IMPACT OF LEED®-NC PROJECTS ON CONSTRUCTORS

Summary

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PREFACE

On behalf of my research team and the industry advisory group, I am pleased to present the summary of the final project reports. The reports consist of three volumes: Volume 1 contains the descriptive report and Volume 2 is the presentation package. In addition, Microsoft Access® based database query system is provided on a CD as volume 3.

It is widely believed that sustainable or green buildings are on the verge of entering the mainstream of our society. In recent years, the LEED® (Leadership in Energy and Environmental Design) rating system has gained nation-wide acceptance as the benchmark for sustainable buildings among corporate and institutional building owners and the design industry. Constructors (general contractors and construction managers) have started to see the need to understand this emerging sector since they are the ones who are responsible for implementing the completed design. Many constructors who were part of LEED® projects realized that they end up playing a major role on such projects and it increases their project management and documentation responsibilities.

This report represents the analysis of LEED®-NC credits with respect to the role and responsibilities of constructors. The analysis was refined based on four case study projects and 18 members of the industry advisory group (IAG). The four case study projects were in various stages of completion and had achieved or were targeting different levels of LEED®-NC certifications. The IAG members consisted of constructors, engineers & designers, owner's representatives, commissioning agents and providers of LEED® technical assistance.

I would like to thank the members of the industry advisory committee for their valuable input. I am especially thankful to the two IAG co-chairs, Grant Mendeljian and Jarrad Pitts, for their support at multiple levels. In addition, I would like to thank my entire research team (Shilpi Mago - lead research assistant, Douglas Moody, James Holden, Varun Potbhare, Amanjeet Singh, and George Berghorn) for their roles in this and other on-going sustainable built environment projects. Finally, I would also like to acknowledge the funding and support provided by the AGC Education and Research Foundation and the Environment Research Initiative at the Michigan State University.

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ABSTRACT

In the wake of sustainable construction entering mainstream and the LEED®-NC green building rating system becoming synonymous with green buildings, the need to assess the impact of this system on constructors' practices is imperative. While owners and designers have taken the lead in pursuing LEED® projects, there is a strong need to define the role of constructors' and their early involvement in the green building process. This research presents an analysis of the impact of LEED®-NC credits on constructors. The impact of LEED®-NC credits has been categorized under three levels: "Major", "Minor", and "Some". The preliminary impact analysis was refined with the help of four case study projects and an eighteen-member industry advisory group. It is envisioned that the research output in the form of a presentation package and a database query system would greatly assist constructors as they navigate LEED®-NC projects.

INTRODUCTION

Sustainable development has long been recognized as the next step that humankind should take in order to recuperate from the aftermath of the industrial revolution (Gottfried 2000). Events such as the Stockholm Declaration, the Brundtland Report, and the Rio Summit have brought nations together to address humankind's increasing impacts on the environment. Some studies indicate that one of the largest contributors of these impacts is the construction industry (CICA 2002). In the wake of sustainable construction entering mainstream, and the LEED®-NC green building rating system becoming synonymous with green buildings, the need to assess the impact of this system on constructors' practices is imperative. This research attempts to analyze and define constructors' role in executing LEED®-NC projects.

Buildings in the United States consume one third of all primary energy produced and close to two thirds of electricity produced (Vanegas and Pearce 1997). According to Kibert (2005), 30% of all new and renovated buildings in the U.S. experience poor indoor environmental quality due to noxious emissions, off gassing from evaporation of harmful substances present in building materials, and pathogens; resulting in low productivity that causes an annual loss of $60 billion. In an effort to address the environmental impacts of buildings and construction activities, several researchers have suggested the inclusion of sustainability in construction project objectives that brings forth the need to reconsider as to how the existing practices in the design and construction industry best align with the sustainability goal (Houvila and Koskela 1998).

In addition, the shift to incorporate sustainable practices into typical design and construction processes requires a redefinition of the existing role of project participants in

order to contribute effectively to sustainable project objectives. An important characteristic of sustainable projects is that they lend themselves to a multidisciplinary and integrated team effort rather than a typical linear design and construction process (Gottfried 2000). This integrated approach requires early involvement and greater participation of different project members in order to better utilize their technical expertise and knowledge.

