

Influence of Project Delivery on Sustainable, High Performance Buildings

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DEDICATION

This report is dedicated to Dr. Michael Horman (1972-2009) who pioneered efforts to demonstrate the impacts of project delivery methods on sustainable, high performance building projects.

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INTRODUCTION

This report provides guidance on the impact of project delivery methods in achieving sustainable, high performance building projects. The findings are synthesized from a two-year study that collected data through 230 surveys, 92 procurement documents, and 12 in-depth case studies.¹ This report provides owners, government agencies, architects, engineers, constructors, and industry trades with facts to improve decision making when selecting project delivery methods and key team members to achieve sustainable, high performance building projects. Four key findings from this report are:

- 1) *Impact of Owner Commitment*: green strategies should be an owner driven factor;
- 2) *Impact of Green Timing*: early inclusion of the green concepts is necessary, as early as the pre-design phase;
- 3) *Impact of Integration*: Project delivery methods that facilitate integration and collaboration between design and construction – construction manager at risk (CMR) and design-build (DB) – can enhance sustainability and performance; and
- 4) *Impact of Contract Payment Provisions*: the use of guaranteed maximum and cost-plus pricing can enhance sustainability and performance.

MOTIVATION FOR SUSTAINABLE, HIGH-PERFORMANCE BUILDINGS

With greater demands being placed on our energy and material resources, 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 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 2008). 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

¹ The research was conducted in two phases. More details can be found in the following research reports: A. Molenaar, K.R., Sobin, N., Gransberg, D.G., McCuen, T., Korkmaz, S., and Horman, M. (2009). Sustainable, High Performance Projects and Project Delivery Methods: A State-of-Practice Report, *Report to the Charles Pankow Foundation*, Claremont, CA, September 2009, 31 pp; and B. Korkmaz, S., Swarup, L., Horman, M., Riley, D, Molenaar, K.R., Sobin, N., and Gransberg, D.G. (2010). Sustainable, High Performance Projects and Project Delivery Methods: Report on Case Studies, *Report to the Charles Pankow Foundation*, Claremont, CA, May 2010, 38 pp.

that sustainable, high-performance building has experienced exponential growth and shows few signs of decline.

The three primary project delivery methods include DB, DBB, and CMR. These methods define the contractual relations, timing of involvement of project participants, and contract conditions such as penalties, incentives, risks, and liabilities among participants.

The growth of the Leadership in Energy, Environmental Design (LEED®) rating system and sustainable, high performance building in the public sector is 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. The Order directs all federal agencies, including the General Services Administration all branches of the military, and others 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.

Sustainable Building Project Delivery

The achievement of sustainable building goals increases the level of project complexity in comparison to traditional project delivery. Increasing interdisciplinary interaction is imperative for optimal solutions. This interdisciplinary interaction, also known as the integrative design process, suggests that attributes such as early involvement of participants, levels and methods of communication, and compatibility within project teams result in better outcomes (Lapinski et al. 2006; Enache-Pommer and Horman 2009; Korkmaz et al. 2007; 7 Group and Reed 2009). The literature also indicates that the project delivery methods might affect the above-mentioned attributes. The three primary project delivery methods include design-bid-build (DBB), construction management at risk (CMR), and design-build (DB). These methods define the contractual relations, timing of involvement of project participants, and contract conditions such as penalties, incentives, risks, and liabilities among participants.

Although the green building industry and the literature point toward the need for higher integration in green building project delivery, literature addressing guidelines toward “how” to meet sustainable goals is lacking. Green building assessment systems such as Green Globes (2009) and LEED (USGBC 2009) are heavily focused on “what” to achieve rather than “how” to achieve. Other forms of guidelines for integrative design in green project delivery (e.g., Integrated Project Delivery [IPD 2009]; Whole Building Design Guide [WBDG 2009]) are recent and are not yet proven through rigorous research. As a response to this need, a comprehensive study is essential for determining how project delivery methods influence achievement of sustainability goals in delivering building projects.

