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TRACKING THE USE OF LEED® IN FACILITIES FOR HIGHER EDUCATION

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TRACKING THE USE OF LEED® IN FACILITIES FOR HIGHER EDUCATION

INTRODUCTION

America's 4391 institutions of higher learning own roughly 240,000 buildings according to The Carnegie Foundation for the Advancement of Teaching (2009) and the United States Green Building Council [USGBC] (n.d.). Most of these buildings' designs reflect a time when energy was cheap and material abundant. Throughout the past century, building designs frequently ignored their surroundings, usurped energy at appalling rates, and did little to teach inhabitants respect for the environment (Fox, 2007; McDonough & Braungart 2002; Orr, 2007).

As our colleges renovate and expand their facilities today, however, their activities reflect a decided shift in values. Over the past few years many universities have adopted environmental sustainability as a pervasive, unifying, motivating force (Second Nature, 2009). They are now placing environmental issues front and center—integrating sustainability into many aspects of teaching, research, and service—and using environmental principles to guide purchasing, planning, construction, operations, and maintenance decisions (Association for the Advancement of Sustainability in Higher Education [AASHE], 2010).

Environmentally sustainable, "green" building provides a way for campuses to control costs, promote health, and impart values. It can also bring public recognition. Hundreds of universities now strive to provide "Leadership in Energy and Environmental Design" through the LEED® Green Building Rating system. More than 470 post-secondary buildings had already earned certification through LEED by the start of 2010.

LEED is a voluntary incentive program that the USGBC (2007) developed as a way to prompt transformational change across the building industry. Following a pilot program (known as LEED version 1), the USGBC released LEED version 2 in 2000 for use by the general public. LEED promotes awareness of sustainability and fosters development of new products and technologies. It engages interested parties in providing the upfront resources (time and money, research and development) that are necessary to foster innovation. These investments help make new approaches available and economically viable for mainstream use. LEED certification also garners a building's owner recognition. This includes the right to mount a plaque on the building, advertize the building as "LEED certified," and announce its rating (basic Certification, Silver, Gold, or Platinum).

Today, building "green" has become a central goal of university leaders. LEED construction is visible on campuses everywhere. Institutions that used LEED in the past decade helped pave the way for hosts of subsequent LEED applicants. Innovators and early adopters who implemented the system in its inaugural years helped the USGBC reach a critical tipping point wherein LEED is widely used and is recognized by the general public (Gladwell, 2000; Goleman, 2009).

Taking stock of how various institutions have earned ratings in the past can provide insight for educational planners and others who use LEED today. Statistical analysis of how the first 446 postsecondary buildings certified through LEED v2 (including v2.0, 2.1, and 2.2) earned their ratings yielded a range of findings. The findings highlighted in this paper are:

1) Within higher education, doctoral institutions have participated in LEED at much higher rates than other types of institutions. Nonetheless, the level of rating (basic Certification, Silver, Gold, or Platinum) earned by postsecondary applicants has not correlated with any institutional characteristic that is tracked by the Integrated Post-Secondary Educational Data System (IPEDS).
2) In a sample of 181 postsecondary buildings (those for which the USGBC provided data regarding credit earnings), the category of "Energy and Atmosphere" had far more influence over rating than any of the other five credit categories.
3) The postsecondary buildings that used v2.2 achieved significantly higher ratings than those that used the earlier programs, up through the start of 2010. Universities had used LEED v2.1 more frequently than v2.0 or 2.2, however.

LITERATURE REVIEW

The literature discussed in this section describes the purpose and history of the LEED Green Building Rating system. The program's developers assert that LEED "encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria" (USGBC, 2009a, ¶ 1). It uses a market-driven approach to hasten the integration of sustainability across the construction industry. The USGBC (2009b) is a nonprofit member-driven organization is based in Washington, DC. It was formed in 1993 to promote building practices that save energy and are cost effective. LEED's major success has been in marketing green building and in fostering policy change (Scheuer & Keoleian, 2002).

LEED is one of several green building rating systems created "to objectively evaluate energy and environmental performance that spans the broad spectrum of sustainability" explains Gowri (2004, p. 56). The earliest of these programs is the Building Research Establishment Environmental Assessment Method (or BREEAM), which is widely used in Europe, Canada, and Australia. Variations of this program include: BREEAM GreenLeaf, BREEAM Canada, and BEPAC (Building Environmental Performance Assessment Criteria). Growi explains that a third major rating system—the Green Building Challenge—is adaptable to regional contexts and has taken root in over 20 countries. Its designers intended to create a system that could be used globally.

Scheuer and Keoleian (2002) note that although LEED is not the oldest of the green building rating systems in the United States, it is the only one national in scope. It has been adopted by private organizations including Herman Miller, the Ford Motor Company, and the Natural Resources Defense Council. Many local governments (including Portland, Seattle, and San Jose) and federal government agencies such as the Department of State and the General Services Administration (GSA) use the system in all new construction projects.

Although LEED was designed for use in North America, the program is quickly gaining appeal worldwide, with countries like India and Canada choosing to adopt tailored variants of the system (Malin, 2009). In 2009, LEED projects were underway in 91 countries as well as all 50 states (USGBC, 2009c).

The Host Organization

The USGBC (2009d) is one of the world's most visible forums on green building, aiming to be "a unique, integrating force for the building industry" (p. i). Since its inception in 1993, the organization has assembled a highly diverse group of members. These members include more than 20,000 corporations and builders as well as colleges and universities, government agencies, and nonprofit entities (USGBC, 2007). The USGBC (2009d) explains:

> We work together to promote green buildings, and in doing so, we help foster greater economic vitality and environmental health at lower costs. We work to bridge ideological gaps between industry segments and develop balanced policies that benefit the entire industry. (p. i)

The USGBC develops its activities, targets, goals, and priorities in working committees comprised of members who volunteer. These members develop strategies and guide the work of staff and expert consultants. The USGBC's Chief Executive Officer, Richard Fredrizzi, asserts:

> At all levels, the employees of our member organizations—their vision for a sustainable built environment, their knowledge of building science and practice and their commitment to results—are why the green building movement has grown exponentially in the last decade and a half. Thousands of volunteers have contributed hundreds of thousands of hours to the development of LEED, chapter leaders all over the country are making transformation happen at the local level, and the employees of our member organizations are raising the bar for their colleagues throughout the industry. (USGBC, 2009b, p. 1)

The USGBC also sponsors a number of educational forums, including its annual *Greenbuild International Conference and Expo*, *Higher Ed Update*, and *K-12 Schools Update*. The organization is an active force in advocating for environmental policies and it is currently expanding its capacity to conduct research (Tom Dietsche, personal communication, November 20, 2009; USGBC, 2009b, 2009e).

