

Sustainable, High Performance Projects and Project Delivery Methods

A State-of-Practice Report

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EXECUTIVE SUMMARY

This paper describes the state-of-practice in project delivery methods for achieving sustainable, high performance building projects. Owners, architects, engineers, constructors, and public policy advocates are demanding that projects incorporate sustainable design and construction practices. In 2004, residential and commercial building sectors were responsible for approximately 7.9 percent of carbon dioxide emissions globally and in 2007, approximately 40 percent of energy consumption in the United States (US). Thus far in 2009, nearly 2,500 projects have received a Leadership in Energy and Environmental Design (LEED®) certification at some level, nearly 20,000 projects are registered with the US Green Building Council (USGBC), and more than 81,000 industry professionals have received the LEED Accredited Professional (AP) status from the USGBC.

To date, there is no comprehensive study that explores the impacts that project delivery methods have on achieving sustainable design and construction. A project delivery method is the comprehensive process by which designers, constructors, and various consultants provide services for design and construction to deliver a complete project to the owner. The three main delivery methods are design-bid-build (DBB), construction manager at risk (CMR), and design-build (DB). This paper is part of a comprehensive study that seeks to determine how project delivery methods influence an owner's ability to achieve their sustainability goals in delivering building projects. The central question that this paper addresses is:

*What is the state of practice for project delivery methods
in sustainable, high performance buildings?*

To answer this question, the research team employed a three-tiered research approach of: 1) industry survey; 2) content analysis; and 3) structured interviews. The industry survey collected 230 responses from LEED APs on certified projects regarding the project delivery methods and certification performance. The content analysis collected a detailed analysis of solicitation documents from 92 public and private projects representing over \$2.2 billion in design and construction cost. Structured interviews were conducted with four design-builders and four owners to help interpret the results. Together, responses were received from 47 of 50 states and the District of Columbia.

The report organizes the results of this study into the following topics:

- *Deciding to Go Green/The Green Guarantee* – the point at which the owner's desired level of sustainability is compatible with the budget and the point at which the project delivery method can provide a commitment from the designer and/or constructor.
- *Delivering Green: State of Practice* – the performance of each delivery method in delivering the promised or higher certification level.
- *Assignment of the Green Responsibility* – the point at which the responsibility for obtaining LEED certification is being assigned in the project delivery process.
- *Green Liability* – the ultimate responsibility for delivering sustainable goals and how owners are communicating and ensuring this responsibility.
- *Green Procurement Approaches* – the state of practice in procurement procedures for selecting designers and constructors.

- *Contract Payment Provisions* – the method of payment and how it affects sustainability objectives.
- *Ambiguity in the Certification Process* – trends regarding the authenticity of the certification sought for projects.
- *Sustainability by...* – the method by which owners are communicating their sustainability goals (Sustainability by competition, specified level, qualifications only, or reference).
- *Sustainable Issues and Barriers* – issues discovered in the course of this research that are creating barriers to the implementation of sustainable, high performance buildings.

The findings of this study revolve around two central themes:

- 1) The importance of integrated project delivery methods in providing optimal performance; and
- 2) The importance of early constructor involvement in meeting sustainable objectives.

The study found that all project delivery methods (design-bid-build or DBB; construction manager-at-risk or CMR, and design-build or DB) were used to achieve all levels of LEED certification (certified, silver, gold, and platinum). However, success differs for each delivery method. This study measures success through a quantification of projects which meet or exceed their initial LEED rating goals and also through a survey of LEED APs with experience on projects with LEED certification. Some of the key facts relating to success include:

- Seventy-five (75) percent of projects in this study use integrated project delivery methods;
- CMR is the most successful project delivery method with a 94 percent success rate and exceeding owners' expectations half the time;
- If owner wants to maximize sustainability within available budget, CMR or DB-Guaranteed Maximum Price (GMP) provide the greatest likelihood of success;
- Success rates favor those project delivery methods that use GMP payment provisions;
- Success rates favor those project delivery methods that do not seek pricing before selection;
- Owners that desire to achieve a specific LEED level at a fixed price prior to construction are successfully using DB-Lump Sum (LS) or DBB to specify the LEED level in the procurement documents;
- Owners that successfully achieved gold or platinum certification in this study assigned the responsibility for achieving project sustainability objectives during procurement at twice the rate of those assigned during design;
- If owners want gold or platinum certification, they should decide to go green early, specify the level, and use DB to get the necessary integration as soon as possible; and,
- DB allows for a transfer of the Green Liability while DBB and CMR maintain the liability with the designer/owner.

This paper is part of a larger comprehensive study that is seeking to determine if project delivery methods influence an owner's ability to achieve its sustainability goals. The final results and work products of the study will be available from the Pankow Foundation late in 2010.

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INTRODUCTION

This paper describes the state-of-practice in project delivery methods for achieving sustainable, high performance building projects. The information fills a void in the current understanding of which project delivery methods are in use on projects that contemplate a Leadership in Energy and Environmental Design (LEED®) certification. While sustainable, high performance buildings do not need to be LEED certified, this study is using that system as the metric for measuring sustainability. This paper summarizes data from current literature, public and private procurement documents, and a comprehensive survey of more than 200 LEED certified projects. The information provides owners, government agencies, architects, engineers, constructors, and industry trades with facts to improve decision making on selecting project delivery methods and key team members to achieve sustainable, high performance building projects.

Motivation for Sustainable, High-Performance Buildings

With greater demands being placed on our energy and material resources, more owners are requiring projects to achieve a level of sustainable design. Owners, architects, engineers, constructors, and public policy advocates are demanding that projects incorporate sustainable design and construction practices. There are many documented drivers that persuade owners to “go green.” Residential and commercial building sectors have been documented to be responsible for

Residential and commercial building sectors are responsible for 40% of U.S. energy consumption.

approximately 7.9 percent of carbon dioxide emissions globally in 2004 (IPCC 2007) and approximately 40 percent of energy consumption in the United States (US) in 2007 (EIA 2009). Healthier long-term living conditions and increases in tenant base and profit potential as well as decreased ongoing energy costs motivate others. Regardless of the cause, it is apparent that high performance building has experienced exponential growth and shows few signs of decline.

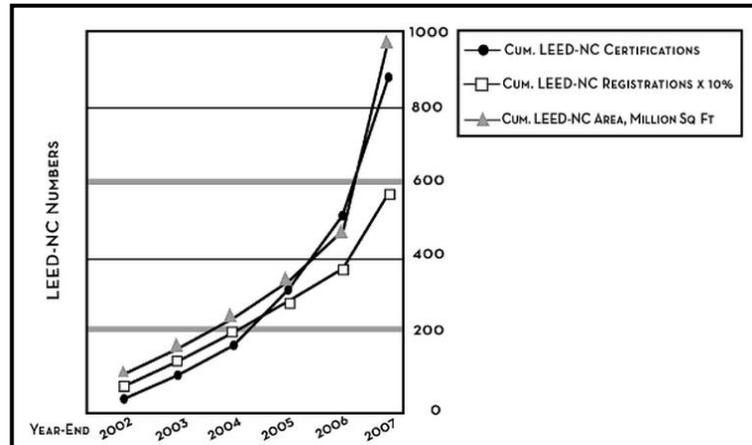
The growth of the LEED rating system and sustainable, high performance building is most profound in the public sector as evidenced by the incorporation of mandated certification levels and LEED credits within policy and building codes at the municipal, state, and national levels. For example, the city of Chicago has incorporated several sustainable requirements leading to LEED certification via the Chicago Standard (“The Chicago Standard”). Furthermore, 955 city mayors with representation from all 50 of the United States have signed the U.S. Conference of Mayors Climate Protection Agreement which will inevitably manifest in LEED certification requirements or similar within these communities (Nickels 2005). The state of California has incorporated building code requirements that parallel LEED credits within the state building energy efficiency code Title 24. At the national level the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings began as a voluntary Memorandum of Understanding in 2006 and became mandatory the next year in Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management. The Guiding Principles direct all federal agencies, including the General Services Administration (GSA) and all branches of the military, to name a few, to incorporate significant green building features into new construction projects. These required green features are most often quantified in the form of LEED rated buildings.

