Legal Issues in Green Construction

Namrata Shrestha

University of Nevada, Las Vegas, shrest12@unlv.nevada.edu

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LEGAL ISSUES IN GREEN CONSTRUCTION

By

Namrata Shrestha

Bachelor of Architecture
Tribhuvan University, Nepal
2007

Master of Architecture
Southern Illinois University, Carbondale
2010

A thesis proposal submitted in partial fulfillment of
the requirements for the

Master of Science in Construction Management

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Howard R. Hughes College of Engineering
The Graduate College

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May 2012
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We recommend the thesis prepared under our supervision by

Namrata Shrestha

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David Shields, Committee Chair
Neil Opfer, Committee Member
Pramen Srestha, Committee Member
Scott Abella, Graduate College Representative
Ronald Smith, Ph. D., Vice President for Research and Graduate Studies
and Dean of the Graduate College

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ABSTRACT

Legal Issues in Green Construction

by

Namrata Shrestha

Dr. David R. Shields, Examination Committee Chair
Associate Professor, Civil & Environmental Engineering
University of Nevada, Las Vegas

The most recent “green construction movement”, made a significant impact on the design and construction industry in the United States. Organizations such as the American Institute of Architects (AIA) have lobbied governmental entities to provide financial incentives to promote green construction. The green construction community also promotes the notion that a healthier working and living environment is achieved. Due to financial incentives coupled with projected long-term energy cost savings, many owners of new construction are considering green construction as an option. Accompanying the “green construction movement”, new kinds of legal issues, particularly relating to green aspects such as certification, energy saving, performance, incentives and cost increase are arising because of innovative ideas involved in green construction and also because of lack of adequate knowledge about the field by all the parties involved in the project. This thesis focuses on identifying and analyzing legal issues that are unique to green construction. Issues related to both the design and construction processes along with the commissioning and long-term operation and maintenance are included in this research. The research is based on data collected within U.S., regarding the issues in green projects, via SurveyMonkey®. Data characterizations along with several statistical
analyses have been conducted to study the various aspects of the green projects with issues. Recommendations and conclusions based on the research are presented.
ACKNOWLEDGEMENT

It is my pleasure to put forward my humble appreciation to the people in my acknowledgement who deserve special mention and whose support and help was always crucial for the success of this thesis research.

First and foremost, I would like to thank my supervisor Dr. David R. Shields for his continuous support, cooperation and encouragement. His guidance throughout the research progress is worth mentioning which has helped me pass many obstacles. Without his support and knowledge, this thesis could not have been a success.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Global environmental awareness and the demand for sustainable solutions have strengthened the “Green Movement” in pursuing its goals. Green movement is the term used to represent the overall effort made in the construction industry towards making the built environment more sustainable and resource efficient (Kibert 2005). The United States of America, the United Kingdom, and Canada - along with many other countries - have been actively moving toward making their countries sustainable and energy efficient. Accompanying this is a change towards the construction of environmentally friendly and sustainable or green buildings.

The U.S. Environmental Protection Agency has defined green building as “the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort” (U.S.EPA 2010). For the purpose of this research, the terms ‘green’ and ‘sustainable’ are used as synonymous. Same is with the terms ‘building’ and ‘construction’ which are used interchangeably in this research. Green projects refer to the actual building structures which incorporated green aspects and that is already being built or is under construction. Also, LEED projects or the projects that are seeking LEED

1
certification or already LEED certified are also referred to as green projects, for the ease of communication.

Many countries have created organizations that are responsible for developing standards for constructing a sustainable built environment and also to rate their buildings’ effectiveness in obtaining this goal (Reed et al. 2009). Table 1.1 lists some national and international organizations and the rating systems used in different countries.

