Upgrading locally-regulated green buildings to LEED standards: a Dubai case study

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Abstract. With Dubai aiming to be one of the greenest cities in the world, the local government has set various requirements and regulations to achieve this goal. The Dubai Municipality has already established and implemented its own locally-developed green building regulation, Green Building Regulations & Specifications (GBR&S), to address major concerns associated with buildings’ resource efficiency. This study proposes a comparison between the GBR&S system with USGBC’s LEED v4 rating to identify where GBR&S falls short and how much it would cost to upgrade to the various levels of LEED certification. The authors also hypothesize that access to efficient, mass public transportation systems is a major factor when determining the cost of LEED certification. With this in mind, proximity to a public transportation network and its effect on the cost of a LEED upgrade were investigated.

1 Introduction

Dubai’s place as a major global trade hub and tourist destination necessitates a stable and robust power grid capable of handling the needs of its roughly 3.13 million inhabitants. With an economy that has transitioned from being reliant on petroleum exports to one centered on trade and transport, the government has targeted renewable energy generation and sustainability as the means to power the emirate. Facilitating stable economic growth required the Dubai government to develop a number of complementing visions capable of directing public policy to meet concrete renewable energy and sustainability goals. The Dubai Clean Energy Strategy targeted a transition to clean energy with a goal of 25% consumption by 2030 and 75% by 2050. The emirate’s carbon emission goal, the Dubai Carbon Abatement Strategy, calls for a 16% reduction of carbon emissions by 2021 [1].

Despite some of Dubai’s goals still being works in progress, a few metrics have either met or surpassed their expectations. The Dubai Electricity & Water Authority (DEWA) reported achieving a 19% reduction in net CO₂ emissions (10% below the Carbon Abatement Strategy expectations for 2019) [2]. Achieving these reductions required a combined thrust of public policy and a set of mandatory building regulations, known as the Green Building Regulations & Specifications (GBR&S). GBR&S focuses on enhancing energy efficiency, implementation of electromechanical energy systems, water conservation, and improving the building’s indoor environmental quality. The systems aim to achieve a 35% increase in energy efficiency, 50% reduction in construction waste, 60% reduction in solid waste, 15% increase in water efficiency, 20% reduction in carbon emissions and 90% increase in air quality [3].
While local green building regulations allow for treating regional concerns better than the US Green Building Council’s (USGBC) Leadership in Energy and Environmental Design (LEED) rating system, these systems are often not as comprehensive. An example of this is found in LEED’s Location and Transportation category, which awards points for proper access to public and alternative transportation systems. Depending on the project’s location and access to public facilities, this category’s points can range from being readily available to infeasible. GBR&S lacks a similar category, thus highlighting one of the differences between the two rating systems. This may be unexpected given the initiatives put forth by the government of Dubai to expand its Public Transportation (PT) network and searching for innovative methods to connect the city more efficiently with less reliance on gasoline-powered personal vehicles [4,5]. The inherent differences between buildings constructed to the local GBR&S standards and LEED standards is of particular interest as LEED has exhibited a good degree of market penetration in Dubai. As of 2013, LEED is the most popular green building rating system in the United Arab Emirates with at least 802 buildings certified in the various tiers [6].

1.1 Objectives
The main thrust of this research will delve into assessing the resource efficiency of Dubai’s green buildings, which are constructed according to GBR&S, in terms directly comparable to those used by LEED. The overarching goal of the paper will be to provide a framework for comparing locally developed green building rating systems against the commonly used LEED rating system. The authors believe this can allow decision-makers to better assess the number of LEED credits and required capital to upgrade a building from the local standards to LEED certification. Additionally, government entities will better understand how their regulations compare to an internationally accepted set of standards and provide them with a means to assess their ability to meet those strategic objectives in line with the United Nation’s Sustainable Development Goal 11, Sustainable Cities and Communities.

This research is also looking to delve into the effect that access to a public transportation (PT) network has on the cost-effectiveness of a potential upgrade from GBR&S to LEED certification. From this, one can estimate the number of points and possible cost savings from selecting a site in a densely developed area, particularly if LEED certification is a potential goal. The developed methodology and results of such assessments may be informative for other cities implementing their own limited, green building regulations.