Industry Growth

Green construction has been a societal and governmental demand in the US for nearly four decades. Although the recent proliferation of the LEED Green Building Rating System™ certification in the construction industry has been highly publicized, LEED is one of numerous initiatives in green construction. Energy reduction and sustainable construction initiatives in the US began occurring as a result of legislation in the 1970's (BDC 2003). The recognition of the need for lowering energy consumption was largely stemmed by the oil crisis of that period. Efforts to reduce energy consumption occurred simultaneously with efforts to improve residential and commercial health standards. The environmental legislation of the 1970's fully matriculated to the construction industry in the 1990's with the development of construction oriented initiatives. Thus began initiatives to include Energy Star, LEED, and Green Globes Enrollment and use of these initiatives has experienced accelerated growth since their inception.

The LEED rating system was developed by the United States Green Building Council (USGBC) in 1998 to act as an assessment tool for evaluating the performance of design and construction from a standpoint of sustainability. Specifically the system focuses on the use of low-emitting or recycled materials, reduction of energy consumption, reuse of land resources, and cooperation with other sustainable infrastructure goals. The current levels of certification include (in ascending order) Certified, Silver, Gold, and Platinum. The levels are based on the number of credits that are acquired in meeting the aforementioned focuses of the system (USGBC 2007). Currently, the LEED rating system is a nationally accepted sustainable construction rating system.

Since its inception, the LEED rating system has grown exponentially. Beginning as simply an evaluation system for new construction, it now provides an overarching evaluation system for most construction sectors including new construction, existing buildings, schools, healthcare, neighborhood development, and homes. As a testament to the efficacy of the LEED rating system, an industry survey phased over a three year period (2003-2006) found that the number of designers that have participated in the construction of a building that received LEED certification went from one in ten to one in five and continues to grow (BDC 2006). As of this writing, nearly 2,500 projects have received a LEED certification at some level in the US, nearly 20,000 projects are registered with the USGBC, and more than 81,000 industry professionals have received the LEED AP status from the USGBC. Figure 1 shows the growth pattern for LEED registered and certified projects as well as the square footage of certified buildings from 2002-2007.



**Figure 1: LEED Growth
2002-2007 (Yudelson 2009)**

Project Delivery Methods

The objective of this paper is to define the state-of-practice in project delivery methods for achieving sustainable, high performance building projects. However, terms surrounding project delivery methods can be confusing and experienced professionals often misuse them. The definition of three terms is essential to understanding project delivery and the facts involved in this case.¹

- **Project delivery method:** the comprehensive process by which designers, constructors, and various consultants provide services for design and construction to deliver a complete project to the owner. The three main delivery methods are design-bid-build (DBB), construction manager at risk (CMR), and design-build (DB).
- **Procurement procedure:** the process of buying and obtaining the necessary property, design, contracts, labor, materials, and equipment to build a project. The four primary procurement procedures are low-bid, best-value, qualifications-based, and sole-source procurement.
- **Contract payment provision:** the contract language that defines how design and construction professionals will be paid for their services. The three primary contract payment provisions are fixed price lump sum, guaranteed maximum price (GMP), and cost plus fee.

Figure 2 depicts the three main delivery methods. While names can vary in the industry and owners often create hybrid delivery methods, there are essentially three primary project delivery methods.

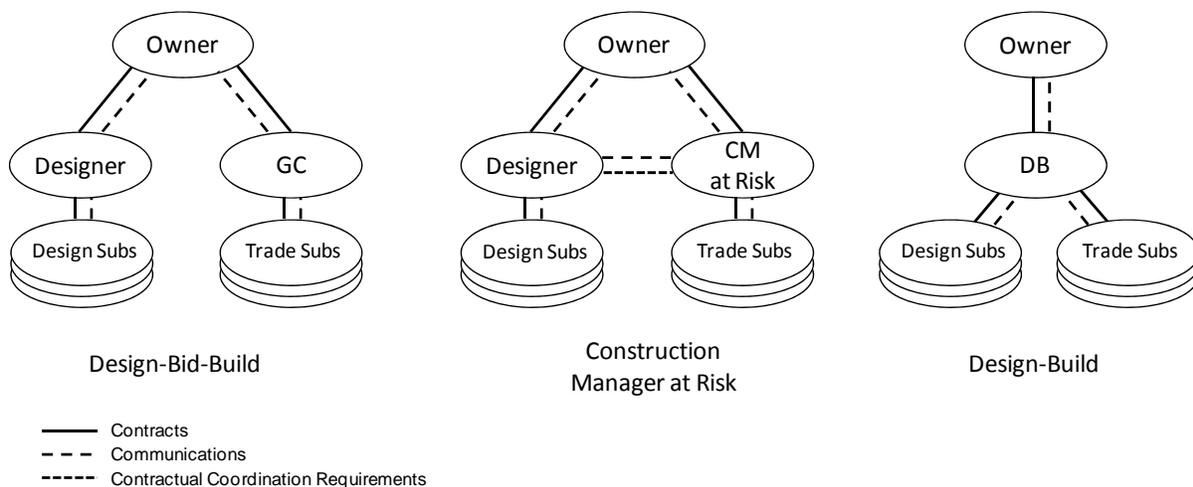


Figure 2. Project Delivery Systems – Contracts and Communications

¹ The definitions have been synthesized from multiple industry documents including: American Institute of Architects (2006), Understanding Project Delivery for the Design and Construction of Public Buildings, *American Institute of Architects*, Minneapolis, Minnesota; American Institute of Architects (2006), Integrated Project Delivery: A Guide, *American Institute of Architect*, Washington, DC; American Society of Civil Engineers (2000), Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors, *ASCE Manual No. 73 – 2nd ed.*, *American Society of Civil Engineers*, Reston, Virginia; and American Council of Engineering Companies (2005), Project Delivery Systems Owner’s Manual, *American Council of Engineering Companies*, Washington D.C.

Design-bid-build is the traditional project delivery method in which an owner retains a designer to furnish complete design services and then advertises and awards the separate construction contract based on the designer’s completed construction documents. The owner is responsible for the details of design and warrants the quality of the construction design documents to the constructor. The process offers “checks and balances” through the separation of design and construction contract, but the separation yields a linear process that is the most lengthy of the three methods. Due to the separation of designer and constructor, the constructor does not have input into project sustainability until the design is complete and the construction contract is executed.

Construction manager at risk project delivery is a method in which an owner retains a designer to furnish design services and also retains a construction manager to build the project – guaranteeing the cost and schedule. In this method, the owner authorizes the CMR to handle many details of a project’s life cycle including preconstruction services and construction. Similar to DBB, the owner is responsible for the details of the design. The value of the delivery method stems from the early involvement of the CMR. Unlike DBB, CMR brings the constructor into the design process at a stage where they can have definitive input. The CMR becomes a collaborative member of the project team and assists with cost estimating, scheduling, constructability reviews, and value engineering studies.

Design-build is a project delivery method in which the owner retains both design and construction services in the same contract from a single legal entity referred to as the design-builder. The design-builder warrants the design and is responsible for the cost any errors or omissions encountered in construction. The owner produces definitive design criteria that the design-builder must follow, but the design-builder in essence “owns” the details of design. Figure 2 shows that the contracting approach is simple. As in construction management at risk, the builder has early constructability input to the design process. As the owner no longer owns the details of design, its relationship with the design-builder must be based on a strong degree of mutual professional trust. The DB delivery method has proven to be highly successful in compressing the project delivery period.

Procurement procedures are a part of the overall project delivery method. Procurement procedures define the process of selecting designers and constructors and purchasing the services and goods of those firms. There are four primary procurement procedures, but as seen in Figure 3, these four procedures lay on a spectrum with hybrids procedures in between.

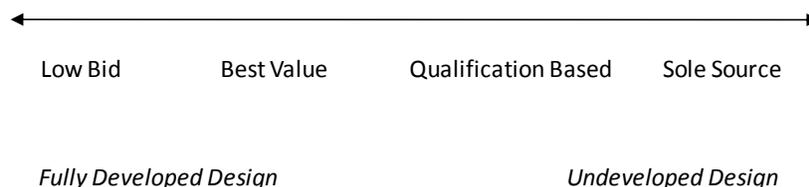


Figure 3. Procurement Procedure Spectrum

Low-bid procurement procedures award contracts to the bidder with the lowest price. The low-bid procedure has a long history in the public sector and is also used by some private owners.