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

The Need for Integration

Several studies on designer and constructor integration explore the impact of integration on delivering sustainability projects. Initial studies show that traditional DBB strategies may not address the issues found in high performance buildings and may actually constrain the constructor’s ability to assist in achieving sustainable objectives (Lapinski, et al. 2006; Riley et al., 2003). Design team separation from the constructor reduces the opportunity for innovative solutions by the constructor and specialty contractors. This is especially pronounced in the areas of mechanical systems and energy modeling (Riley, et al. 2005). A study of performance metrics used to measure the impacts of various project delivery attributes in sustainable construction confirms that the timing of constructor involvement is a key factor affecting all performance outcomes (Korkmaz 2007). Taken together, these studies recommend early team integration to achieve a high level of sustainable objectives. One author’s opinion on the subject is: “The bottom line: it’s very difficult to achieve high-level [green] outcomes without some form of integrated design process” (Yudelson 2009).

Integration of the designer and constructor is established when the owner selects the project delivery method to design and build the project. 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 (Migliaccio et al 2008). Upon selecting the project delivery method, the owner must identify the procurement procedure for selecting the designer and constructor as well as the contract payment provisions for compensating those parties to the contract. The terms surrounding project delivery methods can be confusing and

experienced professionals often misuse them. Standardizing the definition of the three major components of design and construction contract operations is essential to understanding project delivery and the facts involved in this report (Molenaar et al 2009).

- *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. While names can vary in the industry and owners often create hybrid delivery methods, there are essentially three primary project delivery methods: DBB, CMR, and 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 four primary contract payment provisions are fixed price lump sum, guaranteed maximum price (GMP), cost plus fee, and cost reimbursable.

Figure 1 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.

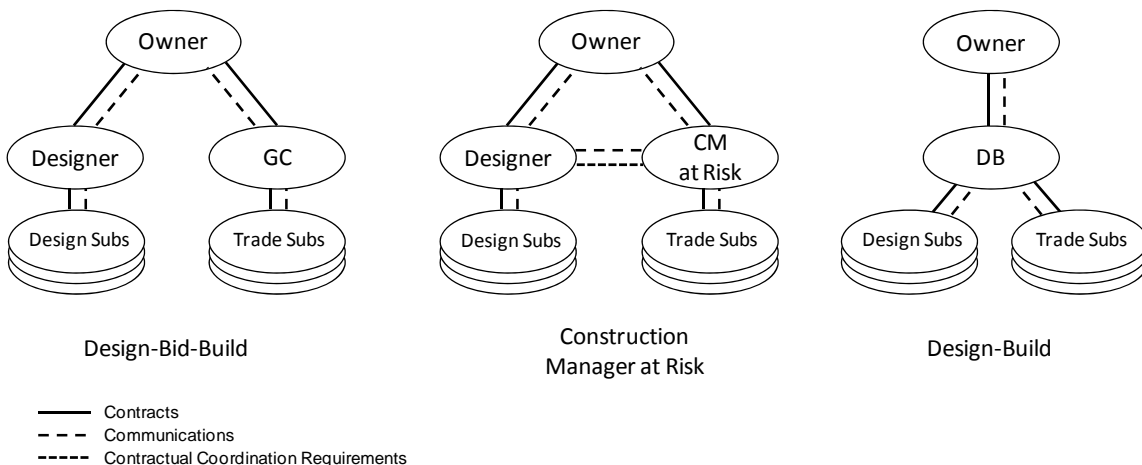


Figure 1. Project Delivery Systems – Contracts and Communications

RESEARCH APPROACH

This project was conducted in two phases with distinctly different methods for data collection and analysis. Phase I employed a three-tiered research approach of: (1) industry survey; (2) content analysis; and (3) structured interviews. The industry survey garnered responses from 230 LEED Accredited Professionals (LEED APs) from 47 of 50 states and the District of Columbia. The content analysis examined 92 projects representing over \$2.2 billion dollars in vertical construction work from 32 different states. Structured interviews with four design-builders (Oklahoma, Texas, Virginia, and Illinois) and four public owners (all GSA) were used to help interpret the results of the survey and content analysis (Molenaar, et al. 2009). The essential research question for Thrust I was:

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

Thrust II of this study made an in-depth examination of 12 LEED projects across the spectrum of project delivery methods. To provide equal comparison among the cases, the study focuses only on office buildings in the US that received awarded at various levels of LEED® certification according to new construction or core and shell categories. Data collection arose from case study interviews of multiple, primary respondents (i.e., owner, designer, and constructor) representing each project (Korkmaz et al. 2010). The essential research questions for Thrust II were:

What is the extent of the effect of project delivery methods and practices on the level of integration achieved in projects?