To provide a look at how LEED can be compared to a local rating system and how these results can be interpreted, a case study centering on Dubai, United Arab Emirates and its GBR&S system will be undertaken. The paper’s case study will focus on a random selection of 16 buildings in Dubai (all built to meet GBR&S standards) that will be studied to determine the extra modifications and investment required to upgrade them to obtain the different tiers of LEED certificates (i.e. Certified, Silver, Gold, and Platinum). Additionally, it will highlight those elements of GBR&S, that when met, sufficiently attain LEED credits at no additional costs. This information will allow decision-makers to have a better understanding of the potential costs required to upgrade the building, thus potentially limiting the risks involved when estimating a return on investment.

2 Methodology
To initiate this research, a thorough study is conducted to comprehend LEED-V4 for New Construction (BD+C), using its relevant credit interpretations published by USGBC and existing research papers on this topic. Furthermore, the GBR&S codes were studied in order to identify the current requirements for new buildings set by the Dubai Municipality (DM).

Proximity to PT is defined in this study to mean a project that is within a 400-meter walking distance of bus stations or in 800-meter walking distance of the Dubai Metro rail stations. Both
modes of transportation must offer a substantial number of routs with frequent services above Minimum Daily Transit Service (as specified by tables 1 and 2 of LEED’s Location & Transportation credit ‘Access to quality transit’). As can be expected, the areas within this proximity are mainly high density areas of the city which offers the projects additional, readily available points from LEEDs Surrounding Density and Diverse Uses credits.

2.1 Assumptions and Data Collection
For consistency in comparisons, each project’s contract documents will be assessed to ensure only standard commercial-quality projects are considered. Furthermore, the project should fall under one of the following two categories, either a boutique development with a value between AED 281-390 per square foot ($76.5 – 98), or mega project with a value between AED 220-280 per square foot ($60 – 76). While conducting the research, the following are considered acceptable sources to estimate the cost of the upgrades: expert judgement, cost consultant input, available research and market quotations. Market quotations are the most reliable source to estimate the cost of the upgrades and were prioritized when multiple sources were available.

Project data are collected through various local contractors, consultants, and property development companies. Data encompasses the full set of contract documents for the projects and available information about the building operation prior to any upgrade. The projects are categorized based on their proximity from public transit (PT)

2.2 Data Analysis
The data analysis is divided into two main parts, an analysis according to LEED and a qualitative comparison between LEED and GBR&S. The LEED analysis uses Microsoft Excel as a platform to optimize (via a minimization of costs) building upgrades. The collected data (from bill of quantities, project drawings and specifications, and contract agreements) will inform the Excel model about what LEED credits can be readily earned with no additional costs. In addition, the model will determine how much it will cost to upgrade certain building elements to meet LEED credit requirements.

The qualitative analysis between LEED NC v4 and GBR&S compares both green building rating systems in a manner that encompasses the mechanism, categories, place of establishment, similarities and differences between both rating systems. Both systems are compared in terms of the financial investment required to upgrade the GBR&S building to one that can attain the different LEED certification tiers. Before conducting the comparison, the projects are divided based on their proximity from PT so that its effects can be isolated and studied with minimal interference from other parameters.

The Excel model includes a comprehensive questionnaire that is used to determine the qualitative and quantitative properties of the buildings required for LEED certification assessment. The questions are designed to identify which credits can be achieved based on LEED requirements. It includes 110 questions ranging from the plot area of the project, BOQ cost of the package, and straightforward questions requiring yes or no answers, which are then input into the appropriate section of the model. Based on the collected data from the user, the model identifies the achievable credits along with their costs depending on the characteristics of the project such as area, geometry and construction materials. The results shown to the user are determined based on predefined functions that were programmed into the model by studying the available literature and obtaining cost estimates based on methods deemed viable. The model selects the lowest financial investments required to achieve each of the four tiers of LEED-V4 NC.
3 Results

Mapping GBR&S and LEED-V4 revealed that 16 points and 12 prerequisites of LEED are attained by complying with GBR&S as presented in Table 1. As such, the owner will not need to make any upgrades that are bespoke for these points and prerequisites.

The questionnaire is replicated 16 times in the Excel model to introduce the characteristics of each project into their bespoke model. After filling the model’s questionnaire, a summary sheet is generated showing the required investment to achieve the different tiers of certification. While the questionnaire provides information for cost estimates for all the credits, the model selects the criteria with the lowest required financial investment to meet the four tiers of classifications. The results for one case study building are summarized in Table 2. The bottom row of the table provides the estimated costs associated with upgrading the project, which are measured as a percentage of the building’s initial value (i.e. project cost). This procedure was repeated for all sixteen projects, with a summary of the projects being provided in Table 3.