**Table 1.1. List of National and International Organizations and Rating Systems Involved with Green Construction**

<table>
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<tr>
<th>S.N.</th>
<th>Name</th>
<th>Country</th>
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<td>U.S. Green Building Council (USGBC)</td>
<td>United States</td>
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<td>2</td>
<td>Leadership in Energy and Environmental Design (LEED®)</td>
<td>United States</td>
<td>Rating Tool</td>
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<tr>
<td>3</td>
<td>The Green Globes™</td>
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<td>Canada</td>
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<td>17</td>
<td>Ecology, Energy Saving, Waste Reduction and Health (EEWH)</td>
<td>Taiwan</td>
<td>Rating Tool</td>
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Leading other countries in this Green Movement, United States of America has been involved in a plethora of ways to make green practices the choice of all the owners, builders and buildings users. Many programs are emerging that incorporate various codes and provide guidance for green construction efforts. The Leadership in Energy and Environmental Design (LEED®) rating system, developed by United State Green
Building Council (USGBC\textsuperscript{®}), the California Green Builder, and The Green Globes\textsuperscript{TM}, developed by Green Building Initiative (GBI) are some examples of rating systems being used for new construction of buildings and operation and maintenance work (Masters and Musitano 2007). Among all, LEED\textsuperscript{®} seems to be most widely accepted, and is practiced by most sectors and owners. According to USGBC, founder of the LEED\textsuperscript{®} rating system, there are over 35,000 registered projects out of which more than 10,500 projects are certified with different level of certification, as of February 2012 (USGBC 2012). This is a huge increase compared 2006 data, when there were only 623 LEED-certified buildings (Howe and Gerrard 2010). The numbers are rising exponentially and according to Kibert. C. J. (2005), with this trend continuing to follow, the green construction will be a majority in the construction industry within couple of years.

The emerging public awareness and popularity of green construction has provided many benefits to the parties involved in construction- like owners, architects, engineers, subcontractors, and also building users. For example, users are gaining healthy environments in which - to work, architects and engineers are gaining prominence for implementing innovative green techniques; owners are gaining recognition for building ‘green’ as well as creating cost benefits due to energy savings.

However, along with various benefits gained with green construction, there is also the possibility of- “liability risks and litigation potential” according to Masters and Musitano (2007). Due to all the benefits that have been advertised regarding green construction, owners of such projects tend to have higher expectations regarding such factors as energy savings and better performance; they also have high expectations regarding their return on investment. High expectations also are prevalent with tenants.
and users of these buildings; they choose such buildings because of the associated benefits. As a result, they also tend to have increased expectations regarding a healthy working environment, indoor air quality, improves employee productivity etc. However, all the project stakeholders are not aware that in order for a green construction to function in the expected way, it requires the combined effort from all the project stakeholders. All the involved personnel should be aware of the goals of the project and also be knowledgeable about and comfortable with the innovative ideas involved with the green construction.

Due to the higher expectations attached to green construction coupled with the innovative ideas included its process and the lack of adequate knowledge about the field by all the project stakeholders, many disputes are arising and various lawsuits are increasing in construction industry. Therefore, it is very important to pay attention to “risk management strategies” in order to minimize various risks associated with the green construction (Masters and Musitano 2007). Although currently, not many reported cases relating to green construction have been reported, the numbers are rising rapidly (Masters and Musitano 2007). Areas in which claims regarding green construction can emerge include lack of proper understanding of the difference between green buildings and conventional buildings, drafting contracts, delays due to governmental approvals, and not meeting the required certifications. However, there are many other areas in green construction that need consideration, and can generate new legal issues, such as proper protection of infrastructure, ensuring continued performance of energy efficiency, and adaptation of green constructions to climate changes (Howe and Gerrard 2010).
1.2 Statement of the Problem

Until now, from the previous section, we already know that green construction is facing an increased number of issues due to such reasons as lack of knowledge, increased expectations from the building, or even negligence. Although, the issues in ordinary construction and green construction mostly are the same, there are some new types of issues that typically relate to green construction. The term ‘issue’ in this research refers to the problems or the cause of dispute regarding certain aspects of the project. The issues can be legal or administrative in nature. Administrative issues are ones that did not necessarily include legal procedures in order to solve the problem, but could have been solved using other procedures, such as arbitration or mediation; contractual changes; costs absorbed by the parties; and informal resolution procedures. Also, litigation can be used to resolve issue. The process of litigation begins with the filing of a civil lawsuit by a plaintiff. Litigation may end anytime in the process if a settlement is reached.