The green building movement in the United States has encouraged the creation of many green building rating systems. The Leadership in Energy and Environmental Design (LEED®) Green Building Rating System, developed by United States Green Building Council (USGBC) is most widely accepted. The owners as well as the design and construction industry has gradually accepted the LEED® rating system in mainstream practice that is evident through growth of LEED® projects over the past few years (LEED® 2005).

Increase in LEED® buildings represents a growing demand for green buildings in the design and construction industry. In the initial stage of the green building movement, the constructors were slow in becoming a part of this movement (Riley et. al. 2004, Syal 2005, GVRD 2004). However, this is undergoing a change and constructors are making great efforts to become a part of this initiative. This research analyzes the impact of LEED® – NC projects on constructors' activities and provides the results in an easy to use presentation package and a database query system. In this research, the term constructor refers to a General Contractor or a Construction Manager and the focus of this research is on LEED®- NC certified or registered commercial building projects.

LEED®-NC: MAIN GREEN BUILDING RATING TOOL IN THE U.S.

The green building rating systems serve two functions of promoting high performance buildings and creating the demand for sustainable construction (USGBC 2006). Presently, the most widely accepted green building rating system in the United States is the LEED® system developed by the US Green Building Council (USGBC). There are other green building assessment systems used worldwide, such as Building Research Establishment's Environmental Assessment Method (BREEAM), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), Green Globes™ US, and Green Building (GB) Tool (Mago and Syal 2007).

United States Green Building Council (USGBC) introduced the LEED® -NC rating system in 1998 and brought together a comprehensive initiative for addressing the impacts of buildings within the environmental, social, and economic context (LEED® 2005). LEED®–NC focuses on new commercial construction and major renovation projects. It is a third party certification system, which allows owners and developers to voluntarily achieve a consensus rating based on four levels; certified with 26-32 points; silver with 33-38 points; gold with 39-51 points and platinum with 52-69. The rating is based on a set of performance-based standards under the six categories of Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and Innovation & Design Process (LEED® 2005).

The eminence of the LEED®-NC rating system is evident in its growth over the years and is now being introduced in countries such as China, India, and Canada. The annual market for green building products and services had grown to $7 billion by 2006 and the number of buildings aiming for LEED®-NC certification has consistently

increased since its introduction in 1998 (Kibert 2005 and USGBC 2006). USGBC has recently committed to 100,000 LEED® certified Commercial buildings by 2010 and 1 million LEED® certified Commercial buildings by 2020 (USGBC 2006).

ROLE OF CONSTRUCTORS ON LEED® PROJECTS

Owners, both public and private, along with designers are taking the lead in pursuing sustainable design and construction practices. The designers have carved a leading role in the green building movement since the very beginning, as they are the creators of the initial idea for the built environment (Riley et. al. 2003). However, as both the source (designer) and the end user (owner) are readily adopting sustainable design practices, it becomes imperative for the process implementer (constructor) to become an active team member in successfully implementing green building projects (Syal 2005). A constructor can provide input on aspects such as, material selection, system performance, decreasing construction waste, improving indoor air quality etc. In addition, the constructor can also assist in streamlining construction methods, value engineering methods, and constructability reviews in order to achieve the green project goals.

As the LEED® rating system makes inroads into the mainstream design and construction industry, the constructors' are realizing that they can contribute towards a project's green objectives by first, understanding LEED® and their role in achieving LEED® credits, and then, through early involvement and greater participation during the major project phases (Syal 2005). There is a strong need to define the role of constructors' and their early involvement in the green building process (Riley et. al. 2003, Mogge 2004, Samaras 2004). The incorporation of a constructor as a value adding team

member comprehends the concept of sustainable development in the true sense, as it imbibes an integrated design and construction approach (Samaras 2004).

PROJECT OBJECTIVES

With the growth of green buildings and the resultant acceptance of the LEED® rating system by owners and designers, the constructors can be a vital source of input in successfully executing green buildings. This momentum of green building movement reinforces the need and timeliness for this project that attempts to identify the constructor's role on LEED®-NC projects. This constitutes the overall goal of this research and the following two objectives were accomplished to achieve the research goal.

