The Usability of Green Building Rating Systems in Hot Arid Climates

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ABSTRACT

To develop adaptable and context sensitive building rating systems, the present work aimed to evaluate four rating systems that emerged recently in the Middle East. Literature review and cross comparison analysis showed that the four examined rating systems namely, Green Pyramid Rating System (Egypt), Green Building Standard SI 5281 (Israel), Qatar Sustainability Assessment System (QSAS) and Pearl Building Rating System (UAE) are not enough adopted to local environmental, cultural, historical, societal and economic context. They showed also a comparable similarity since they all imitate the American LEED and British BREEAM rating systems. The paper elaborates on the comparison results and presents recommendations to improve the questioned rating systems and remind designers with the principles and strategies of sustainable design that goes beyond the existing rating systems in hot climate. The evaluation of the four systems might provide a new approach for regional harmonization among the four systems and the development of adaptable and context sensitive rating system.

INTRODUCTION

During the last 15 years, there has been a regional trend in developing and applying green building ratings systems across the world. In several hot climate countries such systems have been or are developed in an attempt to follow the international green movement. Green building rating systems are increasingly gaining attention in the building industry in the ME. For example, the Green Building Standard SI 5281 (Israel) was founded in 2005, Pearl Building Rating System (PBRS) (UAE) was founded in 2007, the Green Pyramid (GPRS) (Egypt) and ARZ Building Rating System (Lebanon) was founded in 2008, the Idama was proposed in 2009 (Jordan) and Qatar Sustainability Assessment System (QSAS) was founded in 2010 (SI 5281 2005, SI 5281-3 2011, SI 5282-2 2011, Ali, H. and Al Nsairat, S. 2009, Estidama, 2010, GPRS, 2011 and QSAS, 2010).

In fact, buildings' impact in the ME region increased and occurred fast during the last three decades. The building sector represents a major consumer of energy, water and materials in the region and is a primary contributor to carbon emissions. In 2008, the building sector was estimated to be responsible for 24% of the region's total energy use, except Israel (see Figure 1). Between 2005 and 2010 building energy consumption in UAE, Saudi Arabia, Qatar, Israel and Egypt raised by 7-10 percent per year, compared with 0.4 percent per year for the OECD countries (Organization for Economic Co-operation and Development) (Elgendy, K., 2010a). In the ME countries, which falls in a hot and extreme climate, the patterns of building's use of energy, water and materials is increasing and faster population growth and young populations translate to booming cities. Therefore, it is essential to address green buildings rating systems to drive this growth in a sustainable way. However, the problem with most emerging rating systems is that they imitate the LEED or BREEAM rating systems and are not enough adapted to local environmental, cultural, historical, societal and economic context. Thus

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certification systems must be adapted to meet the needs of the Middle East regional climate, social, environmental and economic conditions.

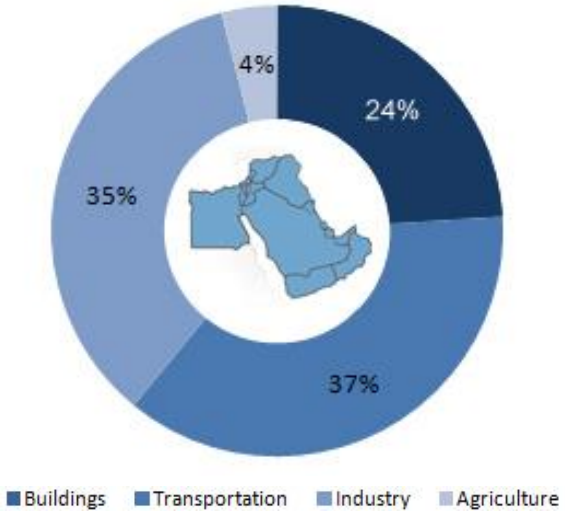

Figure 1 Energy use in the Middle East, Carboun 2013 (Elgendy, K., 2010b).