State-of-Knowledge Relating Project Delivery Methods and Sustainability

The influence of project delivery methods on budget, schedule, and construction quality metrics in construction has been well established. In comparison of project delivery methods, researchers have shown that significant differences in the degree to which schedule, cost, and quality goals are met were heavily influenced by the level of team integration and the selected delivery method. Specifically, these studies showed that the integrated delivery methods or methods with a greater degree of early team integration were superior in meeting the aforementioned goals (Konchar and Sanvido 1998, Pocock, et al. 1996, Ling, et al. 2004, Hale, et al. 2009).

Similarly, several studies on designer and constructor integration explored the impact of integration on delivering sustainability projects. Initial studies showed that traditional delivery method strategies may not address the nuances of high performance buildings and may limit the ability of the constructor to contribute to the sustainable objectives (Lapinski, et al. 2006, Riley et al., 2003). Furthermore, increased lines of communication between the design team and the constructor, specifically in the areas of mechanical systems and energy modeling, were factors linked with successful high performance building projects (Riley, et al. 2005). A study on the performance metrics used to measure the success of project delivery methods in sustainable construction also found that the time at which the constructor became involved was the key factor affecting all performance outcomes (Korkmaz 2007). Collectively, these studies are in consensus that early team integration is necessary for achieving high level sustainable objectives. The effectiveness of this integration is pointedly demonstrated in a synthesis textbook of integrated green design when it states, “The bottom line: it’s very difficult to achieve high-level [green] outcomes without some form of integrated design process” (Yudelson 2009).

*“The bottom line: it’s very difficult to achieve high-level [green] outcomes without some form of integrated design process”
(Yudelson 2009)*

Conversely, studies have also shown that project delivery methods may not have as much to do with sustainable construction performance or cost efficiency as originally suggested, especially at lower LEED certification levels. One study found that the ability of integrated delivery systems, specifically the DB method, was no more capable of delivering LEED credits or sustainable objectives than the traditional DBB delivery method for public jobs with lower certification levels (Carpenter 2005). Other studies found mixed results when comparing the project delivery methods as related to high performance construction. In one study comparing project delivery methods to high performance project success, DB was found to have attributes strongly associated with success but it was concluded that “*a relationship between DB and green design did not explicitly emerge*” (Bilec 2008). Furthermore, a significant amount of data variation existed regarding which delivery method was most appropriate and in what situation.

Given this somewhat conflicting state of knowledge, this study seeks to describe, analytically and without bias, the state-of-practice in project delivery methods for achieving sustainable, high performance building projects.

RESEARCH APPROACH

This paper is part of a comprehensive study that is seeking to determine if project delivery methods influence an owner's ability to achieve its sustainability goals in delivering the building project. The central question that this paper addresses is:

What is the state of practice for project delivery methods in sustainable, high performance buildings?

To answer this question, the research team employed a three-tiered research approach of: 1) industry survey; 2) content analysis; and 3) structured interviews.

Industry Survey

The primary research instrument used to document the state-of-the-practice in this area was an on-line survey. The survey questionnaire was prepared based on the principles prescribed by Oppenheim (1992) for survey questionnaire design. The survey consisted of 12 specific questions and two open-ended questions where the respondents could explain or amplify their answers to the specific questions. The survey was made available on the Internet where it could be accessed by the target population of LEED APs. A random sample by state was selected of the 80,000+ LEED APs in the nation. Roughly 10,000 emails requesting that the LEED AP go to the internet survey and complete it were sent. 549 accepted the invitation and agreed to take the survey by answering the first question in that manner. This furnishes an initial response rate of 5.5 percent. However, the second question asked the respondent to input the name of the LEED project on which they had worked. Only 230 were able to continue and complete the remaining questionnaire. As previously stated, there are over 80,000 LEED APs, but there were only approximately 2,500 LEED certified projects. Thus, 230 complete responses represents a higher than expected response rate. Figure 5 shows the distribution of survey responses across the country and the number of responses in each state. Responses were received from 47 of 50 states and the District of Columbia. Thus, the output from the survey appears to be quite representative of the state-of-the-industry across the nation. Table 1 shows the types of building projects that were covered in the survey responses. Table 2 shows the distribution of survey responses and content analysis solicitation documents by state. The content analysis is explained in the next section.

Table 1: Distribution of Survey Response Projects by Type of Owner

Project Delivery Method	<i>Education K-12</i>	<i>Education University</i>	<i>Government Municipal</i>	<i>Government State/Federal</i>	<i>Military</i>	<i>Other</i>	<i>Unknown</i>	<i>Total</i>
DB	2	8	8	8	13	12	2	53
DBB	5	6	10	3	7	16	7	54
CMR	4	18	12	9	8	62	10	123
Totals	11	32	30	20	28	90	19	230

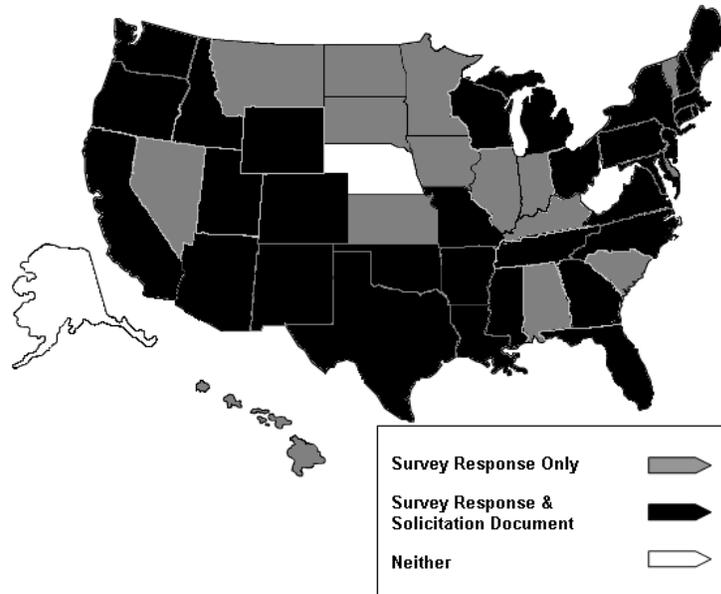


Figure 5: Combined Survey and Content Analysis Coverage.

Table 2: Number of Survey Responses and Content Analysis Documents by State

State	# Survey Responses	# Documents	State	# Survey Responses	# Documents
AK	0	0	MT	1	0
AL	2	0	NC	4	4
AR	2	1	ND	1	0
AZ	11	4	NE	0	0
CA	25	13	NH	1	1
CO	6	12	NJ	1	1
CT	2	2	NM	1	4
DC	3	0	NV	4	0
DE	1	0	NY	7	2
FL	11	1	OH	9	2
GA	10	3	OK	6	2
HI	1	0	OR	4	5
IA	4	0	PA	1	1
ID	2	1	RI	1	1
IL	11	0	SC	3	0
IN	1	0	SD	1	0
KS	4	0	TN	2	3
KY	1	0	TX	27	10
LA	1	1	UT	7	2
MA	6	1	VA	10	2
MD	3	4	VT	2	0
ME	3	1	WA	10	2
MI	6	1	WI	1	1
MN	3	0	WV	0	0
MO	5	1	WY	1	2
MS	1	1			

Content Analysis

Pursuant to identifying current trends in the procurement of green buildings, this study included a content analysis for identifying the language and techniques used in procurement documents for projects in which sustainability was a goal. Specifically, the identification of these trends in relation to differing delivery methods was the intent. A content analysis methodology was utilized to achieve the finest level of granularity: the exact phraseology and terms used in the procurement documents. A content analysis is defined as, “any technique for making inferences by objectively and systematically identifying specified characteristics of messages” (Holsti 1969). While content analysis is typically utilized in social science research, it is also a proven and effective method for classifying language characteristics and commonalities in construction procurement documents (Gransberg and Molenaar 2004). The documents used in the study were acquired from known industry contacts, mass e-mailing efforts, and from internet search engines. The documents focused on new construction projects and were generally representative of the wide variety of high performance projects within the construction market. Representative documents were acquired for traditional DBB projects, CMR projects, and DB projects. The DBB and CMR categories were then delineated further into procurement documents intended to acquire design services and those intended to acquire construction services (denoted by the Architect/Engineer (A/E) and General Contractor (GC) labels respectively). The delivery method, desired LEED certification level, and owner classification demographics of the procurement documents analyzed are shown in Tables 2 and 3. Collectively 92 projects were analyzed representing over \$2.2 billion dollars in vertical construction work from 32 different states.