USGBC members also provide research and outcomes assessment. For example, the New Building Institute is a not-for-profit member of USGBC that describes itself as a think tank working to transfer successful environmental ideas to states, regions, researchers, and industry. Through this Institute, Turner and Frankel (2008) authored a report on *Energy Performance of LEED for New Construction Buildings* that identified underperformance in some early LEED-certified buildings. This knowledge is being used to improve the LEED system today (Malin, 2009; USGBC, 2009e, 2009f, 2009g). The USGBC has taken a series of steps to address the performance gaps identified in that study and others like it (Cheatham, 2009a, 2009b; Environmental Protection, 2009; Stephens, 2008).

It is important to note, however, that even if every new structure were built to the highest LEED rating today, our buildings would still be a long way from achieving environmental sustainability. The LEED program is, nevertheless, meeting its sponsor's primary goal of spurring market transformation.

LEED's System of Continual Improvement

LEED was designed to promote innovation and to continually "raise the bar" with regard to building performance. The system helps generate, apply, and test new approaches. Governments and building developers can then adopt and/or institutionalize the practices that have been shown to work best. Since the program is voluntary, those organizations with greater access to resources are the ones that typically implement LEED. In doing so, they also finance the research and development of new technologies. These technologies become more and more affordable over time as the industry's capacity to provide them improves.

LEED's vice president Tom Hicks asserts, "USGBC is dedicated to continuous improvement." This includes refinements "of the technical and scientific foundation of LEED, of our consensus processes, and of the level of customer service we deliver. We've learned a lot… and are proud to be able to incorporate that knowledge into how we're working today" (USGBC, 2009h ¶ 2).

LEED was originally developed for commercial structures but quickly gained momentum throughout the building industry. In 2009, some 35,000 buildings were either certified or registered to become certified (USGBC, 2009c). Institutions of higher education in the United States owned 3,589 of these—roughly 10.25% of all LEED-designed buildings worldwide as of 2009 (USGBC, 2009i).

LEED's popularity is most evident in North America where, by 2004, LEED encompassed 12-15% of all public construction and 2% of privately owned construction (Gowri, 2004). The USGBC (2009d) has been working to increase its appeal by creating programs tailored to specific user groups.

Although this paper investigates the use of LEED for New Construction and Major Renovations (LEED-NC, v2), universities are beginning to use more and more of these tailored variations of LEED today. These include LEED for Neighborhood Development (LEED-ND), LEED for Schools, LEED for Retail, LEED for Healthcare, LEED for Commercial Interiors, and LEED for Homes. These programs complement long-standing programs known as LEED-NC, LEED for Core and Shell (LEED-CS), and LEED for Existing Buildings (LEED-EB).

Focus of LEED

Green buildings are intended to preserve the natural environment and conserve resources; reduce costs of operations and maintenance; and improve health, morale, and productivity of occupants by improving lighting, ventilation, and air quality. Tangible benefits of participation include government endorsements and tax incentives (for profit-making entities), however, LEED also carries social prestige. It signifies that a building's owner is leading the way for a more sustainable future (President and Fellows of Harvard College, 2009). LEED represents a way to address the growing moral imperative to protect the natural environment (Association of University Leaders for a Sustainable Future, 1990; Architecture 2030, 2009; Reid, 2009).

LEED has become the gold standard for sustainable construction, asserts Daniel Goleman (2009). The program provides "ecological transparency where there was none before" (p. 136). It raises awareness and helps correct problems, ranging from "the dangers of indoor air pollution [to] the high operating cost of cheap heating and air-conditioning" (p.135). Rating systems like LEED help make the unseen visible. They measure qualities that exceed most humans' sensory and cognitive perception (Goleman; Stanisstreet & Boyes, 1997). Gardner (2008) asserts that humans have difficulty making meaning of large numbers and of global concepts. Rating systems that describe environmental and health benefits in very simple terms can help people make quick (and hopefully accurate) comparisons and value judgments. Systems like LEED help people interpret the meaning of abstract information and understand of how that information affects their own lives.

Soon after the USGBC (2009d) was formed, its members identified the need to define construction standards and create ways to measure them. A team of architects, real estate agents, building owners, lawyers, environmentalists, and industry representatives researched existing rating systems. This informed the development of their LEED Green Building Rating system. Most rating systems focus on five main performance categories: (1) site, (2) water, (3) energy, (4) materials, and (5) healthy indoor environments (Gowri, 2004; USGBC, 2009b). LEED includes these as well as a category for innovation and exemplary performance. In 2009, a new LEED category was introduced for Regional Priorities. More new categories are under discussion for adoption in 2012.

LEED version 1 served to pilot ideas and standards. It began in 1998 and was used to certify just 20 buildings (Kibert, 2005). Following extensive modifications, the USGBC (2009d) released LEED v2.0 in 2000, with v2.1 following in 2002, v2.2 in 2006, and v3 in 2009. Although v3 (also known as LEED 2009) took effect in 2009, buildings that were registered under an earlier system may apply for certification under that version. Many version 2 projects are still under construction. However, phase-out dates were recently established to encourage use of the more refined systems. All versions of LEED share a common philosophy and a similar award structure.

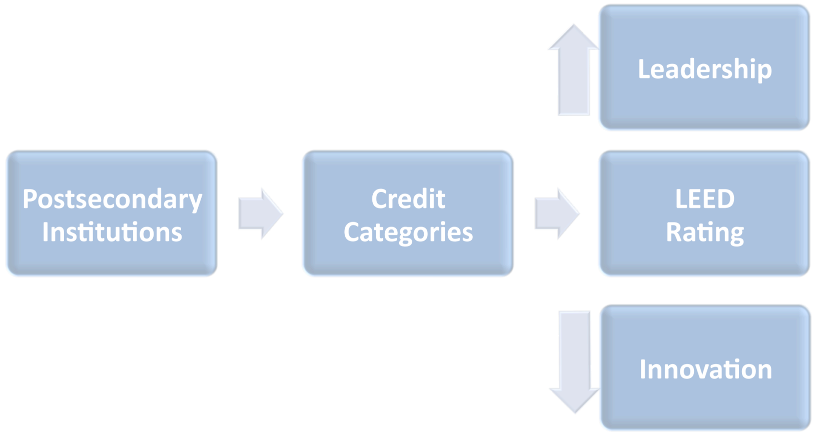
RESEARCH DESIGN

This article reports some aspects of a dissertation conducted through a doctoral program in educational policy, planning, and leadership (Chance, 2010). The purpose of the study was to investigate how postsecondary institutions in the United States had been using the LEED Green Building Rating system. It was designed to identify types of universities that had used the system and to detect patterns in applicants' use of various credit categories. The study focused on the use of LEED-NC v2, because that program was used to obtain 446 of the 470 ratings earned by universities up through the start of 2010. Only about two-dozen projects had used variations other than LEED-NC. The unit of analysis was the individual building that had garnered LEED certification.