Table 1. Similarities between LEED and GBR&S Regulations (partial table)

Table 2. Sample Project Table Summary (Partial)
Projects with a grey shade, in Table 4, are located far from public transportation, while unshaded projects are located in close proximity to public transportation. The selected projects vary in cost with a range from 18.8 million ($5.12 million) for project P7 to 844 million ($229.78 million) for project P9. The construction cost per square foot for these projects is between AED 350 and 226 ($95.3 – 61.5), respectively.

### Table 3. Project Details

| Project designation | Project type      | Project cost ($) | Project size (M2) | Plot size (M2) | Construction COST ($/M²) |
|---------------------|-------------------|------------------|-------------------|----------------|-------------------------|
| P1*                 | Mid rise building | $10,883,007.45   | 10,763.00         | 1,373.00       | 1,017.19                |
| P2                  | Low rise building | $5,940,000.00    | 7,342.10          | 2,533.46       | 813.87                  |
| P3                  | Mega project      | $210,600,000.00  | 230,000.00        | 23,000.00      | 921.12                  |
| P4                  | High rise         | $58,590,000.00   | 75,112.00         | 4,519.25       | 784.69                  |
| P5                  | Low rise building | $6,650,391.33    | 6,770.50          | 2,123.00       | 988.13                  |
| P6                  | Mid rise building | $12,967,242.21   | 20,857.00         | 6,543.40       | 625.44                  |
| P7                  | Mid rise building | $5,080,017.60    | 5,024.00          | 1,398.55       | 1,017.19                |
| P8                  | High rise building| $26,209,180.96   | 32,000.00         | 4,978.00       | 823.93                  |
| P9                  | Mega project      | $227,880,000.00  | 349,125.60        | 34,228.00      | 656.62                  |
| P10                 | Mega project      | $141,149,613.91  | 154,152.00        | 19,850.00      | 921.12                  |
| P11                 | High rise building| $67,065,198.08   | 77,529.72         | 5,441.00       | 700.19                  |
| P12                 | High rise building| $35,602,200.00   | 43,385.00         | 3,182.00       | 825.51                  |
| P13*                | Mid rise building | $18,502,444.87   | 16,584.04         | 3,128.00       | 1,127.34                |
| P14                 | Low rise building | $10,166,880.33   | 11,133.25         | 1,249.00       | 918.65                  |
| P15*                | High rise building| $24,451,962.48   | 29,639.05         | 1,984.00       | 829.92                  |
| P16                 | Mega project      | $96,418,185.87   | 97,341.69         | 7,840.00       | 996.43                  |

Projects near public transportation typically were larger in size and total cost (average = AED 289 million [$ 78.7 million]), than projects further from public transportation (average = AED 147 million [$ 40.0 million]). To facilitate interproject comparisons, upgrade costs are calculated as a percentage of the project cost in Table 4.

### Table 4. LEED Certification Costs as a Percentage of Total Project Costs

| Project designation | Certified | Silver | Gold | Platinum |
|---------------------|-----------|--------|------|----------|
| P1*                 | 0.22%     | 0.48%  | 1.04%| 11.92%   |
| P2                  | 0.28%     | 0.68%  | 1.25%| 15.48%   |
| P3                  | 0.04%     | 0.09%  | 0.48%| 3.58%    |
| P4                  | 0.09%     | 0.23%  | 0.53%| 4.73%    |
| P5                  | 0.20%     | 0.49%  | 0.91%| 12.58%   |
| P6                  | 0.40%     | 0.80%  | 1.44%| 19.66%   |
| P7                  | 0.21%     | 0.39%  | 0.82%| 2.99%    |
| P8                  | 0.18%     | 0.38%  | 0.92%| 4.88%    |
| P9                  | 0.06%     | 0.11%  | 0.76%| 17.06%   |
| P10                 | 0.04%     | 0.09%  | 0.27%| 2.80%    |
| P11                 | 0.05%     | 0.14%  | 0.33%| 3.93%    |
| P12                 | 0.12%     | 0.30%  | 0.73%| 11.78%   |
| P13*                | 0.20%     | 0.45%  | 1.01%| 12.41%   |
| P14                 | 0.22%     | 0.43%  | 0.87%| 13.48%   |
| P15*                | 0.24%     | 0.46%  | 1.05%| 14.87%   |
| P16                 | 0.06%     | 0.13%  | 0.33%| 3.31%    |