1. Identify and analyze the impact of LEED®-NC requirements on Construction management practices.

2. Develop the workshop presentation package and a database-query system to assist the constructors in successfully navigating LEED® - NC rating system.

CASE STUDIES AND THE INDUSTRY ADVISORY GROUP (IAG)

Impact of each LEED®–NC credit on constructors was analyzed in terms of various Construction Management functions: Estimation Decisions and Project Cost, Scheduling-Activities, Duration and Logic, Project Administration and Documentation, Contracts and Agreements, Field Operations and Subcontractor Coordination, and Other Constructor related (Constructor's early involvement/ Innovation and Design process). This was done based on the existing literature and analysis of four Case Study projects. In order to

supplement the preliminary analysis, an industry advisory group (IAG), was utilized. The IAG consisted of 18 professionals representing constructors, owners' representatives, designers, commissioning agents, and LEED®- NC technical assistance providers. The role of case study projects and the IAG was to enrich the analysis with current practices in Green Buildings and provide examples based on experience with LEED® projects.

DEVELOPMENT OF LEED®-NC CREDIT IMPACT ANALYSIS

The impacts of LEED®-NC credits were categorized under three levels of impact: "Major", "Moderate" and "Some" (Figure 1). These impact levels are representative of the constructor's involvement on a LEED®-NC project. The "Major" impact credits include the construction intensive credits such as MR – 2 Construction Waste Management. These credits involve a constructor's direct involvement. The "Moderate" impact credits such as ID-2: Innovation and Design include those credits that are both design and construction related and where the constructor's involvement will benefit the project team in achieving or in complying with the LEED®-NC certification. "Some" impact credits are those, which are primarily design oriented and may, in some circumstances benefit due to a constructor's input.