We can see many issues being reported that relates to green projects via online news, blogs and various other websites. Most of the issues reported relate to three major areas in the green construction which are 1) energy savings in green project, 2) certification of the project, and 3) incentive provisions for a green projects. However, there no research in this field that actually collects sample data of various legal issues, that the construction industry is facing due to the inclusion of the green aspect into the project, and performs statistical analysis to present statistically valid results.

Hence this thesis is intended to fill this knowledge gap with a sample that represents green projects within United States. An online survey via SurveyMonkey® is used to collect the necessary data for this research. This research will not delve into the
detail about each aspect of green construction. This research will set a platform which
will try to identify the basic areas of issues, various types of project delivery methods and
contract types used in those projects with issues, determine the impact of the issues on the
project schedule, identify the project phase in which the issues occurred and the current
resolution procedures that have been used to resolve those issues.

Each aspect can be expanded in the future to see more detailed relationships
between those aspects of the green projects and the issues in green projects.

1.3 Purpose of the Study

The purpose of this study is to analyze green projects to identify the legal issues that are
unique to such buildings, relating to both the design and construction processes along
with the long-term operation and maintenance of the projects. The study will include
cases within United States.

Most of the issues with green construction are similar to that of conventional
construction, such as issues in preparing contracts, delays in schedule, and improper
installation; however, there are some new claims that are typically related to green
construction. Lack of proper testing of the new ideas and technologies associated with the
green construction also plays a major role in the emergence of novel claims in the
construction industry. The legal issues that are not related to green aspect involved in the
project are not within the scope of this study.

This research is based on the analysis of legal issues to establish current and
possible future areas that could result in litigation associated with green construction.
Finally, based on the literature review and data analyses, recommendations will be
provided on how to best plan in order to avoid litigation by employing proper risk management strategies. As a result of this study, it is expected that the various parties involved in the green construction will be able to use the outcomes of this research to become more aware of the possible areas of claims and create ways to minimize the risks to the greatest extent possible.

In general, the expected primary outcomes of this thesis are as follows:

- Analyze the possible legal claims that are unique to the green projects.
- Evaluate the parties that are most likely affected in such projects.
- Identity the resolution procedures that have been currently adopted.
- Analyze the awareness of the various parties involved in green construction about the legal issues.

1.4 Structure of the thesis

This section is intended to present the basic structure of this thesis. This thesis contains seven chapters which are as follows:

Chapter 1 Introduction: Chapter 1 provides the basic knowledge about the construction industry and shows how the construction industry is affected by green movement. This chapter also lists the problem that this thesis intended to research and outlines the major objectives of this research.

Chapter 2 Literature Review: The reviews of various literatures that are available in the field of study of this research are presented in this chapter.

Chapter 3 Research methodology: This chapter presents the outline of the methodology followed by this research.
Chapter 4 Data Collection: Explains various procedures adopted to collect data for undertaking the analysis required by this research. This chapter also explains the result of the data collection effort and shows the trend of data received dates.

Chapter 5 Data Characterization and Analysis: Characteristics of the data collected based on various variables like organization type, involvement in green projects and so forth are shown in this chapter. Also, this chapter presents the various statistical analyses that were conducted with the collected data.

Chapter 6 Discussion of Results: Results of the data analysis from chapter are used to discuss the characteristics and meanings of the results.

Chapter 7 Conclusion and Recommendation: The last chapter of this thesis presents the conclusion of the research based on various findings of the research and also mentions the limitations of the research and provides recommendations for the future research.

1.5 Research Questions

The questions that this research is trying to answer are as follows:

1. What are the effects of green aspect in the design and construction industry with regard to the legal claims?

2. What are the possible areas regarding green construction that can result in various legal issues for project participants?