Table 2: Analyzed Projects by Delivery Method and LEED Certification Level

<i>Project Delivery Method / LEED Cert. Level</i>	<i>Un-specified</i>	<i>Certified</i>	<i>Silver</i>	<i>Gold</i>	<i>Platinum</i>	<i>Total</i>
<i>DB</i>	10	3	12	2	0	27
<i>DBB (A/E)</i>	10	1	7	1	0	19
<i>DBB (GC)</i>	0	3	9	1	0	13
<i>CMR (A/E)</i>	5	2	5	1	0	13
<i>CMR (GC)</i>	8	0	12	0	0	20

**Note: If certification level was by evaluated quality, the minimum level specified is shown.*

Table 3: Analyzed Projects by Delivery Method and Owner Classification

<i>Project Delivery Method / Building Sector</i>	<i>Educ. (K-12)</i>	<i>Universities</i>	<i>Government (Municipal)</i>	<i>Government (State/Federal)</i>	<i>Military</i>	<i>Other</i>	<i>Total</i>
<i>DB</i>	2	6	4	2	11	2	27
<i>DBB (A/E)</i>	2	5	12	0	0	0	19
<i>DBB (GC)</i>	2	4	2	1	2	2	13
<i>CMR (A/E)</i>	1	6	4	0	0	2	13
<i>CMR (GC)</i>	0	8	8	4	0	0	20

Traditional project demographics (location, size, cost, LEED level sought, etc.) were acquired from each set of documents. In addition, four categories of interest were identified in a pilot study of the procurement documents:

- The owner intent to seek official USGBC certification;
- If and how specific LEED credits or sustainable objectives were specified;
- The organization responsible for the certification process with USGBC; and
- If and how designers or constructors were procured in reference to LEED specifically.

Subcategories and a coding system were developed to quantify the language differences addressing these issues. Per accepted content analysis protocol, each subcategory that is coded must be both “exclusive and exhaustive” in nature (GAO 1996). Subcategories were identified in the pilot study of several procurement documents from various projects and differing delivery methods. The owner intent to follow through with official certification was found to vary greatly within the piloted documents. In addition to this variance, it was often ambiguous or oddly specified, indicating contractual risk of a third party evaluation system and/or potential cost of certification may factor into the owners’ decision in how to go green. The manner in which sustainability objectives and goals were specified was also found to be of interest. Several owners/designers specified or mandated explicit LEED credits or sustainable objectives to be met while others were either silent on the topic or presented “suggested” credits that were contractually superseded by a performance specification regarding the required LEED certification level to be achieved. This area was recognized as a means of differentiating specification styles pertinent to the project delivery method used. Similarly, the organization responsible for the certification process via USGBC was also of interest as it may be representative of the entity that is best suited to achieve the certification and representative of a major contractual risk allocation regarding the third party evaluation system. The final identified category sought to capture information regarding the procurement technique; specifically, how owners were procuring designers and builders to meet sustainable building objectives, and on what merit.

Structured Interview Methodology

The survey and content analysis output identified a number of interesting trends, some of which were counterintuitive. Therefore, to validate the trends’ accuracy a limited series of structured interviews with four design-builders (Oklahoma, Texas, Virginia, and Illinois) and four public owners (all GSA) were completed. Design-builders were selected for two reasons. First, this group had experience with all three project delivery methods, and second, the research team was surprised to find the high percentage of LEED buildings delivered using CMR and wanted to test several theories as to why CMR seemed to be preferred over DB. One of those theories was linked to the impact of different contract payment provisions in each project delivery method, and the other dealt with the different credits in project design completion at which the LEED level is guaranteed by the CMR and the design-builder. The results of both possible explanations are discussed in detail in later sections of this paper. The structured interview outlines were developed on lines similar to the method prescribed by the US Government Accounting Office (GAO 1991). The GAO method states that structured interviews can be used where “information must be obtained from program participants or members of a comparison group... or when essentially the same information must be obtained from numerous people for a multiple case-

study evaluation” (GAO 1991). Both these conditions apply to this study, therefore, the tool is appropriate for the research.

PROJECT DELIVERY AND SUSTAINABLE, HIGH PERFORMANCE BUILDINGS

Overview

The fundamental objective of this study is to determine if project delivery methods influence an owner’s ability to achieve its sustainability goals in delivering the building project. To make that linkage, the study explores two primary decisions:

1. The decision to build a sustainable, high performance building;
2. The decision to deliver that building using a particular project delivery method.

These decisions appear to be mutually exclusive. Therefore, they can be made independent of one another. In theory, any LEED level can be delivered with any project delivery method. However, the literature review, industry survey, content analysis, and interviews identified a number of issues that are pertinent to these two decisions. The following topics are discussed in this section of the paper.

- *Deciding to Go Green/The Green Guarantee* – the credit at which the owner’s level of sustainability is compatible with the budget and the point at which the project delivery method can provide a commitment from the designer and/or constructor.
- *Delivering Green: State of Practice* – the performance of each delivery method in delivering the promised or higher certification level.
- *Assignment of the Green Responsibility* – the point at which the responsibility for obtaining LEED certification is being assigned in the project delivery process.
- *Green Liability* – the ultimate responsibility for delivering sustainable goals and how owners are communicating and ensuring this responsibility.
- *Green Procurement Approaches* – the state of practice in procurement procedures for selecting designers and constructors.
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- *Ambiguity in the Certification Process* – trends regarding the authenticity of the certification sought for projects.
- *Sustainability by...* – the method by which owners are communicating their sustainability goals (Sustainability by competition, specified level, qualifications only, or reference).
- *Sustainable Issues and Barriers* – issues discovered in the course of this research that are creating barriers to the implementation of sustainable, high performance buildings.

Deciding to Go Green/The Green Guarantee

The decision to enhance the sustainability of a given building can literally be made at any time between concept and ribbon-cutting. However, as most sustainable features need to be developed during design, the decision is usually made at some point before the design is complete. As previously stated, while sustainable high performance buildings do not need to be LEED certified, this study is using that system as the metric for measuring sustainability. Therefore, it is important to understand the model for the decision to “go green” and the points in a project’s life cycle where a contractual “green guarantee” can be given to the owner by either

the designer or the builder. A green guarantee is defined as the contractual responsibility to deliver a building that will receive the owner’s designated level of LEED certification. Figure 6 illustrates the model for the green decision. The first thing one should notice is that while an owner can bind a designer to design a building to a specific LEED level, it is not guaranteed at a set price until the constructor is under contract. Thus, DB furnishes the earliest green guarantee and DBB furnishes the latest. CMR and DB with GMP do not lock the LEED level in until a GMP is established. Thus, the green guarantee can be realized at any point from the time the constructor is brought on board until the GMP is set. Looking at the four possible project delivery methods leads to the inference that the green guarantee defines the point where the owner’s level of sustainability is compatible with the budget within which the project must be delivered.