Thus to put those rating system in the regional context and better adapt them to the local traditional architectural practice, the remit of this paper is to assess existing rating systems for the development and measurement of sustainable buildings in the ME. The paper aims to examine and refine constructively those problems, particularly by reviewing existing rating systems in the light of a cross analysis study. The research is focused on the strength and weakness as well as elements of success and failure to allow improving the analysed building rating systems in the ME.

METHODOLOGY

The research methodology adopted a dual mixed approach consisting of two phases: a literature review and a cross-comparative investigative and analytical phase followed by a discussion on future improvements potential.

Literature Review: The first phase is based on a literature review that sets the foundation and support for a new insight of green rating systems in the ME. The focus of the literature review is to summarize the existing rating systems.

Cross Analysis: The second analytical phase is mainly focused on the comparison and assessment of the building rating systems. Four rating systems (GPRS, SI 5281, QSAS and PBRS) were compared A cross analysis study is used to answer questions about the strength and weakness of the systems. The cross analysis is based on questionnaires distributed during two assessment workshops. The workshops took place in Amman in 2013 and invited accredited professionals & assessors working with the three rating systems (GPRS, QSAS and PBRS) or involved in their development. For the SI 5281, two professionals were interviewed via Skype meetings.

RATING SYSTEMS IN THE MIDDLE EAST

This section summarizes the literature review undertaken for this study. The four rating systems are briefly illustrated in this section against LEED V3 (2009) and BREEAM (2011). Additionally we searched for case studies in the ME that were certified by the four rating systems. We created an inventory for certified buildings complying with GPRS, SI 5281, QSAS or PBRS. Also we created Table 1 listing the certified and registered buildings in the four countries.

GPRS

The GBC of Egypt and the Housing and Building National Research Centre (HBRC) launched the first edition of the Green Pyramid Rating System (GPRS) in 2010. It is based on a point scoring system divided under seven categories. GPRS links the credits to national statutory provisions and Egyptian National Codes for the design and construction of buildings. The certification levels match the LEED system. There are some unique credits in the site category encouraging the site

selection in the desert outside the Nile Valley and Delta areas, the redevelopment of informal areas and respecting historic or cultural interest. However, there are serious problems and contradiction within the GPRS that hinder its usability for green building rating in Egypt. Among the technical problems we found a duplication of compliance requirements for many credits. GPRS requires compliance with Egyptian and US codes and standards in the same time. This creates many conflicts and requires huge preparation effort. For example, the energy efficiency and indoor air quality credits require compliance with ANSI/ASHRAE/IESNA and HBRC standards. On the other side, there is an over simplification in many credits. Many materials and indoor air quality credits are missing documentation guidance and more importantly referenced standards. The same applies to most comfort (acoustic, daylight and thermal) credits. Also the proposed rating system is not sufficiently addressing the local Egyptian built environment and its context. For example, there are no credits addressing local construction techniques, vernacular architecture, heat island effect, informal housing, natural ventilation and ceiling fans, solar water heating, Cairo's air pollution, occupancy behavior, health and Egyptian socio-economic aspects. The rating system in its current status seems like a deformed copy of LEED discouraging its usability by the local community.

Table 1 Rated Projects in four countries 2013 (Oren 2012, GBCI 2013, Davis2012)

	LEED Registered	LEED Certified	GPRS Registered	GPRS Certified	SI-5281 Registered	SI-5281 Certified	QSAS Registered	QSAS Certified	PBRS Registered	PBRS Certified
Egypt	13	2	2	0						
Israel	21	7			170	40				
Qatar	76	1					-	128		
UAE	557	70							-	557

Green Building Standard SI 5281

The GBC of Israel was established in 2007 and issued the Israeli Green Building Standard IS 5281 Sustainable construction has a point scoring system. According to the Standards Institution of Israel there are 25 certified residential buildings and 15 office buildings, all of them under the first version of SI 5281 (2005), still no certifications under the revised version (2011), however there are 170 project in progress. The standard is in Hebrew with a supplementary technical guide (Version 1.0). Both document are accessible online and resembles to a large extent the BREEAM rating systems with. It is divided under seven categories. The rating system is designed for residential, commercial, educational, retail, health and industrial buildings and there is an effort to include schools. Most referenced standard of the SI 5282 credits are local and few credits refer to the ISO or EU standards. The SI 5282 is research based and adapted to the Israeli context. This is proofed through the reference standards, guidelines, rules of thumb, and appendices A, B, C and D. In the energy category, there is an emphasis on passive and bioclimatic design strategies and active design strategies adapted to the local climate, including shading, natural ventilation, passive heating, building geometry, compactness and proportions, thermal mass, night ventilation as well as photovoltaic systems, solar air conditioning systems and geothermal systems. Also data centres are particularly addressed in this category.

