LEED PERCEPTION DISPARITIES: DESIGNERS VERSUS NON-DESIGNERS

Hyun Woo Lee[1], Youngchul Kim[2], Doyoon Kim[3], and Kunhee Choi[4]

[1] Assistant Professor, School of Civil and Construction Engineering, Oregon State University, USA
[2] Assistant Professor, Department of Civil and Architectural Engineering, City University of Hong Kong, Hong Kong
[3] Senior Sustainability Engineer, Astad Project Management, Qatar
[4] Assistant Professor, Department of Construction Science, Texas A&M University, USA
Correspond to hw.chris.lee@oregonstat.edu

ABSTRACT: With the increased interest in green buildings, the building industry has been experiencing a fast-growing demand for LEED (Leadership in Energy and Environmental Design) certification for the last decade. Still, it is not unusual to see various barriers and issues during its implementation, and experience tells that they can result in harming the overall project performance with reworks, lower productivity, schedule delays, and cost overruns. In order to better understand the industry's observation on issues and their consequences during LEED implementation, we distributed an online survey, and a total of 53 responses were received. The survey results indicate that (1) both designers and non-designers (e.g., contractors) select 'added costs to design and construction' as the biggest barrier; (2) both designers and non-designers select 'decision made too late in the design process' as the most frequently observed issue; and (3) non-designers indicate higher perceived severity in every consequence criteria than designers. The statistical analyses reveal that cost overruns are the most severe impact observed and have a statistically significant relationship with responses in regard to the barrier to LEED implementation.

Keywords: LEED, Online survey, Project performance, Green building development

1. Introduction

With ever increasing concerns in energy consumption and environmental impacts of the built environment, the society increasingly demands for the development of green buildings in recent years. Developing green buildings can essentially contribute to a movement to provide socially and environmentally responsible spaces for users [1].

However, risk in the green building development is still an underdeveloped research area. In response, using an online survey, this paper investigates the industry's experience/observation on LEED (Leadership in Energy and Environmental Design) implementation by different professions. Based on the responses to the survey, this paper seeks to identify observed issues during LEED implementation, and their impacts to project performance as risk factors in green building projects. Then, the paper attempts to determine if different professions have different levels of perception on motivations, barriers, issues, and most importantly, the severity of each impact category.

1.1 What is LEED?

Developing green buildings typically involves obtaining LEED certification. Developed by the US Green Building Council (USGBC), LEED is a green building certification, most widely used in the US industry and worldwide. LEED requirements provide building owners and industry professionals with guidelines for identifying and implementing green building design, construction, operations and maintenance (O&M) solutions [2].

LEED is applicable to new construction, existing buildings, core and shell, schools, retail, healthcare, etc. In order to obtain LEED certification, different attributes have to match detailed standards in a number of key areas. For example, LEED 2009 NC (new construction and major renovations) evaluation measures the *greenness* of a building in the following seven key areas:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and Resources
5. Indoor Environmental Quality
6. Innovation and Design Process
7. Regional Priority Credits

1.2 Motivations for LEED

There are varying reasons why decision-makers choose to take major steps to obtain LEED certification for their buildings. Some are attracted to lower O&M costs over the building lifecycle, from less electricity, less gas, less water, etc. Some owners might be inclined to obtain the certification for market positioning. For example, the more energy efficient the building is, the lower the utility

bill will be; thus, the owner can maintain market competitiveness and possibly get higher rents if tenants appreciate the sustainable environment. Also, the sustainable status of the building is attractive by name to many patrons and might cause lower vacancy rates. Lastly but most importantly, some are simply mandated to implement LEED by municipal building codes and regulations [3].

2. RISK IN LEED IMPLEMENTATION

Risk in sustainable investments is discussed in a number of studies [e.g., 4-6], suggesting that the main driver for such investments is its financial risk and return [7]. Thus, sustainable investments need to be understood from the perspective of investors and developers who are looking for an attractive return on investment (ROI) [8].

In particular, the risk of LEED implementation can be seen in the volatility around its added costs and benefits:

1. The uncertainty of added costs needed to cover the design and construction of LEED requirements: *project cost risk*
2. The uncertainty of benefits (e.g., reduced utility or increased rents) during the building's O&M phases required to yield a positive ROI: *performance risk*

Though the performance risk is widely discussed from the perspective of commercial real estate development and investments, this paper focuses on the project cost risk.