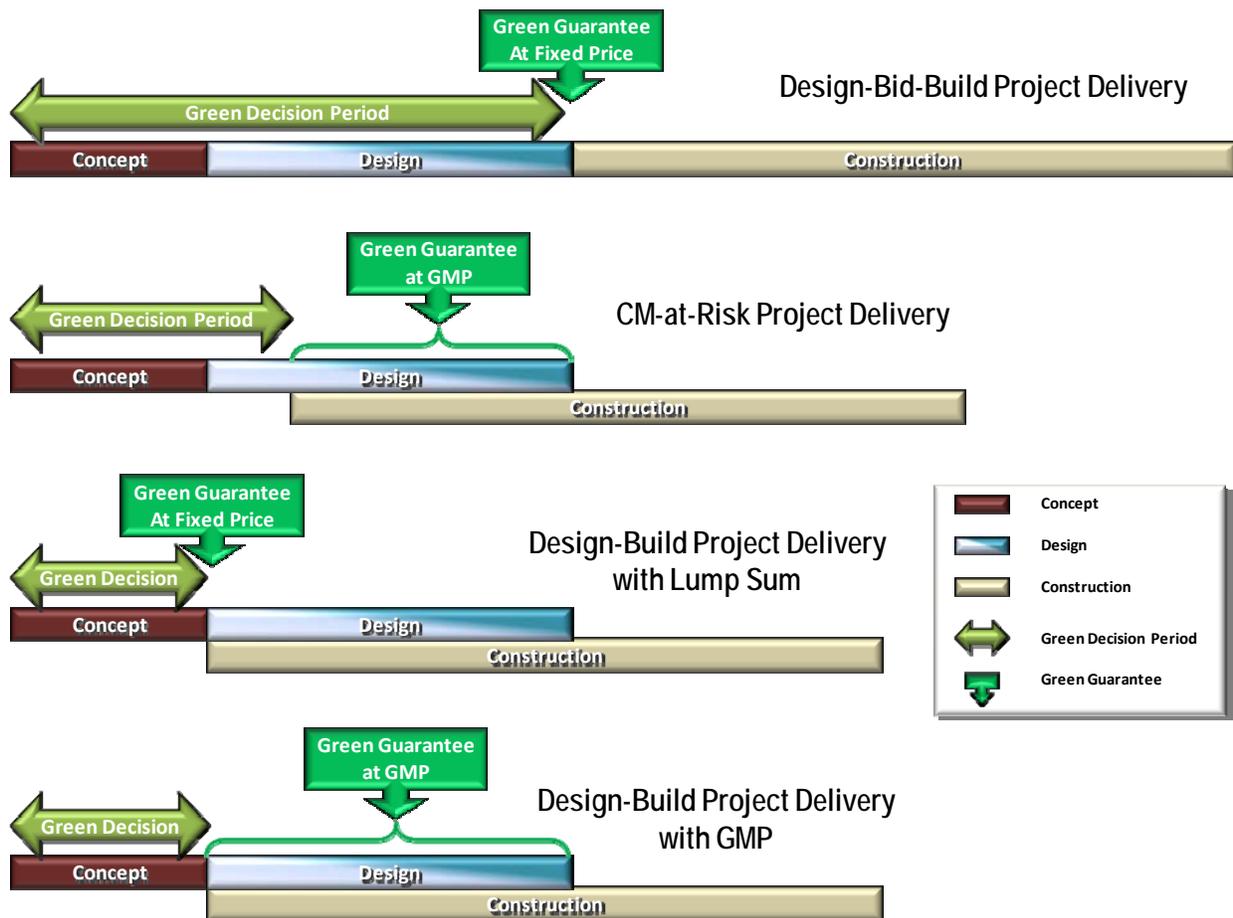


Figure 6: Green Guarantee Model

The survey asked the respondents to identify the point in the sustainable project delivery process where they assigned responsibility for obtaining LEED certification. As shown in Table 4, 57 percent indicated that they assigned this during the procurement phase and only one respondent waited until the design was complete before assigning this requirement. It also shows that DBB and CMR are evenly split between making the assignment during procurement and during design. Nearly 75 percent of DB projects assigned the responsibility during procurement. That

leads one to speculate that the remaining 25 percent must have either made LEED certification optional during the procurement process or added it in after contract award. The content analysis found seven DB projects where certification requirements were either optional or ambiguous, which confirms this inference.

Table 4: Responsibility for LEED Certification Point

<i>Project Delivery Method</i>	<i>During Procurement Before Design Award</i>		<i>During Design Before Construction Award</i>		<i>After Design Completion</i>	
	<i>Percent</i>	<i>Number</i>	<i>Percent</i>	<i>Number</i>	<i>Percent</i>	<i>Number</i>
<i>DBB</i>	49%	27	49%	27	2%	1
<i>CMR</i>	52%	62	48%	57	0%	0
<i>DB</i>	75%	42	25%	14	0%	0
<i>Total</i>	57%	131	43%	98	0%	1

Delivering Green: State of the Practice

Ultimately the proof of the linkage between sustainability goals and project delivery method is in the final LEED certification of projects delivered by various methods. Hence, the survey asked the respondents to indicate the initial LEED level that was sought at the start of the project and the actual level of LEED certification that was received after construction completion. A number of the respondents (81) stated that they had not yet received final certification. Table 5 shows the output from this analysis. First, it shows that respondents used integrated project delivery methods, DB and CMR, for 75 percent of the projects in the population. The survey also asked about constraints on project delivery method usage and 15 DBB projects indicated that they were restricted by lack of legal authority to use alternative project delivery and another 21 stated that their organizational policies and an unwillingness to try new project delivery methods constrained their project delivery method selection decision. Only six DB projects reported lack of legal authority as a constraint and that must be construed as an inability to use CMR. The major influences on DB projects were internal policies to use DB on LEED projects and a perceived industry preference for DB.

The survey shows that respondents used integrated project delivery methods, DB and CMR, for 75% of the projects in the population.

The influence of industry preferences and biases on the project delivery method decision for a sustainable project is confirmed by a number of respondent comments. A typical one comes from an Oregon LEED Silver CMR project: “As a GC, we will NOT bid a LEED project if it is DBB.” Another comment from a Missouri LEED Silver DB project shows the same industry preference/bias “Can’t do it if you don’t use DB.” To show the full range of attitudes toward LEED and project delivery methods, a comment from an Ohio LEED Silver project is interesting: “The design dictates the level of sustainability... Nothing else.” Finally, a comment from a Texas DBB project that *failed* to achieve certification is instructive: “Ability to negotiate is a key need during design and procurement to allow flexibility in design and cost.” Apparently,

this respondent was alluding to the potential for the negotiation of scope and budget inherent to CMR and DB that is not present in a low bid DBB project. Therefore, when an owner selects a project delivery method, the constraints on the availability of specific delivery methods plays an important part in the final decision and may even affect its ability to achieve the sustainability goals it has for the sustainable, high performance building project.

Table 5: LEED Success Rate by Project Delivery Method

<i>Project Delivery Method</i>	<i># Proj</i>	<i>#No Final LEED</i>	<i>% of sample</i>	<i>#Final LEED Rating</i>					<i>Success Rate</i>			<i>Final LEED ≥ Initial LEED</i>
				<i>uncert</i>	<i>cert</i>	<i>silver</i>	<i>gold</i>	<i>plat</i>	<i>Same</i>	<i>Higher</i>	<i>Lower</i>	
<i>DBB</i>	54	28	23.5%	1	10	5	7	3	63.3%	13.3%	23.3%	76.7%
<i>CMR</i>	120	34	52.2%	2	12	35	27	10	45.5%	48.9%	5.7%	94.3%
<i>DB</i>	56	19	24.3%	1	9	17	5	5	60.5%	21.1%	18.4%	81.6%
<i>Totals</i>	230	81	100.0%	4	31	57	39	18				

Table 5 measures the owner’s ability to achieve or exceed its desired level of LEED certification with a factor called the “success rate.” This is the percentage of the sample within a given project delivery method that met or exceeded the initial LEED level. A number of factors are at work when a project’s sustainability success is considered. First is the timing of the go-green decision in relation to the selection of the project delivery method. In DBB, waiting to seek certification until after the design contract is in force deprives the designer of the opportunity to price the cost to design a LEED certified building and therefore creates a situation where the designer may have to absorb the cost of redesign in order to achieve certification. Table 5 shows that this situation occurred in over half the DBB projects. So a failure rate of 23 percent is actually lower than would be expected. The rate may be ameliorated by the fact that many communities have sustainability mandated in their building codes for public projects (San Francisco Building Code, Los Angeles Building Code, Building Code of Baltimore City, et al.) and hence the owner’s tardiness in deciding to go green is not nearly as traumatic given the enhanced designer experience in these areas. Additionally, many design firms have adopted sustainable design practices as prescribed by initiatives such as the 2030 challenge (“The 2030 Challenge”) for all their projects regardless of the owner’s desires which also ameliorates the impact of a late decision on a DBB project.

DB’s success rate is better than DBB, delivering the desired level of sustainability in four of five DB projects. The owner’s major requirement in DB project delivery is the need to fully define the scope of work before awarding the DB contract (Gransberg et al. 2006). Anything that the owner wants to add to the scope after award usually comes with a price. Looking at Tables 4 and 5, one finds that 25 percent of the time the owner decided to go green during the design phase of the DB project, and this correlates with a failure rate of 18 percent. One possible explanation for the correlation was found during the structured interviews. Two of the design-builders indicated that if an unexpected compensable condition was encountered that the owner was usually willing to waive sustainable design features to stay on budget and thus, this attitude would increase the number of DB projects that do not achieve the initial desired certification. Additionally, two of four DB contractors and three of four owners interviewed identified DB as the riskiest project delivery method for achieving LEED certification. Reasons centered on fixing the budget before the design is complete and the compression of delivery period that is usually seen in DB projects.