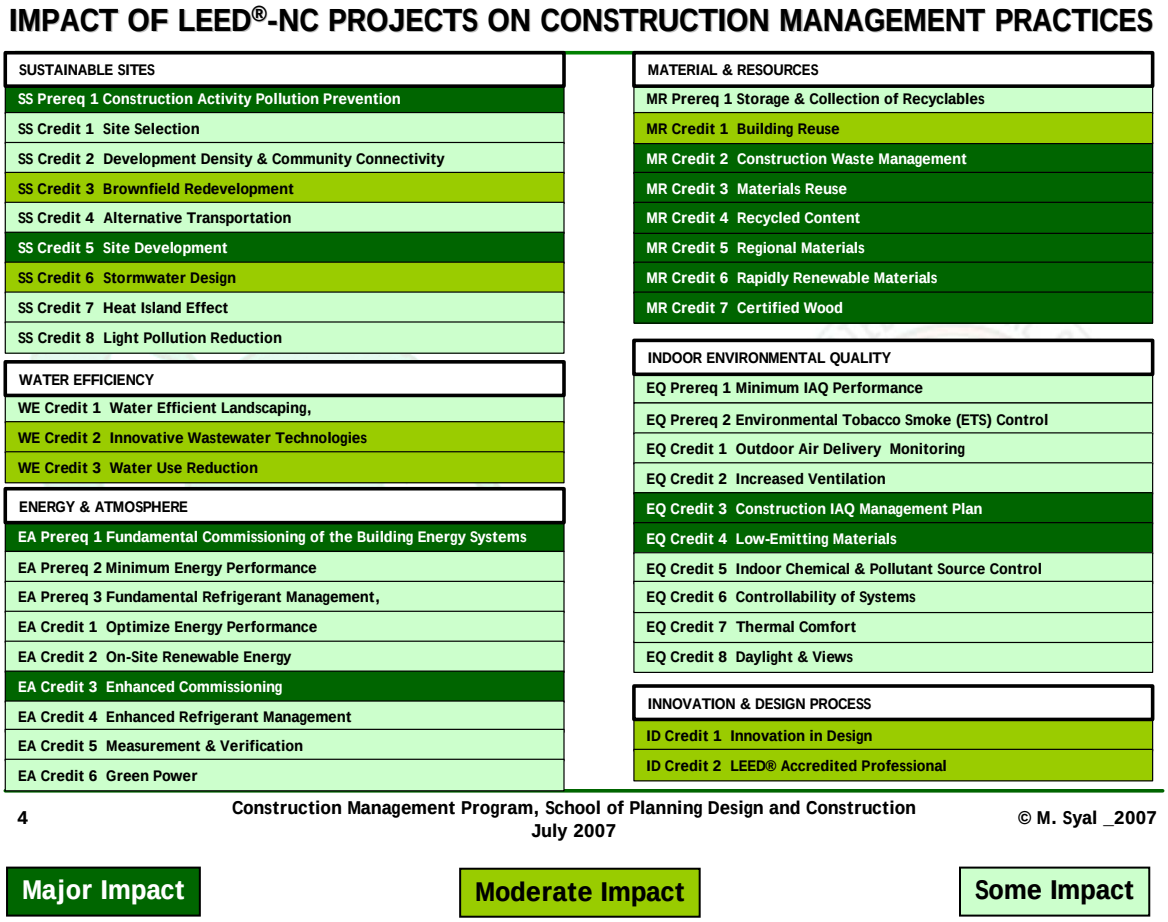

Figure 1: Categorization of LEED® Credits as Major, Moderate and Some impacts

During the analysis, it was found that the impacts identified for certain LEED®-NC credits on constructors' activities were similar, and were accordingly grouped. For example, MR credits 3-7 (Materials Reuse, Recycled Content, Regional Materials, Rapidly Renewable Materials and Certified Wood) were grouped together and their impact was pursued under one section. Figure 2 shows the grouping of "major" impact credits.

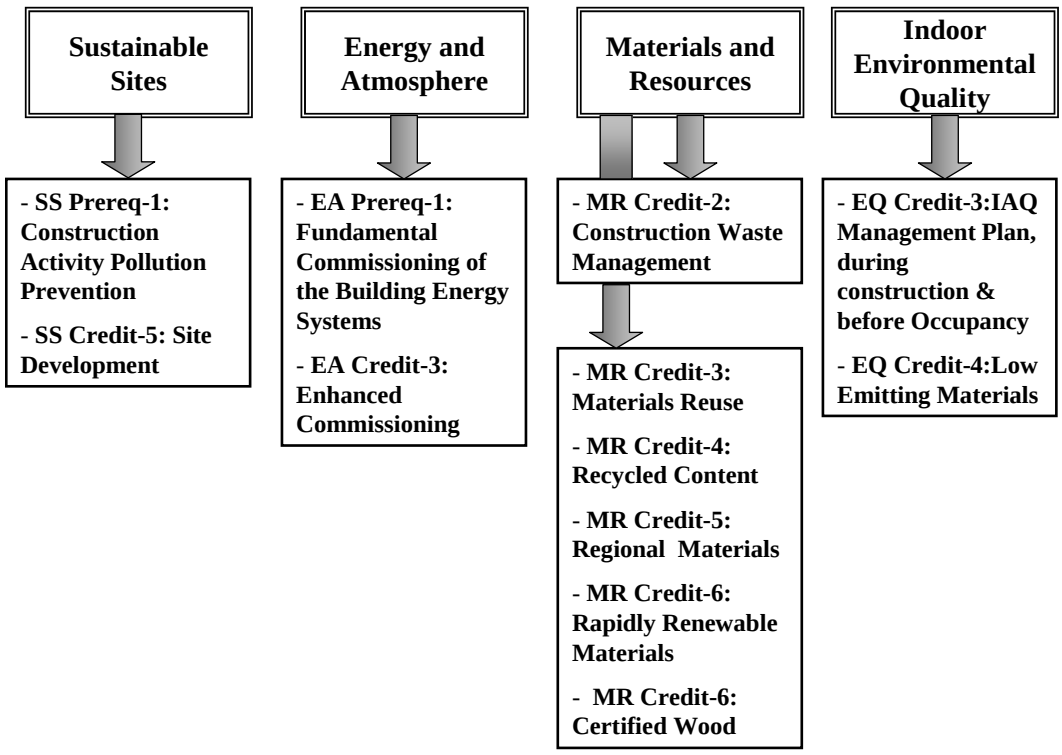

Figure 2: Grouping of Major Impact LEED-NC Credits

The structure of the LEED®-NC Credit Impact analysis consists of three parts, the intent of LEED® Credit, constructor's role/activities as a discussion point, and an example/explanation to supplement the constructor's role. Shown in figure 3 is the sample analysis output for MR credit 2 Construction Waste Management. This sample output is for the "Estimation Decisions and Project Cost" function. The analysis, in many cases is supplemented by figures, pictures, details, sample documents, etc.