Does the level of integration have an effect on project outcomes with a focus on sustainability goals?

The objective of this report is to merge the findings of the two studies and identify trends and measures of certification success in the current state of practice related to project delivery methods.

Table 1 is an aggregate of the project type by project delivery method. The aggregation of the two reports reveals a distribution of public owners to private owners that is essentially equal.

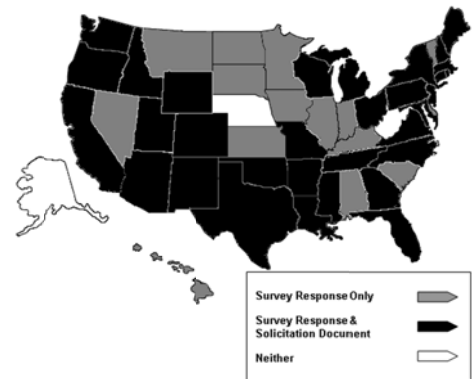


Table 1. Project Delivery Method by Owner Type

Delivery Method	Thrust I		Thrust II		Total
	Public	Private	Public	Private	
DBB	31	23	1	2	57
CMR	51	72	0	4	127
DB	39	14	0	5	58
Totals	121	109	1	11	242

FINDINGS

Impact of Owner Commitment

Owners of projects in this study generally mandate the achievement of sustainability goals in their contracts with design and constructor teams. Sustainability is an extensive concept and includes complex processes that require close multidisciplinary collaboration among project participants to optimize systems in high performance building projects. The processes these buildings require are very different from traditional design and construction practices. The study results lucidly demonstrate that an owner's strong commitment is a requirement to satisfy even minimal aspects of sustainability. However, observations indicate that achieving or exceeding high sustainability targets (i.e., USGBC's LEED® gold and platinum certifications) requires exceptionally high owner commitment. Some of the benefits of highly sustainable buildings do not always result in obvious financial returns to the owner (e.g., low energy consumption, market credibility, occupant's increased productivity, etc.). Therefore, owners need to believe in the concept of green as the "right thing to do" and understand that green buildings can have important and positive consequences for occupants and the environment.

Green strategies should be included in the project no later than the schematic design phase to make them a fundamental part of the project – as early as the pre-design phase (Enache-Pommer 2008; Korkmaz 2010; and Korkmaz et al. 2010). However, earlier inclusion of green concepts is only possible if an owner, the primary stakeholders and decision makers demonstrate a high-level of commitment.

Impact of Green Timing

Green timing refers to the point where the Owner establishes the contractual LEED certification requirement. All building construction contracts contain specific performance requirements and LEED certification is the requirement of interest in this report. Thrust I and Thrust II of this study identified the point in the project delivery cycle

that the requirement to achieve a specified level of LEED certification became a contract requirement. This is termed the “green guarantee”². Figure 2 provides a graphical model of the green guarantee concept.