SI 5282 has unique credits like encouraging the building to match the natural relief and terrain, saving the potable water up to 90% by using efficient plumbing fixtures, estimating the exposure of the building winds and adjacent open areas to take advantage of desired wind or protect the building, consider the solar rights in urban planning, avoiding glare, use bulbs with colour delivery coefficient (CRI) and provide protection against health damage associated with exposure to electromagnetic radiation at high volumes. However, as mentioned by Shaviv 2011, the rating system is complicated, tough and requires expertise knowledge to run many simulation models, including CFD and daylighting, in particularly to quantify the effect of the passive design strategies. Even if this advancement is seen as an advantage; it would require intensive educational programs to prepare professionals and extra soft and hard cost for every building. The SI 5282 is a context adapted rating system that can be seen as an impressive theoretical achievement but without addressing the economical feasibility and seeing government leadership it will not be usable (Oren 2012).

QSAS

QSAS is a green building certification system developed for the State of Qatar. QSAS was developed by the T.C. Chan Centre for Building Simulation and Energy Studies at the University of Pennsylvania. QSAS has manuals and toolkits and online project management is responsible for suite. QSAS Design manuals consist of a set of criteria and measurements and reference guides used to assess the sustainability performance for buildings.

QSAS has three stages of rating systems: Design, Construction and Operations. According to the GSAS/QSAS Technical Guide (v1.0-2012), the system is based on a point scoring system divided under 48 criteria and eight categories. The system can rate different building types including Commercial, Core & Shell, Schools, Residential, Mosques, Hotels, Light Industry, Sports, and Neighbourhoods. By reviewing QSAS Design Guideline and Building Energy Guidelines Manuals QSAS resembles to a large extent BREEAM and LEED rating systems. Most referenced standard are British and American standards and few credits refer to the ISO or EU standards. The energy performance is calculated according to the QSAS Energy Application document and EPSCT Calculation Tool.

QSAS has unique credits like the desertification credit that aims to reverse, prevent or minimize desertification, and protect development from sandstorms. Another unique credit is the Design for Disassembly credit, which aims to design building elements and materials for ease of disassembly. Also QSAS has very unique category namely Cultural & Economic value that encourages maintaining the region's heritage and cultural identity using the basis of Qatari vernacular architecture. However, QSAS is still not mature and is mainly focused on commercial buildings and the fees structure is costly discouraging certification of residential buildings (Fadli 2013). The rating system is for high-tech buildings with a main focus on active technologies. Passive design measures are not encouraged through the different building typologies. Also the certification process is a black box not allowing the development of its criteria with the research and practice community.

PBRS

The Emirates Green Building Council was established in 2006 aiming to support and promote any green building initiatives. The Pearl Building Rating System (PBRS) is developed by The Abu Dhabi Urban Planning Council (UPC) for new construction buildings and they are preparing to award an external consultant to develop pearl rating systems for Existing Buildings & for Operations of buildings. The pearl rating system that is currently in place addresses three major categories of new construction, Pearl Villa Rating System (PVRS) Pearl Building (PBRS) and Pearl Community (PCRS). Projects are awarded 1 to 5 pearls based on number of credits scored. The pearl new construction rating system of the above three categories has become mandatory for Abu Dhabi and Al Ain only. All new buildings have to be constructed to meet 1 pearl requirement. It is based on a point scoring system divided under seven categories. PBRS system is a collection of ideas like both rating systems LEED or BREEAM promoted in a form of elective building code type of format. The rating system is designed for Communities, New Design & Construction and Villas including offices, retail, schools and mixed use buildings.