The researcher—an architect and LEED Accredited Professional—was particularly interested in knowing if postsecondary applicants had been skirting the Energy and Atmosphere (EA) category. EA is one of the six categories where applicants can accrue LEED credits and it is the category most related to climate change.

Statistical analyses utilized quantitative data that had been collected by USGBC as well as data available on-line through the federal government's Integrated Post-Secondary Educational Data System. IPEDS data are collected and disseminated by the National Center for Educational Statistics (NCES). USGBC data were provided directly to the researcher after establishing an agreement on acceptable use of confidential data.

Figure 1: *Conceptual framework showing process for earning LEED certification and associated outcomes.*



Conceptual Framework

Postsecondary institutions apply for LEED credits in order to earn certification, as illustrated in Figure 1. The USGBC implies that in earning LEED certification, applicants contribute momentum to the larger sustainability effort. They provide leadership to society by spurring market transformation. Many applicants also earn Innovative Design (ID) credits by generating innovative, new approaches. To do so they must operationalize their approaches and develop clear criteria that can be used by others in the future. Based on USGBC claims, innovation and leadership are shown as associated outcomes of certification in the conceptual framework (Figure 1).

Although the efficacy of several LEED measures—most notably those related to energy—has come into question, even the system's most vocal critics agree that LEED has been highly successful at raising public awareness of green building practices and of the need for them (Gifford, n.d.; Malin, 2009; Turner & Frankel, 2008). This study focused not on outcomes related to building performance (which others are currently conducting and disseminating to the public), but rather on how applicants have been using LEED. This is a topic the USGBC is apparently studying, but not one it is disclosing publically. Because this was a study related to higher education policy, planning, and leadership, it focused on how postsecondary institutions had been using LEED to support aspects of higher education's shared mission as defined by Kerr (1995) and Levin (2003). Such "uses of the university" (Kerr, 1995, p. 1) include generating knowledge, spurring innovation, and providing leadership to society to address critical social issues.

The study thus explored USGBC's claims that: (1) building owners who earn high ratings contribute valuable leadership in energy and environmental design and (2) the innovations they implement contribute in positive ways to the individual building as well as the LEED system, the construction industry, and society at large. The study sought to explore these issues using available datasets.

Research Questions

The central question of the dissertation study was: *To what degree have institutions of higher education used LEED® to earn certification, provide leadership, and foster innovation in environmental sustainability?* Four steps were developed to address the overarching research question using existing datasets. Each step included specific sub-questions that could be answered using statistical analysis of USGBC and IPEDS data.

Step 1: Assess ratings earned by institutions.

1a) What types of postsecondary institutions have used LEED-NC v2 and what leadership ratings have they earned?

1b) What was the relationship between institutional characteristics (region, control, type, enrollment, and endowment) and rating?

Step 2: Assess how institutions used LEED credit categories.

2a) What categories did institutions typically use to achieve certification?

2b) What was the relationship between the number of credits earned in each of the six categories and overall rating?

2c) What was the relationship between institutional characteristics and use of credit earnings by category?

Step 3: Assess how institutions used LEED categories to foster innovation.

3a) How frequently did postsecondary institutions earn Innovative Design (ID) credits?

3b) What was the relationship between the rating earned and use of ID credits?

3c) What was the relationship between institutional characteristics and use of ID?

Step 4: Assess generalizability.

4a) To what degree has LEED use changed over time, based on the version of LEED employed (with LEED v2.0 being the oldest system and v2.2 being the newest)?

4b) To what degree has LEED use changed over time, based on inclusion in USGBC's credit tally? (It was suspected, and later confirmed, that the buildings included in that dataset were, more often than not, early applicants. This provided a second way of tracking change over time.)

4b) How did the sample compare to the population of all postsecondary LEED buildings?

The dissertation involved statistical analyses of eleven separate sub-questions, and the report of results was long and detailed. As such, the results this paper will focus on specific results that hold the most relevance for educational planners. Readers who desire more detail are encouraged to reference Chance (2010).

Data Sources and Sampling

The study used data provided by the USGBC regarding all 446 postsecondary buildings certified through the LEED-NC v2 program (versions 2.0, 2.1, and 2.2) prior to December 9, 2009. The researcher identified the specific postsecondary institution that owned each LEED-rated building and then downloaded IPEDS data for the institution. Identification of the owner was possible in all but nine of the 446 cases.

USGBC datasets included information related to many of the variables under investigation for all 446 postsecondary buildings. However, credit earnings by category were available for just 181 of the buildings. The USGBC was in the process of automating data collection in order to harvest detailed information from application forms. At the time this study was conducted, the USGBC's data harvesting was being done manually and the credit tally spreadsheets were not up-to-date (Tom Dietsche, personal communication, November 20, 2009). Aspects of this study that investigated the use of specific credit categories therefore reflect 181 of the 446 successful applicants.

Methodology Used in Analysis

Analyses of the data involved descriptive statistics as well as One-Way Analysis of Variance (ANOVA), Independent Samples *t*-Tests, Chi-Square Analysis, Multiple Regression, and Multivariate Analysis (MANOVA). All test were performed using an alpha level of p=.05. Chance (2010) provides a full description of the methods as well as detailed explanation of results.

RESULTS RELEVANT TO PLANNERS

This section focuses on results of the study that are the most meaningful for educational planners and/or facilities planners. These were:

1) Doctoral institutions have participated in LEED at higher rates than other types of institutions, although overall ratings were not significantly related to any specific institutional characteristic, including institution type. Public/private status, student enrollment, university endowment, and geographic location had little to no relationship to specific LEED ratings earned.
2) Among the 181 buildings where specific credit earnings were known, Energy and Atmosphere had the most influence over rating. This is of interest to those applying for LEED certification as well as those interested in mitigating the harmful effects that building have related to climate change. The relative influence of each category is reported below.
3) Although postsecondary buildings in this study had used LEED v2.1 more frequently than v2.0 or 2.2, those using the last of these (v2.2) achieved the highest ratings. The fact that achievement improved significantly over time is noteworthy for educational planners who seek to build systems that integrate feedback to enhance success as their plans unfold as recommended by planning scholars (Hannan & Silver, 2000; Holcomb, 2001; Presley & Leslie, 1999; Rowley, Lujan, & Dolence, 1997; Wilson, 1997).

The following sections explain statistical results related to these particular points and describe their relevance in greater detail.