In his seminal work, Kats [9] surveyed the added costs associated with different LEED certification levels based on 33 buildings in California. Later, the General Services Administration (GSA) [10] performed another study on the added costs using two prototypical buildings: a mid-rise federal courthouse and a mid-rise federal office building. Table 1 compares the findings of the two studies.

Table 1. Added Costs for LEED Certification

LEED Certification Level	Added Costs as a Percentage Increase from Baseline Building Cost	
	Kats [9]	GSA [10]
LEED Certified	0.66%	0.03 to 1.45%
LEED Silver	2.11%	0.14 to 4.94%
LEED Gold	1.82%	1.96 to 8.83%
LEED Platinum	6.5%	N/A

Similarly, a survey done by BD+C [11] reported the following:

- 94% of respondents said the trend of making building projects sustainable is 'growing.'
- 78% thought sustainable design added 'significantly to first costs.'
- 86% of respondents said they thought green buildings were more costly to build than conventional buildings.
- 31% said they had trouble verifying green products.
- 32% of respondents said green buildings would cost from 6% to 10% more, while 41% said the cost increase would be 11% or greater.

By combining multiple sources, Jackson [5] investigated the added costs perceived by the industry when developing LEED-certified commercial buildings. Table 2 summarizes Jackson's findings on the added costs.

Table 2. Added Cost Range for LEED Certification (Adapted from [5])

	Qualitative Perception of Added Cost Range		
	Low	Mean	High
LEED	1%	3%	5%

Despite the common perception on the added costs, advocates for 'Integrated Design' argue that they can deliver a green building at no significant cost increase over a baseline building [e.g., 12]. Matthiessen and Morris [13], in their frequently-cited study, found no statistically significant cost differentials (1) between LEED-seeking buildings and non-LEED-seeking buildings, or (2) between different LEED certifications.

Whether the decision to pursue LEED certification requires significant added costs or not is still an on-going debate (probably not ending soon). Nevertheless, LEED requirements can impact all aspects of the development process, and subsequently can increase the risk of degrading project performance [14]. Therefore, evaluating the project cost risk and acknowledging its volatility are a critical step to successfully implementing LEED.

3. LEED IMPLEMENTATION

Many organizations and municipalities have developed a number of LEED implementation guides to varying degrees of detail. Overall, their main objective is to guide stakeholders through LEED implementation processes so that projects can successfully achieve desired certification levels.

3.1 LEED Implementation Process

According to Bayraktar and Owens [15], LEED implementation processes consist of the following four main phases:

1. Program
2. Design
3. Construction
4. Post-construction

The program phase is to establish the program, to set a master plan for the implementation. The owner's project requirements shall be established: a document that is used during the construction documentation phase by the commissioning authority in order to determine whether the building's design adheres to the owner's expectation. Expectations and goals must be explicitly set by the owner regarding standards and future occupants. Next, when verifying the scope, forming a group dedicated to sustainable practices is important. This includes having them understand LEED specifics and communicate with the owner about the level of commitment to LEED for the

project. Brainstorming the most efficient plan of action for the project with the new team is the last step of the program phase [15].

In the design phase, the design team is trained more on sustainable design features selected. They design the project with the sustainable additions and see how it works with the budget. After which, the construction begins with mobilization. Meetings are set and documents are kept for each step in the process. Site, material, and indoor air quality are all monitored closely for how they comply with LEED certification. After construction, the owner accepts the work and the occupancy ensues. This is needed for the final LEED project submittal. The submittal phase happens after construction so that USGBC can oversee what actually exists [15].

3.2 Issues during LEED Implementation

A number of previous surveys attempted to investigate motivations for and barriers to LEED implementation [e.g., 16]. However, we were not able to identify any surveys or literatures that formally investigated issues that practitioners observed during LEED implementation, and their impacts to project performance. That motivated us to carry out this survey, and report findings to the academia as well as the building industry.

With the lack of literatures, three LEED specialists (architect, consultant, and contractor) were phone-interviewed to validate the argument of this paper. In addition, the interviewees confirmed that they constantly observed various types of issues when implementing LEED, and most time they resulted in degrading the overall project performance.