MR CREDIT 2 CONSTRUCTION WASTE MANAGEMENT

Divert construction and demolition debris from landfills and incinerators. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

ESTIMATION DECISIONS & PROJECT COST

1. The constructor needs to assess the recycling facilities near the project site. The cost of implementing a Construction Waste Management (CWM) Plan is a function of various project specific factors such as (Matthiessen & Morris 2004, Mogge 2004, Katz et. al. 2003) :
   - Project location – It is an important factor that affects the cost of implementing a Construction Waste Management Plan. For instance, projects located in downtown areas may have space constraints, which may not allow sorting of waste on site. Consequently, construction waste may be collected as commingled waste on site and waste separation may be done outside the site premises, which may increase the cost of CWM significantly.
   - Site logistics and building layout planning - The project team may decide to rent a space for waste collection and/or sorting outside the project premises due to lack of space on site, increasing the project overhead cost (Winn 2006).

MR CREDIT 2 CONSTRUCTION WASTE MANAGEMENT

ESTIMATION DECISIONS & PROJECT COST

- Availability of recycling facilities– It may impact the cost of hauling the waste from the project site to the recycling facility. It may also influence the option of on site waste sorting or commingled waste recycling.

Examples:

a. In "Case Study Project – B" about 93% of all construction and demolition waste (6,000 tons) was diverted from landfills. A "gyp monster" was used to grind drywall for use as a soil amendment. The original office building was deconstructed and used as structural fill to help raise the entry roadbed (LEED - Alberici 2004).

b. In "Case Study Project – A", the project team used a cardboard compactor, to offset the cost of collecting and sorting the waste on site (Case Study Project– A 2007). The compactor used is shown in the next slide.

Figure 3: Sample Analysis Output for MR-2: Construction Waste management (Estimation Decisions & Project Cost)

For “Moderate” impact credits, a discussion of the I&D Credits is presented as an illustration. This LEED®-NC category is unique, as it is open-ended and provides immense opportunities for utilizing a constructors’ input in the green building process. It also reinforces the need for an integrated design process, which allows the project team to draw from the knowledge of various project participants. The impacts identified for this credit are based on a different approach, as there are no pre-determined performance standards as defined for other credits. Points in this category are achieved by two methods: exemplary performance in the existing credits and/or use of an innovative solution (Figure 4).

This project identified a constructor’s role in achieving these credits, based on the exemplary performance credits and the Credit Interpretation Requests (CIR). The first method of exemplary performance sets a benchmark higher than the existing credit requirements and therefore, necessitates a greater commitment from the project team. Further, the credits in which exemplary performance is allowed are primarily the major impact credits, as identified in this research. Thus, a constructor’s role becomes pivotal in achieving these credits by exceeding the benchmark and attaining the I & D points. As a result, a greater commitment is required from the design and the construction team, including subcontractors, field personnel and all other members involved in the project from the constructor’s organization. The second method requires the project team to develop innovative solutions and/or a design approaches to addresses sustainability issues relevant to the project and those, which can serve as examples for other projects.