The notable aspect of the CMR success rate is that it is high, and half the time the initial LEED level is exceeded. This is probably because a late go-green decision as shown in Table 4 does not have an unexpected negative impact on the project's budget until the GMP is fixed. Thus, in CMR project delivery, the scope of sustainable features of work can remain somewhat flexible during the preconstruction phase, where the constructor is able to make input to the sustainable design features. This input comes in the form of sustainable material availability, pricing, and the ability to earn construction LEED credits. Most GMPs are negotiated and thus, the owner and designer can literally negotiate which credits the project will accrue while getting real-time pricing for those features from the entity that will actually complete the construction. It must be noted that DB projects that use a progressive GMP would also have this ability and may in fact improve the success rate for this project delivery method. The survey did not differentiate between DB-Lump Sum and DB-GMP.

With the above discussion in mind a second factor that impacts LEED success rate for each project delivery method is the timing associated with the contract pricing provisions. In DBB, the construction contract is awarded after the design is finished. Hence, the green guarantee comes when the construction contract is signed. If the architect made sustainable design errors or omissions, the owner must then decide whether or not to increase the project's cost to attain the desired LEED level or accept a reduced level of certification. In DB-Lump Sum, a similar situation exists but in this case the project cost is fixed before design is complete. Thus, if the owner specified a required level of LEED certification, then achieving that level is a contract requirement. However, any enhancement above that specified level, requiring a substantial increase in construction cost comes out of the design-builder's pocket, creating a financial bias against exceeding the minimum specified level. In DB with a progressive GMP and CMR however, the price of the work is not fixed until the constructor can verify that the scope can be delivered within budget constraints. Additionally, the design-builder and CMR are typically selected on a basis of qualifications, which creates an incentive to exceed the owner's expectations and make the constructor more competitive for the next job.

Many GMP contracts also have shared savings clauses, but research casts doubt on whether they are effective in significantly modifying contractor behavior (Septelka and Goldblatt 2005). Bresnen and Marshall (2000) philosophically conclude that "clients and contractors are complex social entities, and their behaviors are not necessarily modified simply by the existence of incentive schemes." Thomsen (2006) summarizes the relative value of shared savings clauses versus future work when he says: "There must be a perception that repeat work will follow good performance. By far the *most important incentive that an owner has is the promise of repeat work.*" (Thomsen 2006 italics added). Finally, the structured interview with one design-builder confirmed the idea the ability to negotiate the scope of work prior to fixing the price in CMR and DB-GMP leads to a perceived incentive to exceed owner expectations; whereas, DBB and DB-Lump Sum shift the focus to profit and delivering only the contract requirements.

The survey asked each respondent to rate the impact project delivery method selection had on the ability to achieve the owner's desired level of sustainability. Four possible ratings from "no impact" to "absolute impact" were offered. Table 6 shows the results of that effort. At first glance, 90 percent of the respondents felt that the project delivery method impacted the owner's

ability to achieve its goals for sustainability. Design-bid-build was about 10 percentage points lower than CMR and DB in the respondents' perceptions. "Some impact" was the most frequent response for DBB projects. CMR projects had the highest number of "absolute impact" responses with DB having the greatest number that responded that it had "significant impact." These numbers line up with the success rates for each project delivery method shown in Table 5. The fact that twice as many CMR projects were rated as having the most impact probably explains the fact that twice as many CMR projects exceeded the required LEED certification. A similar trend is observed with DBB. Roughly 10 percent of the respondents believed project delivery method had no impact and 23 percent of the DBB projects failed to achieve the initial LEED level. Thus, one analysis supports the other and leads to the conclusion that project delivery method does indeed impact an owner's ability to achieve sustainable design and construction goals.

Table 6: Survey Response Regarding Project Delivery Method Impact on Achieving LEED

<i>Project Delivery Method</i>	<i>Project Delivery Method Impact on Achieving or Exceeding LEED Goal</i>				<i>TOTAL</i>	<i>Impact</i>	
	<i>None</i>	<i>Some</i>	<i>Significant</i>	<i>Absolute</i>		<i>None</i>	<i>Sum of 3</i>
<i>DBB</i>	10	22	17	5	54	10	44
<i>Percent</i>	18.5%	40.7%	31.5%	9.3%	100.0%	18.5%	81.5%
<i>CMR</i>	10	27	32	51	120	10	110
<i>Percent</i>	8.3%	22.5%	26.7%	42.5%	100.0%	8.3%	91.7%
<i>DB</i>	4	15	22	15	56	4	52
<i>Percent</i>	7.1%	26.8%	39.3%	26.8%	100.0%	7.1%	92.9%
<i>Totals</i>	24	64	71	71	230	24	206
<i>Percent</i>	10.4%	27.8%	30.9%	30.9%	100.0%	10.4%	89.6%

Table 7 contains a content analysis of the open-ended answers to the question: "Why do you think project delivery method impacts LEED success?" Most of the comments provided could be grouped into the five reasons shown in the table. Once again a clear trend appears for each project delivery method. Respondents discussing DBB cited budget issues as the most often selected reason. CMR responses focused on the preconstruction period where the constructor makes input to the design and DB responses stressed the need for team integration, which was the major theme when the population was taken as a whole.

Table 7: Reasons for Project Delivery Method Impact on Project Sustainability

<i>Project Delivery Method</i>	<i>Why Project Delivery Method Impacts LEED Success</i>					<i>Total</i>
	<i>Need Constructor Design Input</i>	<i>Budget Issues</i>	<i>Mutual Team Goals</i>	<i>Need Integration</i>	<i>Need to Evaluate Constructor Qualifications</i>	
DBB	5	10	6	4	6	31
<i>Percent</i>	16.1%	32.3%	19.4%	12.9%	19.4%	100.0%
CMR	33	17	11	29	7	97
<i>Percent</i>	34.0%	17.5%	11.3%	29.9%	7.2%	100.0%
DB	7	7	8	20	1	43
<i>Percent</i>	16.3%	16.3%	18.6%	46.5%	2.3%	100.0%
Totals	45	34	25	53	14	171
<i>Percent</i>	26.3%	19.9%	14.6%	31.0%	8.2%	100.0%

Table 8 parses the same data by final LEED certification level. Those that failed to achieve certification cited a need for a project delivery method that promotes mutual project delivery team goals. Certified and silver projects indicated the need for constructor design input, and the two highest levels, gold and platinum, cited the need for integration to achieve those particular levels of sustainability.

Table 8: Reasons for Project Delivery Method Impact on Project Sustainability Broken Out by Final LEED Certification (includes projects with final certification only)

<i>Project Delivery Method</i>	<i>Why Project Delivery Method Impacts LEED Success</i>					<i>Total</i>
	<i>Need Constructor Design Input</i>	<i>Budget Issues</i>	<i>Mutual Team Goals</i>	<i>Need Integration</i>	<i>Need to Evaluate Constructor Qualifications</i>	
Uncertified	0	1	3	0	0	4
<i>Percent</i>	0.0%	25.0%	75.0%	0.0%	0.0%	100.0%
Certified	7	5	6	5	2	25
<i>Percent</i>	28.0%	20.0%	24.0%	20.0%	8.0%	100.0%
Silver	14	12	2	13	3	44
<i>Percent</i>	31.8%	27.3%	4.5%	29.5%	6.8%	100.0%
Gold	9	6	3	12	2	32
<i>Percent</i>	28.1%	18.8%	9.4%	37.5%	6.3%	100.0%
Platinum	5	1	1	6	0	13
<i>Percent</i>	38.5%	7.7%	7.7%	46.2%	0.0%	100.0%
Totals	35	25	15	36	7	118
<i>Percent</i>	29.7%	21.2%	12.7%	30.5%	5.9%	100.0%

To summarize, Table 5 shows that the idea that any LEED level can be delivered by any project delivery method is true. However, the facts shown in Tables 6 through 9 demonstrate that there is some linkage. The state of the practice appears to favor those project delivery methods where the contract pricing provisions allow negotiation of scope and do not fix the contract amount until the constructor has been able to make substantive input to the sustainable design process as well as validate the LEED credits to be earned from sustainable construction features. Finally, Tables 7 and 8 demonstrate that integration between the designer, builder and owner is essential to achieving LEED certification at the highest two levels.