4. SURVEY DEVELOPMENT

An online survey was developed using Google Docs™ to learn from industry practitioners about their experience and observations during LEED implementation. The main objectives of the survey were:

1. To determine if different professions (designers versus non-designers) have different levels of perception on motivations, barriers, issues, and most importantly, the severity of each consequence, and
2. To investigate statistical relationships between issues during the implementation and their impacts to project performance.

4.1 Survey Questions

The survey was developed twofold. Part 1 of the survey inquired about the background of respondents, including their professions, target sectors, and target markets. The survey was targeted towards different professions in the building industry: designers and non-designers (contractors, LEED consultants, engineers, and owners). The two target sectors were set as commercial and residential, and in North America, Europe, to Asia (including Middle East).

The main part of the survey is Part 2. As pointed earlier, with lack of literatures, the preliminary interviews with the three LEED specialists served as basis for developing survey questions in Part 2. Upon drafting, the questions and their choices were further reviewed and revised by the specialists. Each question had six choices. If the choices didn't span the real observation, there was room for survey-takers to input an "other" option and write comments about their choice if need be.

As to why the industry would seek LEED certification, Question 1 on the survey read: "Why would you be most inclined to have your building be LEED certified?" Its choices are:

3. Less O&M costs (e.g., less utility)
4. Market competitiveness (e.g., higher rents, lower vacancy rates)
5. Government regulations
6. Corporate brand image
7. Concerns for the environment
8. Owner's request

With this inquiry, this paper attempts to help investigate how to improve LEED by knowing why people are attracted to it. LEED can be branded and advertised in different ways and to different people; thus, knowing why people pursue it can be the first step in moving forward.

Question 2 addressed the barriers to LEED implementation: "What is the biggest barrier to obtaining LEED certification?" Its choices are:

1. Added costs to design and construction (D&C)
2. Split incentive (the party doing the upgrade might not directly benefit)
3. Uncertainty of benefits (e.g., uncertain energy savings)
4. Longer time to design
5. Comfortable with the status quo
6. Owner is not interest in LEED

From this inquiry, this paper attempts to help identify why more buildings are not LEED certified. By addressing these specific concerns, LEED can again amend its branding and advertising tactics and maybe its certification criteria and pricing to address those who are hesitant.

Part 2 then asked Question 3: "What kind of issues have you seen in LEED implementation the most?" Its choices are:

1. Issues in coordination with subcontractors or suppliers
2. Issues in material compliance verification and information gathering
3. Issues in collaboration with general contractor's team members
4. Issues in communication with the client or client representative project manager
5. Decisions made too late in the design process
6. Constantly changing LEED codes and requirements

Question 4 allowed respondents to indicate the observable severity of each consequence on a scale of 1 to 5 (higher is severer). Based on the preliminary interviews, four types of impacts to project performance were selected as:

1. Reworks
2. Schedule delays
3. Lower productivity
4. Cost overruns

With recognizing that all of these ratings can be based on individual perception based on their experience, we had people rank the severity in order to understand what needs immediate attention.

4.2 Survey Distribution

The survey was distributed through industries in the US and Asia by a snowball sampling method, and the answers were stored in Google Document format. This snowball sampling solicits survey participation based on the referral from other survey respondents [17]. Snowball sampling is appropriate and useful in identifying unknown expects in a certain field to increase the survey participation. However, the method is a type of non-probability sampling; hence it can be subject to potential bias. The limitation will be discussed later.

5. SURVEY ANALYSIS

As a result of the survey distribution, a total of 53 responses were received, but a few responses were incomplete. Inevitably, the numbers of samples for each analysis slightly vary (either 51 or 52).

Considered in the analysis are the following professions: designers (37%) and non-designers (63%) including contractors (29%), engineers (21%), LEED consultants (10%), but no owner. The respondents from Asia (including the Middle East) made up 18% of the respondents while North America made up 80% (Table 3). 98% of respondents were focused on the commercial sector.