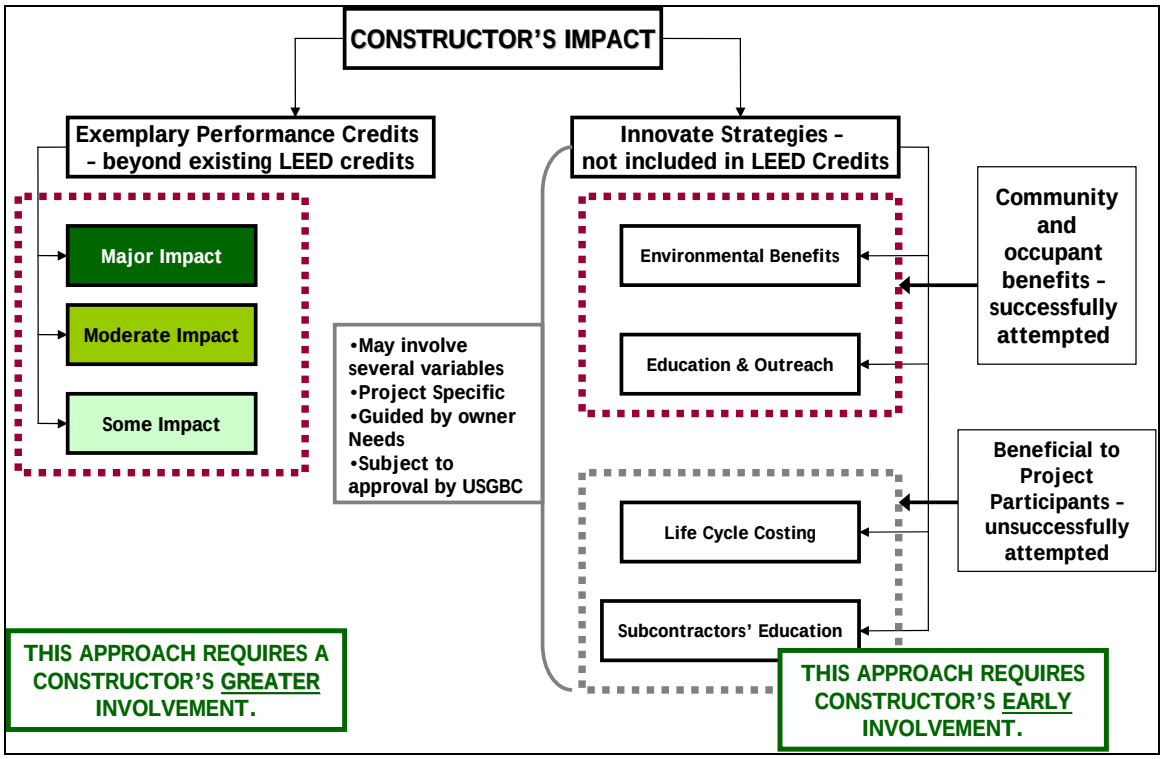

Figure 4: Constructor's role in achieving Innovation and Design Credits

PROJECT DELIVERY METHODS FOR GREEN PROJECTS

Based on the impacts identified in the Project Phase and LEED®-NC Credit Impact analysis, a constructors' role in different project delivery methods was also identified. A major observation was that the Design Build contractual method (AGC 1993) is most favorable for a green project as it helps in involving all project participants early in the project but the lump-sum contractual method is being used most commonly. Figure 5 illustrates the design build contractual method for a green project and a constructor's role in it.