Assignment of the Green Responsibility

Table 9 shows the responses from the survey with regard to when the responsibility for obtaining LEED certification was assigned in the project delivery process. A clear trend is evident. The numbers of uncertified, certified and silver projects are roughly equal for the two possible points in time. However, the gold and platinum projects where the LEED certification responsibility was assigned during procurement is double those where it was assigned during design. Additionally, the ability to exceed the initial LEED rating was considerably higher for those projects that waited until design to assign the responsibility. These two pieces of information lead to the conclusions that if an owner desires a highly sustainable building, i.e. gold or platinum, it should assign the responsibility for obtaining LEED certification as early as possible. However, if an owner would like to maximize the sustainability within the constraints of budget and schedule, it is better to delay until the designer and the builder are able to collaborate during the design process.

Table 9: Assignment of LEED Certification Responsibility Timing

Procurement Procedure	# Proj	#No Final LEED	% of sample	#Final LEED Rating					Success Rate			Final LEED \geq Initial LEED
				uncert	cert	silver	gold	plat	Same	Higher	Lower	
During Procurement	131	40	57.1%	2	16	29	26	13	60.4%	27.5%	12.1%	87.9%
During Design	98	32	42.8%	2	15	25	13	5	42.4%	45.5%	12.1%	87.9%
After Design	1	1	0.1%	0	0	0	0	0	-	-	-	-
Totals	229	81	100.0%	4	31	57	39	18				

Green Liability

Providing a green guarantee creates a “green liability.” The green liability is an issue in failed certifications or certification below the contractually defined level. The research explored the relationship between delivery methods and allocation of risk for non-certification. For example, it is likely that owners will utilize a performance specification (i.e. “...project shall achieve a LEED Gold certification...”) when using the DB delivery method. In contrast, owners using the traditional DBB delivery method will likely prescribe specific LEED prerequisites and credits to be achieved (a design specification). Projects analyzed in the content analysis clearly validate this concept as 74.1 percent of the DB projects did not mandate specific LEED credits or quantifiable sustainable objectives while 100 percent of the analyzed DBB specification sections did. Consequently, 76.9 percent of the analyzed DBB projects clearly indicate that the owner/architect entity is responsible for the certification process with USGBC (and hence the implied liability for certification). As further evidence of this trend in DBB, the following phrase was repeated in several of the specification sections analyzed to represent DBB contractor procurement:

“Additional LEED prerequisites and credits needed to obtain the indicated LEED certification are dependent on the Architect's design and other aspects of the Project that are not part of the Work of the Contract”

Conversely, 85.2 percent of the analyzed DB projects in the content analysis do not allocate the responsibility (and subsequent risk) for certification with USGBC. While the intent of this is unclear, it is clear that either the owner or the design-builder entity may bear the liability for certification. While it may initially appear that the performance specification (and consequently a delivery method that can better accommodate the same), could potentially create less risk for the owner with regards to loss of certification or lowered levels of expected performance, the actual performance of this delivery method as determined by the survey portion of this study suggests otherwise. The survey found that the performance of the DB and the DBB delivery methods in achieving or exceeding the desired certification level (contractually opposite ways of specifying sustainable objectives) was approximately the same. While the outcome of DBB and DB success is essentially the same, DB allows for a much earlier green guarantee through performance specifications.

Green Procurement Approaches

Each project delivery method has a number of options for selecting the winning competitor and these are called procurement procedures. Table 10 shows the five different procurement procedures sampled in this study. They range from low bid to sole source. One can see that the highest success rates were associated with the procurement procedures that did not include price in the selection process. Competitively negotiated procurement placed third with best value a close fourth and low bid a full 10 percent less than best value. Again the all four LEED certification levels were successfully delivered using all five procurement procedures. QBS procurement is normally used in DB-GMP and CMR projects where price is negotiated after the award of the contract. Best value and competitively negotiated procurements tend to be popular for DB projects and low bid is usually reserved for DBB projects. However, each procurement procedure had at least one instance of each of the three project delivery methods. Most integrated project delivery methods either eliminate price competition or include price as one of several factors evaluated to make the contract award. The fact that QBS procurements enjoyed the highest success rate correlates with the output shown in Table 7 where contractor design input and integration were thought to be aspects most critical to LEED success within the two integrated project delivery methods.

Table 10: Impact of Procurement Procedure on Final LEED Ratings

Procurement Procedure	# Proj	#No Final LEED	% of sample	#Final LEED Rating					Success Rate			Final LEED \geq Initial LEED
				uncert	cert	silver	gold	plat	Same	Higher	Lower	
Low Bid	39	20	17.0%	1	8	5	2	3	60.9%	17.4%	21.7%	78.3%
Best Value	80	27	34.8%	1	9	23	14	6	59.3%	27.8%	13.0%	87.0%
Comp Negot	65	21	28.3%	2	9	14	15	4	50.0%	40.9%	9.1%	90.9%
QBS	28	10	12.2%	0	3	9	5	1	45.0%	50.0%	5.0%	95.0%
Sole Source	18	3	7.8%	0	2	6	3	4	46.7%	46.7%	6.7%	93.3%
Totals	230	81	100.0%	4	31	57	39	18				

Contract Payment Provisions

As previously discussed, the impact of contract payment provisions on the owner’s ability to exceed its desired level of sustainability can be profound. DBB and DB-Lump Sum require the constructor to fix its price before it can make substantive input to the design process. Tables 7 and 8 both showed that this input is essential to achieving the integration necessary to achieve the highest LEED certifications. DB-GMP and CMR both allow the necessary constructor input to the design and furnish a green guarantee after negotiating the project’s GMP. The survey responses indicated that the industry prefers to have the opportunity to negotiate both the scope and the cost. The survey output showed that in those cases where this was possible, the success rate was enhanced. Therefore, owners should carefully evaluate their sustainability goals in the context of the constraints they may have on using contract payment provisions that facilitate rather than hinder the achievement of those goals.

Ambiguity in the Certification Process

Notable trends regarding the final application of the project certification sought were found in the content analysis portion of this study. The most common finding (46.7 percent of the analyzed projects, regardless of delivery method) was for the project to seek official certification with the USGBC. However, a discussion of the remaining 53.3 percent of the projects analyzed is appropriate. Fourteen point one percent of the projects analyzed contained ambiguous language that did not clearly communicate the intent to certify. For example, a phrase such as “...shall meet the requirements of a LEED silver rating...” versus “...shall achieve certification at the silver level with the USGBC...” can be interpreted with vastly different outcomes. The first may intend that a silver certification will be achieved by the project but may also mean that the LEED rating system will be used to meet sustainability objectives without certification; thus meeting the “requirements”. The second example leaves no doubt that an official certification via the USGBC is the contractual intent. Furthermore, 21.8 percent of the projects analyzed either listed certification as optional (i.e. as an added price to a base bid for example) or used the LEED evaluation system as a measurement for evaluating sustainable aspects of the design and construction while clearly not seeking official certification (i.e. “...project shall be registered with the USGBC but will not seek certification...”). These findings are perhaps symbolic of a risk-averse attitude by owners towards the third party evaluation system and/or a lack of understanding in how to incorporate the third party evaluation system into proposals and subsequent contracts. Owner aversion to increased cost may also explain these findings. Interestingly, the remaining 17.4 percent of the projects analyzed did not discuss certification at the project level but did procure designers and/or builders based on their experience with the LEED rating system. This is perhaps indicative of the late decision to go green that appears to occur in the current construction market.

14.1 percent of the projects analyzed contained ambiguous language that did not clearly communicate the intent to certify.

Sustainability by...

Categories revealed in the content analysis provide a model for how owners can articulate their sustainability goals and procure the best teams to provide the green guarantee. These are:

1. *Sustainability by Competition* – procurement by competition of LEED certification level;
2. *Sustainability by Specified Level* – procurement by prescription of the LEED certification level;
3. *Sustainability by Qualifications Only* – procurement through team qualifications regarding LEED experience and definition of LEED certification level later in design; and
4. *Sustainability by Reference* – procurement with some reference to sustainability but without articulation of a desired certification level or team qualifications.

The first and highest category in the hierarchy is sustainability by competition. Within this category, only projects that weight or score higher LEED certification levels within the procurement are included. This implies that owners utilizing this procurement style view the sustainable objectives of their projects with the utmost importance. The second category is sustainability by specified level. Projects that are included in this category specify their sustainable objectives by a specific performance level (i.e. project shall achieve a LEED gold certification...). The third category is sustainability by qualifications. These projects do not specify a given certification level (whether mandated or evaluated) but do evaluate the designer and/or builder based on their experience or credentials for sustainable construction. The last category is sustainability by reference. Projects within this category do not specify a given LEED level (whether mandated or evaluated) nor do they evaluate the sustainable design and construction credentials of designer and/or builder. However, they do refer to some function of sustainability in the solicitation document. For example, “this project is a sustainable building.” This is the lowest category as it is implied that owners utilizing this procurement style value the sustainable building aspects of the project the least. The results of this analysis are presented in Table 11 and are arranged by the aforementioned categories and the project delivery method used.