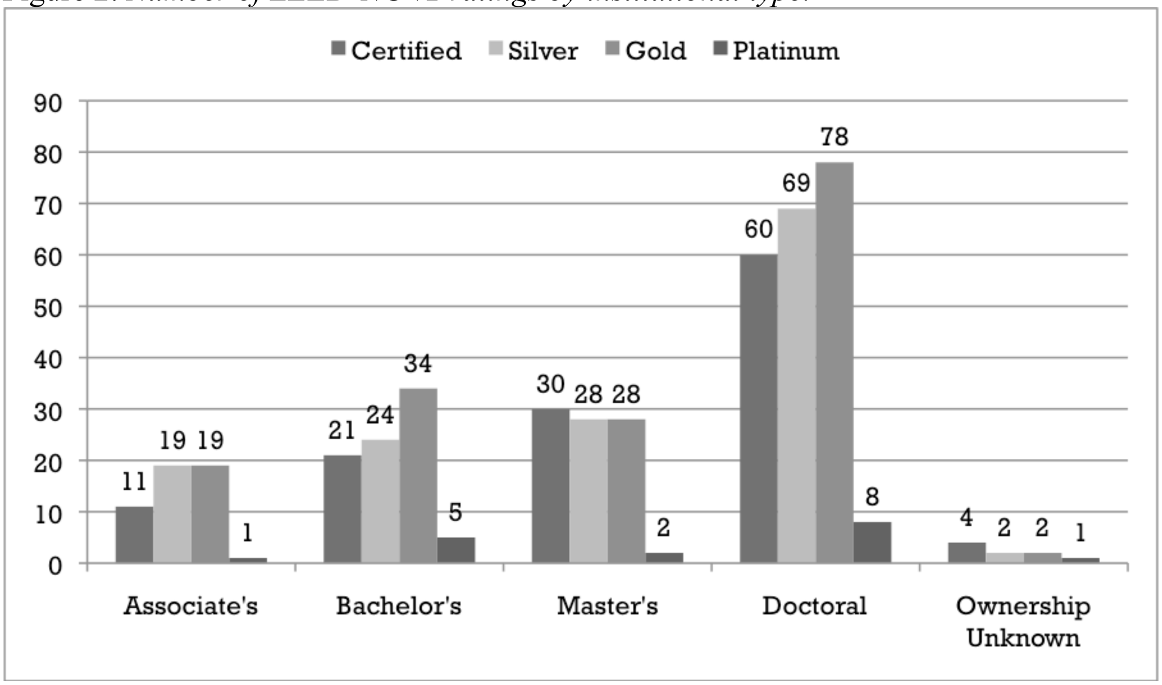
Step 1: Assess Ratings Earned by Institutions

Universities have been highly active in the green building movement, comprising 14% of all LEED users (Fedrizzi, 2009). Overall, 256 different universities had garnered certification through LEED-NC prior to 2010. Of them, 79 had earned multiple LEED certifications. Among colleges and universities, LEED has been most popular with research-focused institutions (see Figure 2).

Doctoral and Research-Intensive institutions owned 49% all buildings certified through LEED-NC v2 through the start of 2010. This type of institution represents just 6.4% of all collages and universities in the US (The Carnegie Foundation for the Advancement of Teaching, 2009). Their lead has held consistent over time.

Although Associate's colleges initially lagged behind Bachelor and Master's institutions in the early years of LEED, they are quickly catching up. It is evident that institutional type relates to *which universities* use LEED, but it does not appear to affect *which ratings* they receive. As mentioned above, no significant relationships could be identified between rating and any institutional characteristic reported through IPEDS.

Figure 2: *Number of LEED-NC v2 ratings by institutional type.*



Step 2: Assess How Institutions Used LEED Credit Categories

Of all six categories, Energy and Atmosphere (EA) has had the single biggest influence on the ratings. Differences by rating were significant using regression modeling as well as multivariate analyses. MANOVA indicated that EA shared 47% of its variance rating. This was significantly greater than Water Efficiency (WE) with 31% shared variance, Indoor Environmental Quality (IEQ) with 30%, Sustainable Sites (SS) with 25%, Innovative Design (ID) with 20%, and Materials and Resources (MR), which had just 9% of its variance shared with rating. A Pillai's Trace test confirmed the significance of the MANOVA model ($F = 3729.032$, df = 6, 172, value = .992, $p < .01$).

Regression modeling helped determine how the categories had been operating cumulatively. A one-way between subjects ANOVA was used to determine that a significant regression model had been achieved ($F = 279$, df = 6, 174, MSE = 19.897, $p < .01$). No problems arose with regard to linearity, independence of errors, effects of outliers, or multi-collinearity.

Using a step-wise regression procedure, Energy and Atmosphere predicted the most about the sample's ratings. After EA, Sustainable Sites added the most new and unique information to the prediction model. The overall order of loading to achieve the optimal predictions was EA, SS, IEQ, ID, MR, and WE. Table 1 summaries the regression model and Table 2 shows the regression coefficients. Both use LEED rating as the dependent variable.

Table 1: *Summary of regression model for LEED Rating.*

Predictors of LEED Rating, in order of influence			R	R^2
starting with	EA	(Energy & Atmosphere)	.641	.411
adding	SS	(Sustainable Sites)	.776	.602
adding	IEQ	(Indoor Env. Quality)	.854	.728
adding	ID	(Innovative Design)	.897	.804
adding	MR	(Materials & Resources)	.928	.861
adding	WE	(Water Efficiency)	.952	.906

R indicates relationship between category and LEED rating.
R^2 indicates the portion of the category's variance shared with LEED rating.

Table 2: *Regression coefficients using LEED Rating as the dependent variable.*

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Err.	Beta	t	Sig.
(Constant)	-2.302	.120		-19.205	.000
EA (Energy & Atmosphere)	.120	.006	.462	18.941	.000
SS (Sustainable Sites)	.132	.010	.327	13.299	.000
IEQ (Indoor Env. Quality)	.113	.009	.309	12.606	.000
ID (Innovative Design)	.135	.015	.218	8.706	.000
MR (Materials & Resources)	.121	.012	.242	10.316	.000
WE (Water Efficiency)	.149	.016	.230	9.091	.000

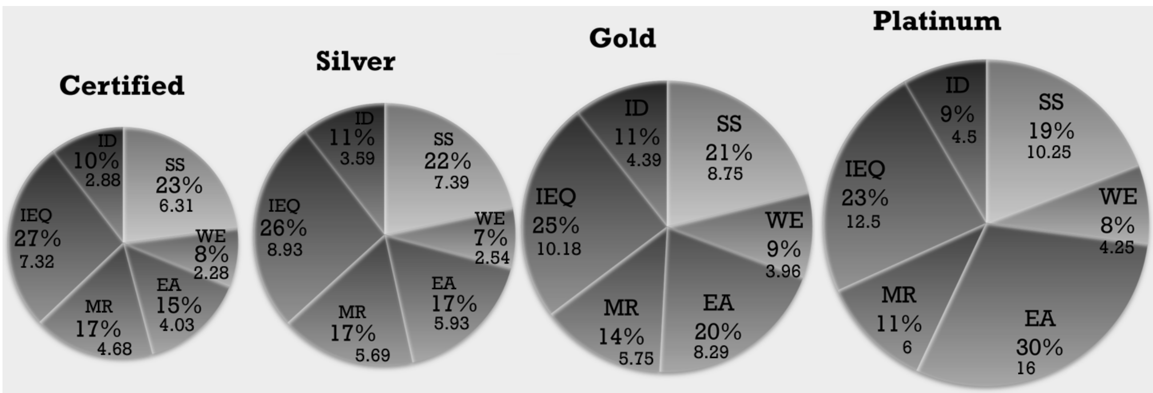
The order of loading indicates that the way WE varied was quite similar to the way EA varied. Both share a great deal of their variance with rating but, in regression modeling, so most of the information that WE could provide about rating had already been accounted for once the information about EA was known. As a result, WE dropped down the list of contributors to the model's predictive value.