Table 3. Respondents by Professions and Target Markets

Professions	N	%	Target Markets	N	%
Designers	19	37%	North America	41	80%
Contractors	15	29%	Asia	9	18%
Engineers	11	21%	All of the above	1	2%
LEED consultants	5	10%			
Other	2	4%			
Total	52	100%	Total	51	100%

5.1 Reasons for LEED

Table 4 summarizes the responses to Question 1 regarding reasons for seeking LEED certification. Both designers and non-designers (Non-D) share the same perception that the biggest reason for LEED is owner's request, followed by less O&M costs. It is important to note that designers acknowledge more indirect benefits from LEED: concerns for the environment (16%) and market competitiveness (16%).

We found that with no survey participation from owners, the results turned out to be different from the findings of the previous surveys that targeted commercial building owners. For example, Turner Construction [16] reported that owners selected, as the biggest "reasons for commitment to environmentally sustainable practices", "impact on brand/reputation" and "cost savings" (tied).

Table 4. Reasons for Seeking LEED Certification

Reasons	Total (N=52)	Designers (N=19)	Non-D (N=33)
Owner's request	40%	37%	42%
Less O&M costs	21%	21%	21%
Government regulations	15%	11%	18%
Concerns for the environment	12%	16%	9%
Market competitiveness	8%	16%	3%
Corporate brand image	4%	0%	6%

5.2 Barriers to LEED Implementation

Responses to Question 2 about the barriers to LEED implementation turned out to be uniform between designers and non-designers. Overall, 63% think that the biggest barrier is the added costs to the design and construction phases. The second highest reason (21%) is the uncertainty of benefits (Table 5). It is interesting that non-designers have heightened recognition on the added costs of LEED-seeking projects, with selecting the added costs as the biggest barrier by far (76%). This could be due to that they are significantly more involved in estimating process than designers.

Table 5. Barriers to LEED Implementation

Reasons	Total (N=52)	Designers (N=19)	Non-D (N=33)
Added costs to D&C	63%	42%	76%
Owner's not interested	21%	42%	9%
Uncertainty of benefits	8%	5%	9%
Split incentive	2%	0%	3%
Other	6%	11%	3%

Reinforcing the finding, an engineer added a comment to the response that "on [his] last major hospital project that [was] nearing completion, the plan during design and early construction was for LEED certification" but costs were being cut to fit the budget so "the decision was made to not go through with LEED certification itself due to the costs. The building still has plenty of LEED principals, but will not be certified."

5.3 Issues during LEED Implementation

Reponses to Question 3 about the issues encountered during LEED implementation were split among the four choices: decisions made too late, issues in material compliance verification, issues in coordination with subcontractors or suppliers, and issues in communication with the client or the client representative (Table 6).

Overall, 31% think that decision made too late in the design process is the biggest issue encountered, closely followed by the other three issues. Both designers and non-designers selected the four choices in different orders.

Table 6. Issues during LEED Implementation

Issues with	Total (N=52)	Designers (N=19)	Non-D (N=33)
Decisions made too late	31%	32%	30%
Material compliance verification	23%	26%	21%
Subcontractors or suppliers	21%	11%	27%
Client or client representative	19%	32%	12%
General contractors	2%	0%	3%
Constantly changing LEED requirements	2%	0%	3%
Other	2%	0%	3%

The revealing implications of these results indicate that the lack of coordination and efforts for LEED in the early design makes information gathering difficult, and makes it hard to coordinate with different parties later in the design process. As a result, late decisions in the LEED implementation process are inevitable and create ripple effects on project performance.

A LEED consultant in Asia reiterates this issue, sharing that "most of the building would have been designed before the implementation of LEED, and thus the number of credits that can be reasonably achieved is almost always limited."

