOTES

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[i] www.greenbuildingindex.org
[ii] www.greenbuildingindex.org
[iii] This category was the focus of our study, as is made clear subsequently.
[iv] www.greenbuildingindex.org
[v] www.greenbuildingindex.org