The number of credits available in each category varies widely (from 5-17 under version 2), a follow-up regression model was generated to investigate the affect of category size. Each category was given equal weight in this follow-up procedure. The loading sequence for predictions was identical to that reported above. The predictive capacity of each member of the sequence was also remarkably similar in the two models. Results indicated that variability within a category (i.e., amount and pattern of deviation from the average score in that category by rating group) is much more important than size of the category in determining overall rating earned. Despite the fact that smaller categories have less overall potential to contribute, this did not influence ratings nearly as much as variation of points earned within each category.

Figure 3 separates the sample into subsets based on the four LEED ratings. This facilitates visual comparison and shows that buildings that earned low-level, basic Certification relied most heavily on Indoor Environmental Quality. They earned 27% of their points in this category, averaging 7.32 IEQ credits.

As rating increased, the proportion of credits earned in Energy and Atmosphere (EA) rose dramatically. EA earnings increased from 15% among Certified buildings, to 17% at the Silver level, and to 20% at Gold. The four Platinum buildings in the sample group earned a whopping 30% of their credits in EA. They averaged 16 of the 17 available points.

Figure 3: *Proportion and number of credits the sample earned in each category, by rating.*



Key: ID=Innovation in Design, SS=Sustainable Sites, WE=Water Efficiency, EA=Energy and Atmosphere, MR=Materials and Resources, IEQ=Indoor Environmental Quality

Overall, however, this sample used the categories of EA and MR at lower rates than would be expected based on the proportion of points that they could possibly earn in these categories (see Table 3). A deterrent to earning MR credits is that some points in this category only apply to projects that re-use parts of existing buildings. In EA, deterrents to earning EA points include the high cost of energy modeling, on-site power generation, and the purchase of energy produced off-site from renewable energy sources. The USGBC has adjusted the LEED system to encourage future applicants to invest in Energy and Atmosphere credits.

Table 3: *Comparison the portion of LEED credits available to totals earned.*

Categories	Credits Offered to Each Applicant	Total Credits Earned by Sample Group
SS Sustainable Sites	20.3% (14)	21.8% (1348)
WE Water Efficiency	07.3% (05)	08.4% (522)
EA Energy and Atmosphere	*24.6% (17)*	*18.0% (1111)*
MR Materials and Resources	*18.8% (13)*	*15.6% (968)*
IEQ Indoor Environmental Quality	21.7% (15)	25.7% (1590)
ID Innovation & Design Process	07.3% (05)	10.5% (648)
Total	100% (69)	100% (6187)

In all, the 181 buildings averaged just 6.14 of the 17 available EA credits. Some postsecondary buildings earned LEED ratings without much consideration of the EA category (see Figure 3). Earning energy credits was clearly not a focus for every applicant. It was possible (for a time) to earn a LEED rating without accruing *any* EA points beyond the mandatory pre-requisites. Four of the 181 sampled buildings did exactly that—three of them received basic Certification and one received Silver certification—despite earning zero points in EA. All told, 29% of the sample earned four or fewer of the 17 available Energy and Atmosphere credits.

An initial policy to address this problem was enacted by the USGBC four years ago. Projects registered with the USGBC since June 26, 2007, have been required to earn at least two points in Energy and Atmosphere. LEED v3 reflects changes designed to address this problem as well. Applicants must earn a higher number of credits to secure any rating (as shown in Table 4).

Table 4: *Minimum credits required for LEED certification at various levels*.

LEED-NC Certification Levels	Minimum points in v2	Minimum points in v3
Certified	26	40
Silver	33	50
Gold	39	60
Platinum	52	80

Compiled from: USGBC (2001, 2002, 2008, 2009d)

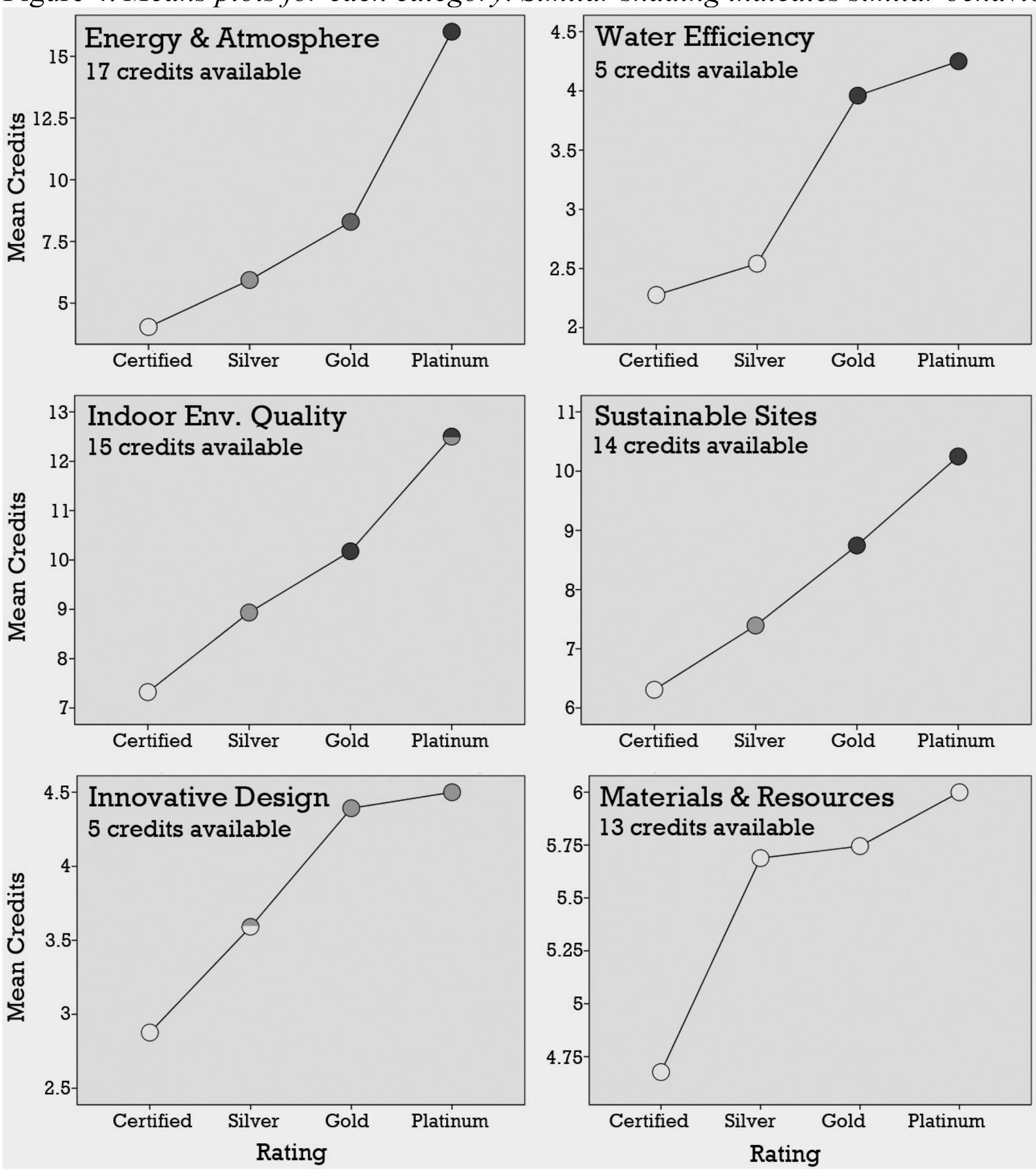
EA accounts for a much larger share of the point offerings than before (see Table 5). This gives applicants much greater incentive to invest in EA. With the pending phase out of v2 programs, it will be increasingly difficult for applicants to achieve certification without investing in Energy and Atmosphere as many low-level LEED earners did in the past. Under LEED v3, the EA category will be essential to even low-level ratings.