5.4 Impacts to Project Performance

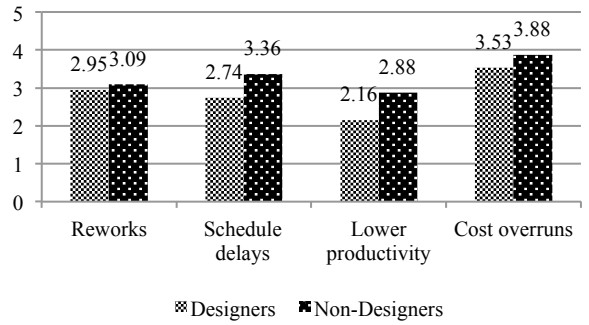
In the last part of the survey, the subjects were asked to rate the observable consequences of issues in a corresponding severity scale of 1 to 5, in increasing severity. The categories were reworks, schedule delays, lower productivity, and cost overruns. On average, cost overruns received the highest rating of 3.75 (Table 7), indicating that cost overruns are the most severe impacts to project performance from the issues during LEED implementation. Paired statistical tests confirmed that within the confidence level of 95%, the severity rating of cost overruns is statistically the highest, and the rating of lower productivity is statically the lowest.

Table 7. Mean Ratings of Each Consequence (N=52)

	Mean	Std. Deviation
Reworks	3.04	1.252
Schedule delays	3.13	1.284
Lower productivity	2.62	1.013
Cost overruns	3.75	1.169

Notably, non-designers consistently rated higher in every consequence criteria (Figure 1). This finding shares a similar implication with Question 2 that they have more recognition on the added costs for LEED certification.

Figure 1. Comparison of Mean Ratings by Designers versus Non-Designers



In addition, a Fisher's Exact Test was performed to determine statistical relationships between the severity ratings of each consequence (Question 4) and barriers (Question 2) / issues (Question 3). Because the survey responses that are less than 5 counts account for more than 20%, a Fisher's Exact Test was selected over a Pearson Chi-Square test to perform a more robust analysis. The test found that the relationship between the barriers and the severity of cost overruns is statistically significant within the confidence level of 0.95 (Table 8). However, the issues during LEED implementation do not have any specific statistical relationship with the severity of the consequences (Table 9). We analyze that it is because the responses to Question 3 are widely split among the four of the six choices.

Table 8. Statistical Relationship between the Barriers and the Consequences (N=51)

	Reworks	Schedule delays	Lower productivity	Cost overruns
Value of Test Statistics	18.212	17.056	21.063	22.278
Exact Sig. (2-sided)	0.132	0.238	0.133	0.042*

* p-value < 0.05

Table 9. Statistical Relationship between the Issues and the Consequences (N=51)

	Reworks	Schedule delays	Lower productivity	Cost overruns
Value of Test Statistics	21.320	21.925	29.443	25.489
Exact Sig. (2-sided)	0.750	0.723	0.302	0.490

6. CONCLUSIONS

The building industry has been experiencing a fast-growing demand for LEED certification. However, the investigation on issues during LEED implementation and their impacts to project performance is still an underdeveloped research area. Only few literatures have studied risk in LEED implementation, with focus on cost implications.

In response, we distributed an online survey, and a total of 53 responses were received. The survey findings include (1) both designers and non-designers select 'added costs to design and construction' as the biggest barrier; (2) both designers and non-designers select 'decision made too late in the design process' as the most frequently observed issue; and (3) non-designers indicate higher perceived severity in every consequence criteria than designers.

In addition, the statistical analyses revealed that cost overruns are the most severe impact observed. The survey result provides evidence that the observed barriers during LEED implementation significantly relate to the project cost risk. These findings appear to agree with the implications of the literatures that investigated the added cost levels of LEED-seeking projects.

In conclusion, we suggest that in LEED-seeking projects, the project team must be able to collaborate from the onset of design process. In doing so, they can reduce the occurrence of various issues later in the LEED implementation process, and accordingly reduce the project cost risk.

7. STUDY LIMITATIONS AND FUTURE RESEARCH

With the lack of time and industry contacts available for the survey, applying snowball sampling seemed appropriate and was selected for exploratory purposes. We acknowledge the limitation of the technique that makes the generalization of the responses to the rest of the building industry difficult. Further, the survey participants were predominantly from North America with no owner responses, which may make the survey results biased in terms of geography and professions.

The survey did not provide any indication of any statistical relationship between the issues and the severity. We expect that more research should be conducted with real project data to further explore the relationship between the issues and their impacts to project performance.

What has been completed has lead to a future study. We have initiated the development of an interactive LEED credit management practice in order to reduce the occurrence of the issues discussed in this paper, and to reduce their impacts to project performance. The focus will be on the material review and submittal process (MRSP). The results will be reported in another academic publication.

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