Table 11: Sustainability by...

<i>Project Delivery Method/ Sust. by...</i>	<i>DB</i>	<i>DBB (A/E)</i>	<i>DBB (GC)</i>	<i>CMR (A/E)</i>	<i>CMR (GC)</i>	<i>ALL</i>
<i>Sustainability by Competition</i>	14.8%	0.0%	0.0%	0.0%	0.0%	4.3%
<i>Sustainability by Specified Level</i>	55.5%	47.4%	100.0%	61.5%	60.0%	62.0%
<i>Sustainability by Qualifications Only</i>	14.8%	42.1%	0.0%	30.8%	40.0%	26.1%
<i>Sustainability by Reference</i>	14.8%	10.5%	0.0%	7.7%	0.0%	7.6%

The results from this process clearly show that most owners are procuring designers and builders with a specific certification level in mind (sustainability by specified level). Owners utilizing the integrated project delivery methods including DB and CMR, appear to more often have a specific LEED certification level in mind when they are acquiring either designers or builders.

Conversely, the DBB category at the procurement phase of the design team (DBB A/E) was the only delivery method to show significant variation from this trend. Owners procuring design teams and utilizing the traditional DBB delivery method were found to communicate the sustainable objectives of the project through a specified LEED level approximately as often as they relied solely on the evaluation of the design teams experience with the LEED rating system. This indicates that owners utilizing the DBB delivery method often rely on the expertise of the design team in selecting an appropriate LEED level; more so than any other delivery method. Within this same delivery method it was also found that owners took a strictly prescriptive approach to specifying the LEED rating goals when acquiring the constructor entity for the project.

ISSUES WITH SUSTAINABILITY AND DELIVERY

As was previously described, an analysis of projects with sustainable objectives but utilizing different delivery methods was accomplished via a content analysis methodology. Presented here are the main findings of this analysis by delivery method. The presentation of delivery methods is ordered from the DBB delivery method (the least integrated delivery method) to the DB delivery method (a fully integrated delivery method).

The Design-Bid-Build Delivery Method Issues

For the content analysis of the DBB delivery method, two distinct procurement phases were established: acquisition of the design team (DBB A/E) and the acquisition of the constructor (DBB GC). Between these two procurement phases, several findings emerged. It was found that owners do not typically have a specific LEED certification level in mind nor have they decided whether or not to seek certification with the USGBC when procuring design teams. Conversely, owners were found to clearly have certification goals in mind when procuring constructors. This indicates that owners using the DBB delivery method most often develop clear sustainability goals with the aid of the design team rather than with internal sources (or the aid of the constructor). Owners utilizing DBB delivery also use prescriptive measures to specify LEED credits to be achieved and consequently retain the liability for doing so. While performance specifications regarding LEED could be used to specify the desired sustainability goals, owners are clearly averse to this practice.

In regard to procurement, 36.8 percent of the projects in the content analysis procured the design team based on the experience of the firm and the personal experience of key staff members. However, no apparent vetting processes were typically utilized when procuring the constructor.

Construction Manager at Risk Delivery Method Issues

The content analysis of projects utilizing the CMR delivery method was also split into the procurement of the design team (CMR A/E) and the procurement of the constructor (CMR GC). Like the DBB delivery method, the content analysis found that owners do not always specify their sustainable design and construction goals when acquiring the design team. Unlike DBB, the trend of failing to articulate clear cut sustainability goals continued to the constructor's procurement. This indicates that owners may prefer to wait for the at-risk construction manager's design input and consequent pricing information before making the decision to go green and select a pragmatic level of certification. Furthermore, owners most commonly did not

indicate specific LEED credits to be achieved or allocate the liability for certification when acquiring the constructor, indicating that the contractual flexibility of utilizing design specifications or performance specifications is available and that the ability to allocate the responsibility of certification to the most qualified party exists. This is found in the GMP negotiation process and confirms the trends seen in the survey data.

Both the design team and the constructor were most often found to be acquired based on the previous experience of the company in LEED certified projects (46 percent and 45 percent respectively). Unlike, the DBB delivery method, work or action plans specific to the LEED certification sought were included and scored in the procurement of both the design team and the constructor.

Design-Build Delivery Method Issues

The DB solicitation document content analysis found that owners typically have clear cut sustainability objectives as measured by a set LEED certification level and the desire to officially certify projects with the USGBC. Similar to the CMR delivery method, explicit LEED credits were typically not specified and the liability for certification was typically not allocated when procuring the design-builder. This again serves as evidence of the ability to use a performance specification with this delivery method as well as the ability to allocate the responsibility for certification to the party most fit to manage the task.

The procurement of design-builders was most often based on the experience of the company with sustainable construction, within a best-value procurement procedure. However, it may also be noted that some DB projects were found to include a scored criterion for elevated LEED levels beyond the minimum level required. Examples of this were exclusive to the DB delivery method.

CONCLUSIONS

The findings of this study revolve around two central themes:

- 1) The use of integrated project delivery methods provides optimal performance; and
- 2) The importance of early constructor involvement in meeting sustainable objectives.

The study found that all project delivery methods were used to achieve all levels of LEED certification. However, success differs for each of the project delivery methods. Success was measured through a quantification of projects which met or exceeded their initial LEED rating goals and also through a survey of LEED APs who have completed certified projects.

Integrated project delivery methods were used in 75 percent of the projects studied. CMR is the most successful project delivery method with a 94 percent success rate and exceeding owners' expectations half the time. Both DB and CMR show distinct advantages in project performance when compared to DBB. Success in both CMR and DB is enhanced by the use of GMP payment provisions. Success rates favor those project delivery methods that do not seek pricing before selection. If owners want to maximize sustainability within available budget, CMR or DB-GMP provides the greatest likelihood of success.

If owners want platinum or gold certification, the results of the study suggest that they should decide to go green early, specify the level, and use DB to get integration as soon as possible. Owners assigned the responsibility for gold and platinum projects during procurement at twice the rate of those assigned during design. Sixty-two (62) percent of projects in the content analysis articulate sustainable objectives by a predetermined, specified level of certification in the solicitation documents. Specific green building decisions including the responsibility for certification with USGBC and the identification of specific LEED credits are typically not allocated/identified until after procurement (72 and 74 percent respectively).

KEY SUCCESS FACTORS

By way of summary, the study found the following key facts relating to success include:

- Seventy-five (75) percent of projects in this study use integrated project delivery methods;
- CMR is the most successful project delivery method with a 94 percent success rate and exceeding owners' expectations half the time;
- If owner wants to maximize sustainability within available budget, CMR or DB-Guaranteed Maximum Price (GMP) provide the greatest likelihood of success;
- Success rates favor those project delivery methods that use GMP payment provisions;
- Success rates favor those project delivery methods that do not seek pricing before selection;
- Owners that want to achieve a specific LEED level at a fixed price prior to construction are successfully using DB-Lump Sum (LS) or DBB to specify the LEED level in the procurement documents;
- Owners that successfully achieved gold or platinum certification in this study assigned the responsibility for achieving project sustainability objectives during procurement at twice the rate of those assigned during design;
- If owners want gold or platinum certification, decide to go green early, specify the level, and use DB to get the necessary integration as soon as possible;
- DB allows for a transfer of the green liability while DBB and CMR maintain the liability with the designer/owner;
- Sixty-two (62) percent of projects in the content analysis articulate sustainable objectives by a predetermining a specific level of certification; and
- Specific green building decisions including the responsibility for certification with USGBC and the identification of specific LEED credits are typically not allocated/identified until after procurement (72 and 74 percent respectively).

This paper is part of a comprehensive study that is seeking to determine if project delivery methods influence an owner's ability to achieve its sustainability goals in designing and constructing building projects. The research team is currently conducting detailed case studies to further explore the determinants of success in delivering sustainable, high performance building projects. The final products will include a *Guide to Delivery Methods for Sustainable, High Performance Projects*, a summary of exemplary case studies that will include a variety of project delivery methods under different LEED ratings, and criteria development for USGBC to gather project delivery related information on future project registrations. The results of the final study will be available from the Pankow Foundation late in 2010.

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