Table 5: *Number of credits available in each LEED category.*

LEED-NC Categories		Credits in v2	Credits in v3
SS	Sustainable Sites	14 (20%)	26 (24%)
WE	Water Efficiency	05 (07%)	10 (09%)
EA	Energy and Atmosphere	17 (25%)	35 (32%)
MR	Materials and Resources	13 (19%)	14 (13%)
IEQ	Indoor Environmental Quality	15 (22%)	15 (14%)
ID	Innovation & Design Process	05 (07%)	06 (05%)
RP	Regional Priority	n/a (00%)	04 (03%)
Total Points Available		69 (100%)	110 (100%)

Energy and Atmosphere was, however, already critical to high-level success under v2. Among sampled buildings, those that made solid use of EA credits were best able to earn Gold and Platinum. Further supporting the results of regression modeling described above, multivariate analysis indicated the number one factor propelling Platinum earners beyond Gold was the applicant's score in EA. The results of the MANOVA are illustrated in Figure 4. In this figure, wherever the difference between groups was statistically significant, a different shade of gray was used to fill the dot. For instance, because each rating group differed from every other rating group with regard to the use of EA credits, each group is shown in a unique shade of gray. In contrast, there were just two different ways applicants behaved with regard to Water Efficiency, so just two shades of gray were necessary on that chart. Because planners who use LEED are typically interested in knowing the relative impact of various categories, results related to each category are discussed below.

Figure 4: *Means plots for each category. Similar shading indicates similar behavior.*



Energy and Atmosphere (EA). There was tremendous variation in the number of points each rating group earned in EA. This was the only category where each and every one of the four rating groups differed significantly with regard to the totals earned in the category. As per Figure 3, the 65 Certified buildings in the sample averaged just 4.03 credits in EA. The 61 Silver buildings earned 5.93. The 51 Gold buildings earned 8.29. The four Platinum buildings earned an average of 16 points, or 94.1% of all Energy credits offered.

Because credit tallies were available for just four of the populations' 17 Platinum earners, these findings must be viewed as tentative. It is possible that Platinum earners that earn certification later in time may behave in ways that differ from this preliminary sample group. To assess the likelihood of that, analysis in this study included investigation of how consistently the four Platinum earners behaved in each category.

Because assumptions of equal groups and equal variances were not met in the EA category, Games-Howell was used to control for multiple comparisons. This procedure generates more conservative results than standard equations. Although the Platinum group was small, all four applicants earned high EA scores. In accruing totals of 15, 16, 16, and 17 points in EA, they were consistent in their use of this category.

Water Efficiency (WE). Overall, the sample averaged 2.88 WE credits, 57.7% of the five points available in Water Efficiency. Two distinct ways of using Water Efficiency emerged. Certified and Silver earners acted similarly; they can be considered a single group with regard to use of WE credits. Certified earners accrued an average of 2.28 credits in WE while Silver accumulated 2.54 points. Together, they differed significantly from the way Gold and Platinum earners used WE. In the second group, Gold achieved 3.86 credits and Platinum earned 4.25. In WE, assumptions of equal variance were met, suggesting stability of results despite the small Platinum sample size.

Indoor Environmental Quality (IEQ). The USGBC provides up to 15 credits in IEQ. The sample earned an average of 8.78 of them. This represents 58.6% of the available total—a high level of use relative to most other categories. This category also provided the highest number of points to the sample group's total raw score. Overall, IEQ shared 29.9% of its variance with rating.

Buildings with basic Certification averaged 7.32 IEQ points, Silver 8.93, Gold 10.18, and Platinum 12.5. However, increases in IEQ were not as consistently linked to increases in rating as increases in EA and WE were. Certified earners actually relied more heavily on IEQ than higher-level earners did. Figure 3 shows that the largest proportion of their points came from IEQ. This was true of all groups except Platinum.

Assumptions of equal variances were not met in IEQ. Moreover, the four Platinum earners were quite inconsistent in their use of IEQ (accruing 10, 11, 14, and 15 of the 15 possible points in this category). The average credit totals in IEQ did not provide a very accurate reflection of the behavior of the individual applicants, particularly at the Platinum level. As a result, it was not possible to gauge the influence that IEQ had on ratings with as much accuracy as the other categories.

Because the assumptions were not met, the more conservative Games-Howell procedure was used. This particular procedure suggested that, in IEQ, Platinum earners did not behave markedly differently than other rating group. Some Platinum earners behaved like Gold earners but others acted in the same way as Silver and Certified earners. There were, nonetheless, significant differences in the way the three other rating levels (Certified, Silver, and Gold) performed in IEQ.