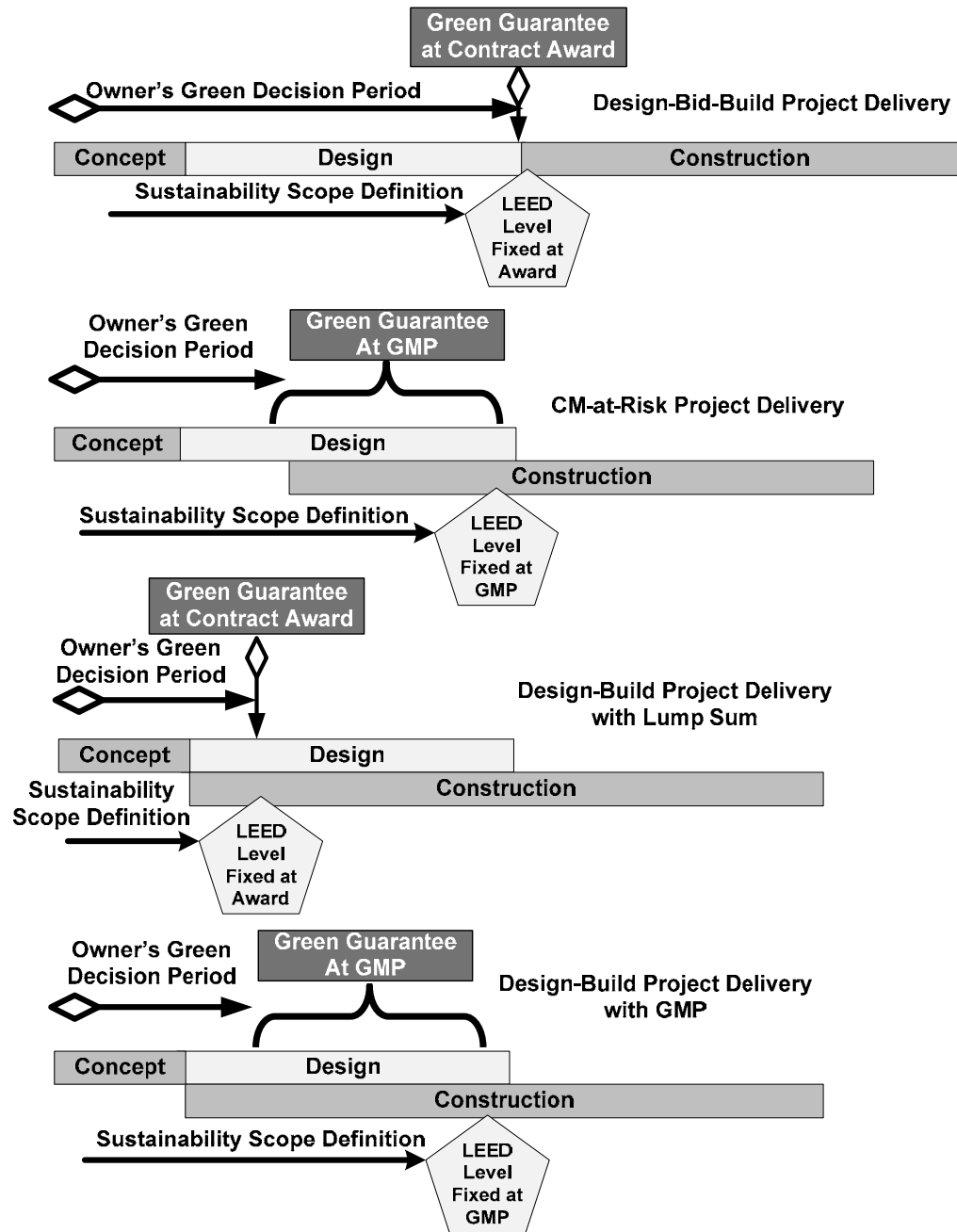


Figure 2. Green Guarantee Model

² Please note that the term “green guarantee” does not refer to a contractual guarantee of a LEED certification or rating level. The ultimate LEED rating is determined by a third party to the project delivery contract and it therefore not typically guaranteed by the designer, constructor or design-builder.

Seventy-five (75) percent of projects in this study use integrated project delivery methods – DB or CMR – and these integrated methods provided a higher success rate in achieving the stated sustainability goals.

This study defines the green guarantee “as the contractual responsibility to deliver a building that will receive the owner’s designated level of LEED certification.” It also suggests that “green guarantee defines the point where the owner’s level of sustainability is compatible with the budget within which the project must be delivered.” Based on these statements the earliest guarantee is provided by DB and the latest by DBB. The green guarantee in CMR is based on the timing when the GMP is fixed.