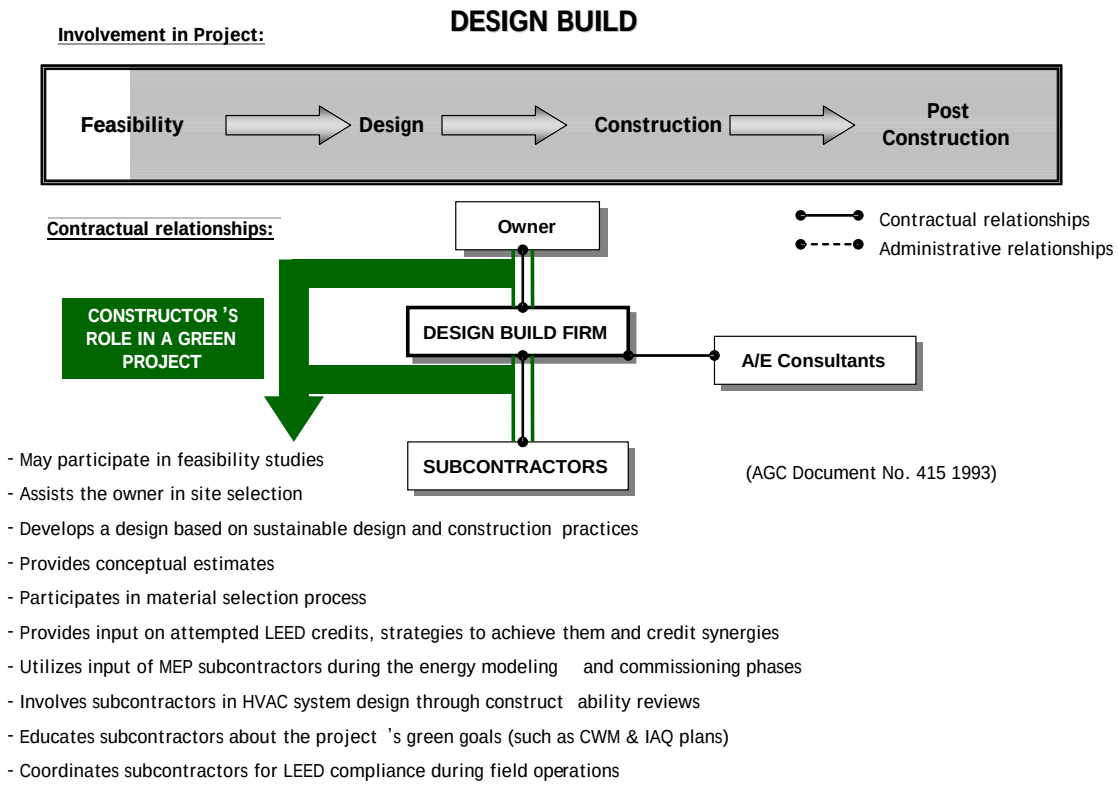

Figure 5: Constructor's role in Design Build delivery method

A constructor's involvement in this method may start from project initiation or during the feasibility phase. In addition, the constructor is more closely involved in the design phase of the project as compared to other delivery systems.

CM at Risk and Negotiated GC delivery methods are very similar in nature and allow for earlier involvement of constructors as compared to the GC contractual method. The CM as Agency contractual method transforms the constructor's role as a consultant to the owner. The CM as Agency portrays a different role in a green project as compared to the prime contractors who are also part of the green building process. In GC lump sum method, which is one of the most common forms of contractual methods, the contractual relationship does not allow the project team to utilize the constructor's input during the

early phases of the project. However, the constructor's full participation in the project execution phase becomes very important in this form of green project delivery.

LEED®-NC IMPACT DATABASE – QUERY SYSTEM APPLICATION

The objective of creating the database query system is to provide the constructors with a tool, which can assist them in navigating the LEED®-NC Credit Impact analysis and ascertain their role and contribution on the project. The LEED®-NC Impact database is a relational database, which works on the Microsoft Office® Access platform.

The conceptual design of the database is based on the LEED®-NC credit impact analysis. In this database, two types of tables were created: the "Impact Level" table and the "CM Function" tables. The Impact level table stores the information for each credit such as the credit description, LEED® category, CM function, and the Impact level. This information is related to the CM function tables. The CM function tables include the impacts for the all the LEED® credits in the form of Discussion Points and Examples/Explanation.

After creating the database entities and establishing the relationships, the queries required to access the database were developed. The queries were developed for sorting and retrieving of information for a particular LEED® credit and that credit's impact on a CM function. For instance, in order to view the impact of MR – 2: Construction Waste Management on the Estimation function, the query shown in Figure 6 would work. The physical model of the database was designed with the intention that upcoming CM functions and LEED® credits could be incorporated without altering the existing database structure.