Sustainable Sites (SS). Under LEED v2, the USGBC offered 14 credits in the category of Sustainable Sites (SS). Games-Howell analysis distinguished three SS user groups: (a) Certified, (b) Silver, and (c) Gold and Platinum together. The sample group averaged 7.45 credits, or 53.2% of the points available, in Sustainable Sites. Although assumptions of equal variances were not met in SS, the four Platinum earners were fairly consistent in their use of this category (accruing 9, 10, 11, and 11 of the 14 available points). In all, 24.8% of overall variance in LEED rating was shared with Sustainable Sites. Certified buildings averaged 6.31 points in Sustainable Sites, Silver averaged 7.39, Gold 8.75, and Platinum 10.25. Gold and Platinum did not behave in distinctively different ways in this category.

Innovative Design (ID). Despite the fact that ID is limited to just five points under v2, the category accounted for 20.1% of the variance in the sample's ratings. Institutions earned 3.58 points in this category, or 71.6% of all available Innovative Design points. This represents a high level of achievement in a single category. In the sample, Certified buildings averaged 2.88 ID credits, Silver 3.59, Gold 4.39, and Platinum 4.5 credits.

There were only two significantly different ways of using ID. As shown in Figure 4, the number of ID credits earned by Platinum and Gold buildings did not differ significantly. A ceiling effect appeared due to a significant number of cases that earned all five ID points and could go no higher. In this category, Silver earners were split into two types of behavior. Some used ID like the Gold and Platinum earners, while others used ID in ways similar to Certified earners. In ID, the assumption of equal variances was met suggesting stability of the results.

Materials and Resources (MR). This category had the least influence. It shared just 8.7% of its variance with rating. Although the category affected applicants' ability to meet the minimum point threshold, it did little to distinguish the level of rating they would achieve. All four rating groups accrued fairly similar numbers of the 13 available MR points. Certified buildings averaged 4.68 MR credits, Silver 5.69, Gold 5.75, and Platinum 6. Applicants garnered an average of 5.35 credits in MR—just 41.1% of what this category offers. This was the lowest level of use of any category, and even the highest rating earners averaged only 6 of the 13 available MR credits.

It was noted earlier that many applicants failed to utilize the categories of EA and MR to the level that would be expected based on their overall point earnings. However, in stark contrast to EA, all rating groups earned fairly similar numbers of Materials and Resources credits. All four groups averaged fewer than half of the 13 available MR credits. Although the point totals in MR did rise with rating, the averages and spreads did not vary enough between groups to influence rating level in notable ways. As such, all groups are shown with the same shade of gray in Figure 4.

Step 3: Assess How Institutions Used LEED Categories to Foster Innovation

It was initially hoped that qualitative analysis could be conducted using the titles of Innovative Design credits earned by applicants. This might have revealed the nature of innovations being posed by postsecondary applicants. Unfortunately, qualitative data were not available. They were being stored in individual application forms but had not been compiled into a master file by the USGBC at the time of this study. That means the USGBC was not implementing ID proposals for use by others in the way that was originally intended (Tom Dietsche, personal communication, November 20, 2009 & March 3, 2010).

Using quantitative data, Step 3 employed descriptive statistics to assess the degree to which postsecondary institutions have used Innovative Design (ID) credits. This step used the MANOVA described above to explore the question of ID. It also used a series of One-Way ANOVA tests to study relationships between institutional characteristics and use of ID credits. However, no significant relationships were found.

ID is a very popular category. Applicants earned a higher portion of the credits available in this category than in any other category. The ceiling for this category is 5 points, and many Gold, Platinum, and even Silver earners reached this ceiling.

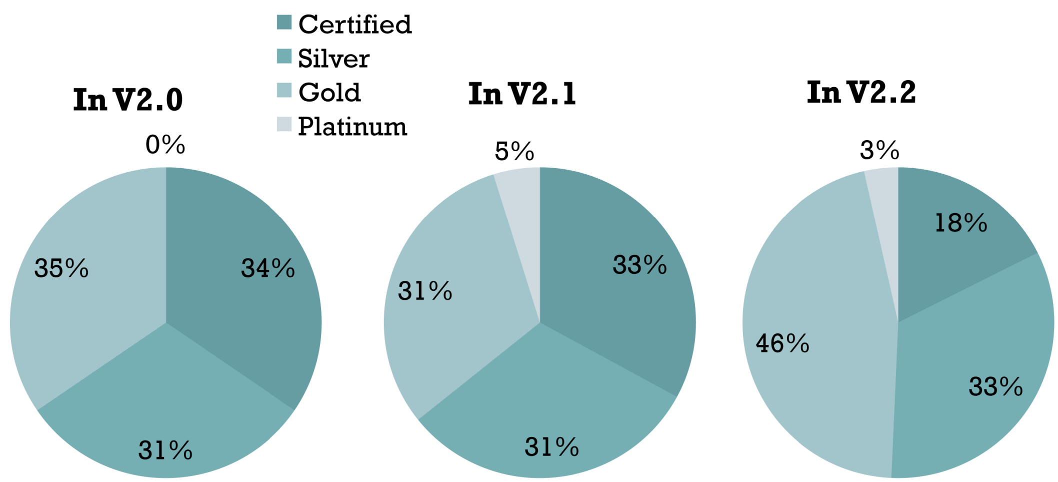
New USGBC policies promote higher levels of innovation. LEED v3 offers six ID points, one more than offered in v2. In seeking to encourage the generation of new knowledge under LEED v3, the USGBC has reserved two ID credits specifically for *new* innovations. Exemplary performance in an existing credit area is no longer sufficient to earn maximum credit in the ID category.

Step 4: Assess Generalizability

Postsecondary applicants have most frequently used LEED v 2.1—the longest running of the versions—yet using LEED v2.2 has yielded significantly higher ratings. Figure 5 shows the percentage of applicants in each version of LEED v2 that achieved each rating. Nearly half of v2.2 users earned either Gold or Platinum, a substantial increase in achievement over earlier versions.

Applicants using v2.2 earned significantly higher ratings as well as significantly higher point totals than users of prior versions. Each applicant using LEED-NC v2 had the possibility of earning up to 69 points. Although v2.0 and v2.1 users did not vary markedly in their point totals (averaging 34.48 and 35.20 respectively), institutions that used v2.2 averaged 37.42 points. This represents a significant difference according to analysis of variance ($F = 5.814$, df = 2, 444, MS = 276.845, $p < .01$).

Figure 5: *Percentage of postsecondary buildings earning each rating, indicating improvement over time based on version*



The final step of the study included careful analysis of trends over time to assess how well the behavior of the early applicants depicted subsequent use of v2 programs. Statistical analyses revealed that the sample group of 181 buildings included a high proportion of early LEED earners. As such, the results *related to credit use* over-represent how early applicants behaved.

Analysis of all LEED-rated postsecondary buildings indicate that ratings are on the rise. In the sample group, this rise can is the result of increased achievement over time within two main categories: Sustainable Sites and Indoor Environmental Quality. Using Tukey HSD, the ANOVA for Sustainable Sites was significant ($F = 8.400$, df = 2, MS = 35.047, $p < .01$) and the ANOVA for IEQ was also significant ($F = 7.409$, df = 2, MS = 37.754, $p < .01$).