Most referenced standard of the PBRS credits are from US and UK with few credits referring to the ISO standards. The strength of PBRS is that is based on sustainable urbanisation mode for Abu Dhabi aiming to create more sustainable communities, cities and global enterprises and to balance the four pillars mainly environmental, economic, cultural and social. So the system was built specifically or customized to the UAE climate and needs. PBRS has unique social credits promoting physical activity (gymnastic), well lit group spaces (cafeteria), BBQ lots, silent rooms, security CCTV, urban farming and gardening, and seniors' spaces. However, the professional community meet the system doubts due the increased cost of buildings. Also the system is not simple and concise depending on many British standards.

COMPARISON RESULTS

In this work, the goal was to create a classification that allows a cross comparison of credits. From the cross comparison analysis, credits with strong similarities were revealed. We classified the credits into classes, according to three ISO standards defining sustainability in building construction and other studies found in literature (ISO 2008, ISO/TR 2004, ISO/TS 2005, Wagner-Muschiol and Friedmann 2009). Then we followed the methodology developed by Kuhn et al. 2012 as following:

a) Credits based on checklists: the implementation of the credit in this type of method, generally takes place

through a checklist. They evaluate a wide and diverse range of criteria, mixing the demand for quantitative and qualitative data inputs.

b) Credits based on performance goals: this type of method is usually a list of standards (that are the criteria of evaluation). The indicators sets are distinguished mainly, by the type of criterion evaluated and by the development activities that they support. Also, as noted by Hurley and Horne (2006), indicators generally measure the operational performance of a building, while checklists are intended to measure a project or a plan performance.

c) Credits based on computer programs (simulation or modeling): computer programs usually support the connection between input and output data in this kind of system. They are based on input and output models. They deal predominantly with quantitative data. The evaluation is usually made out from a limited relation of criteria.

d) Credits based on monitoring (Post-occupancy evaluation (POE), commissioning and monitoring): Credits based on extensive monitoring of energy flows, including lighting loads, HVAC loads and plug loads, for a minimum of one year was. Analysis can be used to compare real performance with predicted in order to manage substantial saving (either energy cost or energy use).

Comparison Result: Table 2 and 3, summarizes the criteria analysis of the four rating systems showing the different credit method in percentage.

Table 2 Criteria analysis and results summary

	Checklists	Performance Goals	Computer Programs	Monitoring & Commissioning
Prerequisites and Rating System Credits				
GPRS	51%	31%	6%	12%
SI 5281	33%	44%	9%	14%
QSAS	45%	36%	6%	13%
PBRS	39%	35%	8%	18%
LEED NC	38%	40%	8%	14%
BREEAM	40%	35%	9%	16%

The four systems use score point system (numeric values) for evaluating how much the building is green, but each system has its own measurement comparison system. The four tools provide programs involving the building life cycle process – pre-design, design and post-design (occupation). In general, the four tools are presented for existing as well as new constructions for different types of buildings including operation and maintenance.

According to Table 1, the number of green rated projects that comply with national rating systems is larger than the projects that comply with LEED or BREEAM, except for the GPRS in Egypt. Table 2 shows that there is an increased emphasis on checklist or performance goals credits. Measurement and performance monitoring credit do not represent more than 14% of the credits except for PBRS which reaches 18%. Table 3 indicates the comparison among GPRS, SI 5281, QSAS, PBRS, LEED and BREEAM in terms of assessment categories. There are many common criteria and categories between the four examined rating systems; such as limiting the consumption of energy and water in the building, improving the environmental quality in both indoor and outdoor, resources and material conservation, service quality, and site strategies. The four rating system all operate from an ecological foot print minimization paradigm. At the same time, each system focuses on certain aspects more than the other ones according to the country's local context.

Table 3 Comparing GPRS, SI 5281, QSAS, PBRS, LEED & BREEAM regarding criteria assessment categories.