*Projects P1, P13 and P15 attained a maximum of 76 points.
Summarizing the results of Table 4, the average costs (as a percentage of the total project cost) to reach LEED Certified, Silver, Gold, and Platinum certification are 0.16%, 0.35%, 0.80%, and 9.72%, respectively. Isolating to consider only those projects near public transportation, the cost increases are 0.10%, 0.22%, 0.55%, and 4.75% for LEED Certified, Silver, Gold, and Platinum, respectively. A comparison between projects near and far from public transportation produced pronounced differences for all levels of certification, with average savings (measured as a % of the total project cost) of 0.13%, 0.27%, 0.49%, and 9.93% for Certified, Silver, Gold, and Platinum, respectively. An ANOVA test, shown in Figure 1, assessing these variations found a statistical significance (p-value <0.0001) when comparing the costs required to obtain LEED Certified, Silver and Gold versus obtaining LEED Platinum.

![Figure 1. ANOVA Test LEED (All Categories).](image)

4 Conclusion
Since the release of BREEAM in 1990, many green building rating systems started materializing around the world. Each of these systems has their own energy, water, and indoor environmental quality goals that take into consideration the local resources, environment, and economy. These rating systems are customized to suit the needs of the countries they originate in, which might cause them to be less applicable in other countries. However, it is important to understand the inherent differences between global rating systems (e.g. LEED, BREEAM) and these local rating systems. Unlike most local green building rating systems, the US Green Building Council’s Leadership in Energy and Environmental Design (LEED) rating system attempts to take a more holistic approach to sustainability and thus contains some standards that these local systems may omit. While the local rating system may not be able to directly include these omitted standards, it is important for the local government to identify and address these differences using other means (e.g. using this information to inform other regulations).
This paper’s research approach involved a literature review presenting the status of sustainability in the UAE and the Emirate of Dubai in specific, project examples of LEED NC V4 and GBR&S rating systems, and comparative analysis of both green building rating systems. A methodology was prepared to utilize the available literature to compare the two rating systems by assessing a total of 16 projects to form a precise comparison between both LEED NC V4 and Dubai’s Green Building Regulations & Specifications (GBR&S) considering the cost estimate required to meet the different LEED certification tiers.

A side-by-side comparison between GBR&S and LEED systems concluded that building to GBR&S standards earns a project 16 LEED points and 12 pre-requisites without any additional capital being invested (excepting LEED’s administrative costs). This reduces the required capital costs for upgrading a building to LEED certified standards since the building only needs to actively plan for obtaining 24 points instead of 40 points. A similar analysis, using another local rating system, could isolate the number of LEED points and pre-requisites earned by following a local rating system, thus informing the decision-maker of the number of points that must be earned to obtain LEED certification.

Given the cost information obtained from estimates and bill of quantities, the authors identified the costs of upgrading from GBR&S standards to each LEED tier. The average cost increase to reach LEED Certified, Silver, Gold, and Platinum certification are 0.16%, 0.35%, 0.80%, and 9.72%, respectively. While this information only considers information from a select number of case study buildings in Dubai, the framework can be adopted and modified by interested parties for comparing LEED to their own local rating system. The publication of typical costs required to reach each of the LEED tiers can reduce the financial uncertainty for project stakeholders, particularly if the project owner is determining if it might be necessary to begin approaching potential debt investors to raise capital. While detailed engineering will be required to determine the exact payback period for any water or energy efficiency retrofit, the provided information can be used during feasibility studies to determine if it is economically feasible to consider including LEED certification as one of the project’s strategic goals.

Isolating those projects nearer to public transportation systems found that the average cost increase to reach LEED Certified, Silver, Gold, and Platinum were only 0.10%, 0.22%, 0.55%, and 4.75%, respectively. These cost reductions are related to their ability to obtain additional LEED points at no cost due to their site’s ability to obtain points via the Location & Transportation category (e.g. Access to Quality Transport, Surrounding Density and Diverse Uses). These cost reductions can further incentivize construction near public transit systems, thus furthering a government’s goals in meeting the United Nation’s Sustainable Development Goal 11, Sustainable Cities and Communities.

5. References
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