Under v3, Sustainable Sites will continue to be an important source of credits. Indoor Environmental Quality will become less important to applicants because the USGBC has decreased the influence that category has in the overall scheme of things.

Table 5 shows that point offerings in SS have increased from 14 to 26 but offerings in IEQ remain constant at 15. As such, IEQ has a much smaller share of the overall pie under LEED v3. As illustrated in Table 5, IEQ accounts for just 14% of all points available in v3, down from the 22% under v2 programs.

CONCLUSIONS

This paper describes each category's relative affect on rating—which can help university planners in making decisions about their use of LEED. It also identifies areas where the USGBC has demonstrated organizational learning over time. This demonstration can be of use to planners who aim to shift institutional culture, particularly those who want to create change initiatives at a national scale (Hannan & Silver, 2000). The conclusions below deal with planning, leadership, and innovation.

Planning and Implications for Planning LEED Facilities

Postsecondary applicants have earned significantly higher point totals and ratings in recent years. It appears that applicants are learning to use the system more effectively and to excel with regard to priorities identified by the USGBC. It is also evident that the USGBC is tweaking its system to enhance outcomes.

The USGBC appears to be learning from past experience and continually revising its policies in response critique, experience, and the increasing capacity of applicants and the market (Cheatham, 2009a, 2009b). In this way, it is moving to overcome the shortcomings evident in older versions of the system. With regard to effective planning, the USGBC can be considered a model learning organization.

The USGBC is pushing for much higher levels of success in the future. LEED v3 sets a much higher bar for achieving each level of certification, as evident in the increased point thresholds shown in Table 5.

Findings do suggest, however, that the USGBC's feedback loops and data collection practices could be expanded and further refined. New policies could be implemented to facilitate deeper analysis of results, increasingly effective program evolution, and better understanding of how LEED facilitates innovation and provides leadership. The USGBC can enhance its efficacy by refining its feedback mechanisms and making its change process clearer to the public.

The USGBC is making strides toward transforming the construction industry. It has developed mechanisms to increase its success over time. Under v3, the USGBC is shifting its emphasis decisively toward Energy. Point offerings have expanded greatly in the three different categories that most affect global sustainability: Sustainable Sites, Water Efficiency, and Energy and Atmosphere. As evident in Figure 4, the overall proportion of available points (or, share of the overall pie) is now larger for SS, WE, and EA. LEED v3 reflects a shift away from past applicants' heavy reliance on Indoor Environmental Quality and toward macro-scale, climate-related issues. Version 3 also recognizes that standardized approaches are not adequate to address a full range of issues. A new category has been introduced, and Regional Priority (RP) now accounts for 3% of points available in LEED v3.

Use of EA and SS credits, will undoubtedly grow under v3 die to dramatic increasesd in their point offerings. In the past, EA and SS each contributed to ratings in unique ways. With 35 credits now available in EA, variability in the use of this category is very likely to expand under v3. It is likely to increase the category's predictive value.

SS will remain a primary contender with EA with regard to predictive value, while the predictive value of IEQ and ID is likely to fall because the point offerings in these categories have not expanded much (or any). Regression analysis showed that, under v2, the sample's achievements in Energy and Atmosphere have not mimicked (or overlapped) achievements in Sustainable Sites. The two categories do not share a great deal of variance with each other. As such, focusing on both of these categories simultaneously may help institutions secure high ratings.

Leadership by Universities

Within both the sample and the population, Platinum awards have been very rare. Earning Platinum requires high-level commitment, particularly within the category of Energy and Atmosphere. This supports USGBC's claim that LEED constitutes leadership in energy and environmental design.

Patterns in the data suggest that LEED is fostering widespread change and that its measures are true to its name. The system has been rewarding applicants who have invested in "energy" as well as "environmental design." This is evident because the largest predictors of overall rating among universities sampled have been Energy and Atmosphere (EA) and Sustainable Sites (SS).

Although it was not possible to measure leadership as a construct independent of rating, it does appear that leadership is a critical component of the LEED program. USGBC implies that the degree of leadership provided by an applicant is directly linked to the level of the certification the applicant earns. The USGBC associates market transformation with transformational leadership. The organization has not operationalized the construct of leadership in any way other than rating.

These finding described above have implications for the USGBC, future LEED applicants, facilities planners, and educational planners. LEED v3, unveiled in the fall of 2009, includes a number of meaningful policy changes. It also offers a range of programs tailored to active user groups and it requires more investment from applicants. Under v3, point thresholds are much higher. Additional standards have been introduced. Using v3 will require greater commitment and this will, in turn, require more leadership from the people who organize and finance construction. These changes suggest that the USGBC is tracking performance and responding to what it finds.

Although not all LEED earners made strides in the energy category, the USGBC (2007) has implemented a series of policy changes to rectify this problem. In addition, LEED v3 requires owners of LEED-certified buildings to submit data about their energy and water consumption for five year's of the building's operation. This will help the USGBC track building performance and adjust its requirements in response.

LEED v3 also expands the portion of credits available in EA and raises the number of credits required for each rating level. This will encourage higher achievement in EA over time—it is now more attractive to applicants and because ratings will not be as easily obtained without it.

All these changes indicate that the USGBC wants to ensure all applicants do, in fact, provide some level of "leadership in energy" in addition to "environmental design." Statistical analysis shows that there has always been a reward for university applicants who focusing on energy, because they have consistently received LEED's highest ratings.

Innovation and Knowledge Generation

The USGBC has developed a system that supports and encourages innovation. The organization can improve in this area by better harnessing the ideas that applicants develop through the innovation in Design category. It should integrate successful approaches into subsequent versions of LEED. This way, applicants can benefit from the knowledge others have generated.

LEED also has the potential to generate new knowledge at the level of the individual. This happens when individuals become LEED accredited. It also happens when LEED buildings are designed to teach their occupants. All buildings—and particularly those designed to educate students—should include features that convey values and teach positive behaviors.

Unfortunately, today's LEED standards do not require postsecondary buildings to explicitly teach students. Elementary and postsecondary buildings more frequently include components that teach environmental concepts and reinforce healthy ways of living. Including pedagogical components is mandatory for applicants who use the LEED for Schools program that was implemented in 2007. LEED for Schools is required for K-

12 applicants but is optional, and rarely used, in higher education. To teach people, designers can: (a) architectural features that encourage certain behaviors or elicit reflection, (b) operations and maintenance activities that are visible to students, and (c) signage that describes environmental concepts.

The postsecondary institutions that participated in LEED up until 2010 enrolled more than 2.2 million full-time students each year. Using LEED can be an effective way for campus leaders to impart environmental knowledge and values to these students.

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