Items of comparison	Green building rating system					
	GPRS	**SI 5281**	**QSAS**	**PBRS**	**LEED**	**BREEAM**
Site Selection	15	22	51	12	26	28
Energy Efficiency	25	40	72	44	10	19
Water Efficiency	30	6	48	43	35	6
Materials	10	5	24	28	14	20
IEQ	10	18	42	37	15	15
Management	10	1	24	13	-	12
Waste	-	2	-	-	-	-

Culture & Economics	-	-	39	-	-	-
Innovation	-	7	?	3	4	-

Figure 2 shows the performance sensitivity of the four rating systems on a radar graph. In general, the credits classification structure and content of SI-5281and QSAS were found close to LEED while PBRS close to BREEAM. Surprisingly, there is no agreement on weighing the different environmental criteria. For example, GPRS and PBRS appreciate water conservation more than energy efficiency compared to SI-5281 and QSAS, which reflects LEED's main concern with energy use and BREEAM's concern with water. The Indoor Environmental Quality (IEQ) was very important among the compared rating systems, which is a positive aspect favoring human wellbeing, except GPRS. However, we believe that water scarcity should be the most important category together with human wellbeing. Also, POE and operation commissioning were all optional and not enforced (Table 2).

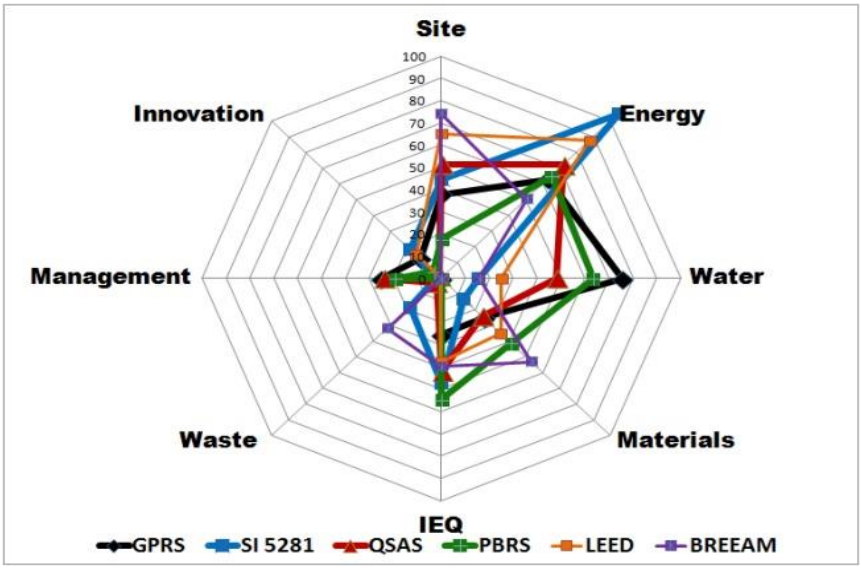

Figure 2 Performance sensitivity of GPRS, SI 5281, QSAS, PBRS, LEED and BREEAM.

As a result of the cross analysis and the workshop analysis we found out that the four rating systems are proposing theoretical models that needs to move to effective market implementation politically (government) and economically (NGOs & private sector). The four rating systems require more adaptation to local and regional context. More importantly they should differentiate themselves from well established rating systems. Already LEED & BREEAM programs are considered the most fairly comprehensive in scope – from registration to calculation to building certification. In the case of the four rating systems, the initiation approaches were bottom down not bottom up approaches. Therefore, according to Table 1, the uptake and market penetration is slow compared to LEED or BREEAM. In the four countries, there is no encouragement/engagement in the form of working out incentives or law enforcement to apply the four rating systems.
In fact, each country in the region is looking to achieve those criteria individually. The entry of the LEED and BREEAM rating system into the Middle East property market coincided with increasing demand for regional and local system. As a result, different systems to label the sustainability in the ME were developed under serious time pressure in the last ten years. The four compared systems are based on American and British standard. In the same time, there are currently no standardization efforts working at local level to quantify and assess sustainability. As a consequence, those systems failed to attract local stakeholders to accredit and award local sustainable buildings. This situation could be detrimental to the usability of all rating systems in the ME region.