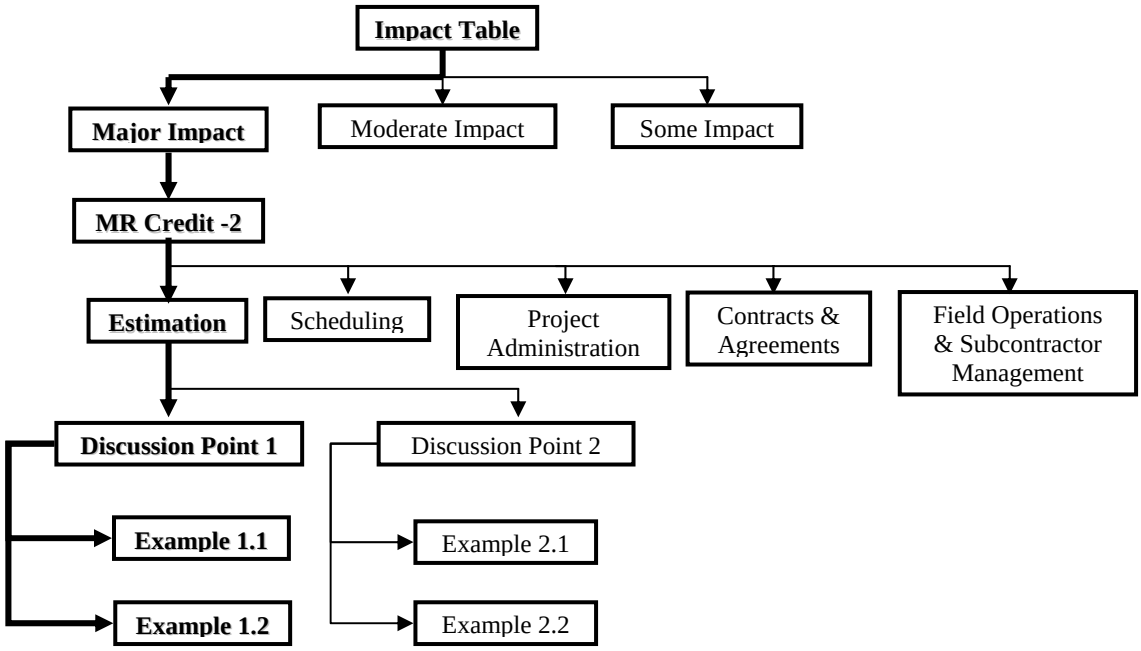

Figure 6: Query mechanism for retrieving estimation impacts for a sample LEED®-NC Credit (MR -2)

The main window of the database acts as a navigation menu for the users. From this main window, the user may select a specific LEED®-NC category to view the impacts, view the references for the database, or exit the database. In addition, the LEED®-NC credits are color-coded based on major, moderate and some of impact credits.

SUMMARY & CONCLUSIONS

The concept of green buildings has received tremendous interest in the last few years and is gradually becoming a part of mainstream construction industry. Additionally, the LEED® green building rating system has been widely accepted by public and private owners, further fueling the demand for green buildings. It is expected that the value of green building construction will be close to $12 billion in 2007 (USGBC 2007). In the

context of growing interest in green buildings, this research effort focused on the role of constructors in the green building process as integral participants on a LEED® project. The research identified how constructors can understand the impacts of various LEED®-NC requirements on their roles and practices in executing green projects, which can equip them to become a value-adding member of the project development process.

One of the primary aspects of understanding the LEED® requirements is to focus on those credits that require constructors' direct involvement. This was achieved by categorization of LEED®-NC credits, into "Major", "Moderate" and "Some" impact levels to facilitate the constructors' understanding of their roles in providing input on these credits. This categorization can also assist constructors to plan for the activities required to achieve these credits.

Early involvement of a constructor can also provide the owner and designer with information related to cost implications of pursing certain LEED® credits. The constructor's team can develop "what-if" scenarios of cost implications of pursuing specific LEED® credits. In addition, the constructor can also undertake life cycle cost analysis of materials and products to determine the optimum solution based on the owner's requirements. Constructors' involvement in the initial phases of the project can help in educating the subcontractors about LEED® requirements and related additional responsibilities, which can help to prepare for these requirements.

This research presents an analysis of the impact of LEED®-NC credits on Constructors. The impacts were analyzed for various construction project management aspects: estimation decisions & project cost, scheduling- activities, durations & logic, project administration and documentation, contracts and agreements, field operations and

subcontractor coordination, and other constructor related aspects. Such analysis in the form of the presentation package and the database query system can greatly assist Constructors as they navigate LEED®-NC projects.

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