Impact of Integration

Even though it is possible to informally involve the constructors in the design phase of a DBB project, integration is undoubtedly a function of the contractual relationships established in the project (AIA 2009). Design-bid-build project delivery is the least integrated of the three primary delivery methods in that the constructor is contractually separated from the design team. Design-build is the most integrated in that the constructor is contractually integrated in the design-build team through a single contract with the owner. Construction Manager-at-Risk falls somewhere between DB and DBB project delivery methods in that CMR has contractually facilitated communications during the design phase. However, the point in design at which the constructor is hired can greatly impact the level of team integration

Table 2. Success of Rate of Delivery Methods

Delivery Method	Success Rate (project achieved of stated LEED level)			Total (final LEED ≥ initial LEED)
	Same	Higher	Lower	
DBB	63.3%	13.3%	23.3%	76%
CMR	45.5%	48.9%	5.7%	94%
DB	60.5%	21.1%	18.4%	81%

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 in this study 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. Seventy-five (75) percent of projects in this study use integrated project delivery methods – DB or CMR – and these integrated methods provided a higher success rate in achieving the stated sustainability goals. Table 2 summarizes these results for the 149 of the 230 projects that had received a rating at the time of the survey.

Table 2 measures the owner’s ability to achieve or exceed its desired level of LEED certification with a factor called

the “success rate.” 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. 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 Figure 2, does not have an unexpected negative impact on the project 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 and the constructor is able to provide input on the sustainable design features.

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. Although Figure 2 differentiates DB-Lump Sum and DB-GMP, it should be noted that the survey did not. Design-build’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. The trends from the 12 in-depth case studies verified these findings: CMR and DB project delivery methods facilitated higher levels of integration and although cost growth appeared from every project delivery method, projects executed with traditional DBB displayed a trend in cost growth.

Impact of Contract Payment Provisions

This study found that the designer and constructor payment provisions do have an impact on the achievement of sustainable objectives. This impact had not been recognized prior to this study (Del Percio 2010; Gibbons 2009). This is a symptom of a process that is still viewed as entirely design-oriented and not a product of integrated delivery. “[T]he first green building contract addendum – the AIA’s B214-2004 – purely addressed scope when it debuted three years ago. Notwithstanding the inherent limitations with form contracts and exhibits... the industry clearly perceives risks arising out of green building projects... we will see more organizations [like DBIA] developing and promoting similar consensus documents with risk management provisions as we continue to move forward in 2010” (Del Percio 2010).

Selection through some form of qualifications for the designer *and the constructor* and compensation with a

GMP (public) or cost-plus payment (private) contracts provide better results in regards to sustainable, high performance buildings. These procurement and payment methods permit the award of both the design and construction scopes without a commitment to a firm fixed price. This permits an integrated approach to negotiating the details of the project's sustainable design and construction features. Additionally, GMP provisions provide for the inclusion of mutually agreed contingencies that can become the pool for incentivizing the sustainability features of the final constructed facility (Ripley 2004). Thus, the expectation that GMP contract pricing provisions will create an aura of financial flexibility that permits the project team to optimize the final level of sustainability with the other constraints of the project is logical. In fact, the state-of-practices survey for this study found that CMR projects were the most successful in meeting or exceeding the owners' specified level of LEED certification.

Examining Figure 2 and Table 2 together reveals that LEED success rates for each project delivery method is a function of 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.

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. Findings from the analysis of projects successful at achieving the LEED goal in Thrust I were completed with those project delivery methods that do not

seek pricing before selection. Trends indicate that if an owner wants to maximize sustainability within available budget, CMR or DB-GMP provides the greatest likelihood of success. The pricing factor by owner type was 90 public owners and 86 private owners from a population of 230 survey respondents.

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. The number of gold and platinum projects where the LEED certification responsibility was assigned during procurement was double those where it was assigned during design.

The findings from the 12 in-depth case studies revealed that projects with high owner commitment and those that achieved a higher certification level most often adopted a cost-plus fee arrangement, especially for the projects identified as exemplary projects. Eleven of twelve projects in the study were projects by private owners. Respondents in the second study preferred cost-plus fee because the project team, designer and constructor, focused on the project goals rather than deviating from the goals to protect their own financial interests.

CONCLUSIONS

The results of this research reveal four common elements in projects that maximized sustainable design and construction efforts:

- 1) *Impact of Owner Commitment*
- 2) *Impact of Green Timing*
- 3) *Impact of Integration*
- 4) *Impact of Contract Payment Provisions*

The study found that all project delivery methods were used to achieve all levels of LEED certification. All project delivery methods benefit from strong owner commitment to sustainability principles. Integrated project delivery methods are most successful and were used in 75 percent of the projects in the study's survey. 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.

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