TOWARDS HARMONISED SYSTEMS

Green Building Councils in the ME will have a long way; they have to manage to position themselves as leaders promoting green buildings in the countries where they operate. By comparing and evaluating the four rating systems lesson could be learned and problem could be avoided. Cam and Ong (2005) defined the roles of building environmental performance domain that can assure innovative design and sustainable built environment. Therefore, we believe that a harmonized system within the ME would have distinctly better chances if the following issues are addressed:

Institutional Setting: Since the oil embargo 1973, Western countries developed local codes and standards, which are revised annually, for the built environment. Those codes correspond to their context and are strongly linked to practice and buildings industry. However, in the four examined countries, the (b) local codes and standards are still not mature when compared to American or British ones. So there is a regulation problem on the institutional level. More importantly, (b) energy and water are heavily subsidized in most of the four countries. The comparison revealed that the certification rates (Table 1) are low and the fees structure is very high (registration, certification, auditing). Thus the whole political regulation landscape regarding resources efficiency is contradicting with the rating systems scope and objective. Therefore, it is important to address the (a) efficiency regulations and (b) subsidies policies on the institutional level and avoid the dependence on Western standards, codes and rating systems. This should be done through facilitating the adjustment and upgrading for the specification of environmental assessment factors in a dynamic, flexible and simple way.

Scientific Rigor & Priorities: There is very few studies that have been done to diagnose the building-stock's performance in the ME. Developing an assessment framework should be based on in-situ building performance research and technical knowledge. Table 2 revealed the importance of increasing the technical rigor. This includes the setting benchmarks and increased emphasis on measurement and performance. Figure 2 revealed the importance of credits weights. The investigated rating systems are located in hot climates, with scarce water resources which require a different approach and credits focus. Issues like solar protection, water conservation, life style, solar cooling and urban planning should be more strongly addressed in future developments. This include advancing environmental footprint issues, like urban heat island effect and climate change.

Regionalisation: The assessment framework should suite the local context of each country in the ME; depending on its culture, issues, stakeholders, practices and institutions. Surprisingly, SI 5281 is the only rating system that was written in a native language. Therefore, it essential for each country to design its own indicators in its own way and serve its shared goals in local language. This includes also the development of local criteria to quantify the social part of sustainability that includes tradition and culture.

Providing a Platform: Multi-stakeholders should participate in developing the rating systems, as they require participative and collaborative process. Experts, designers, elected officials, working group, agency players, and others should be introduced as key participants in this process. The building industry should be encouraged to get into sustainable track to achieve a real transformation, regarding water and energy. There is a need to link those rating systems to grass root initiatives rather than developing them within academia or elite practicing companies.

We believe that examined certification systems need strong adaptation to meet the needs of the Middle East regional climate, social, cultural, environmental and economic conditions. Also there must be a harmonization effort between ME rating systems similar to the work of OpenHouse project (OpenHouse 2013) that aims to develop and implement a common, transparent, European building assessment methodology. Otherwise, we will have a proliferation of immature systems without accumulated knowledge and unifying experience.

CONCLUSION

This study compared four rating systems in the ME. There is still a long way before those examined systems examined become mature and widely usable. Despite that the development of the examined rating systems is intended to facilitate the assessment of sustainable design in the ME; they fail to suit the local context culture issues, resources, priorities, practices and economical challenges. The GPRS, QSAS and PBRS systems neglect the interpretation of essential local sustainability measurements in their assessment set and normative standards. The comparison developed between the four rating systems

compared was on the basis authors understanding and the workshop questionnaire and discussions. Due to the size and complexity of the comparing 4 rating systems the assessment might be biased but the process of literature review and ISO standards comparison minimized that minor probability. Future work will focus on comparing the four ratings systems based on a case study. We conclude that the existing rating system needs increase the technical rigor and to put more weight on the most important categories, mainly water, IEQ, pollution and energy. This research suggests a number of recommendations to develop a harmonized green building assessment system in the ME. The usefulness of rating systems in the future depends on their flexibility and ability to measure the merits of buildings.

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