3. Who are most likely to face legal issues in the process of green design and construction?

4. What type of project delivery method and contract type experiences the most issues?
CHAPTER 2
LITERATURE REVIEW

The literature review will address areas of research related to this thesis. The literature review will start with the overall view of green construction, its usefulness and current status in the construction industry. This chapter will continue with the review of the literatures in current areas regarding issues or problems in green construction that have evolved as a result of new techniques involved.

2.1 Green Construction

Green construction seeks to correct or minimize the environmental impacts of conventional construction. The built environment has huge impact on the natural and social environment, resource consumption, indoor environmental quality, human health associated with it, and land use (Liu 2011). Conventional buildings and their construction are responsible for a large consumption of all kinds of resources, for example, energy, water, and raw materials. They also contribute to a large amount of waste production and also produce carbon dioxide emissions which contribute to greenhouse gases. According to U.S. Environmental Protection Agency (EPA) buildings are responsible for approximately 39 percent of primary energy use, 68 percent of electricity consumption, 38 percent of carbon dioxide emissions, and 12 percent of potable water consumption (U.S.EPA 2010). According to Kibert, C. J. (2005), building constructions are responsible for many health related issues such as “Sick Building Syndrome (SBS),
Building Related Illness (BRI), and Multiple Chemical Sensitivity (MCS)” which conventional constructions do not pay much attention to (Kibert 2005).

Green construction therefore is an effort to reduce all the previously identified negative impacts and improve the living environment with various benefits relating to environmental, economic and social aspects (U.S.EPA 2010). The projects following ‘green’ aspects are using their resources more efficiently and effectively. These constructions contribute towards reducing negative impacts and achieving a better living environment by implementing sustainable site development, energy efficiency, better material selection, and water use reduction as well as enhancing indoor environmental quality (USGBC 2011). Due to these expected beneficial returns from green construction, the numbers of green building projects are increasing worldwide. Many organizations within various countries are working actively to make the environment healthy by building green buildings (USGBC 2011).

2.2 Green Building Rating Systems:

Green building rating systems are used as a tool to evaluate buildings to determine how ‘green’ they are (Fowler and Rauch 2006). The history of the evolution of the green building rating system dates back to 1990 when the United Kingdom launched its first environmental certification system, The Building Research Environmental Assessment (BREEAM) (Smith et al. 2006). In 1998, the U.S. Green Building Council (USGBC) implemented the LEED® rating systems (Smith et al. 2006). Other green building rating systems available in the United States are Green Globes™, launched by the Green
Building Initiative (GBI), the GB (Green Building) Tool; and a U.S. version of BREEAM.

Among all the rating systems available, the LEED® rating system is the most widely accepted and popular (Kibert 2005). USGBC (2011a) data shows that “over 40,000 projects are currently participating in the commercial and institutional LEED® rating systems, comprising over 7.9 billion square feet of construction space in all 50 states and 117 countries. In addition, nearly 10,000 homes have been certified under the LEED® for Homes rating system; with nearly 45,000 more homes registered.” Its attractiveness is also demonstrated by some governmental jurisdictions passing legislation that requires public buildings to be designed, constructed, and certified under LEED®. California is an example where it has taken the initiative to implement sustainable practices and also created an Executive Order S-20-04 (EO) in December 2004 under which all new or renovation projects built with state funds must be certified under LEED® with a LEED Silver or higher level (Brown 2011). The federal government has also taken similar actions for their buildings.

The LEED® rating system is based on credits for various provisions used in design and construction resulting in a more sustainable building. Based on the levels the project was designed and constructed to and the actual credits achieved by the buildings; LEED certification can be at one of four certification levels: Certified, Silver, Gold; and Platinum. The process to achieve certification is illustrated in Fig. 2.1.
The following sections describe each step in the LEED certification process.

2.2.1 Project registration

The first step in obtaining LEED certification is to register the project. GBCI (2011a) describes the step as follows:

“...after determining that LEED is right for a project, the next step is to register the project. Registration serves as a declaration of intent to certify a building or neighborhood development under the LEED Green Building Rating Systems. Registration provides access to a variety of tools and resources necessary to apply for LEED certification. Registered and certified projects are also listed in the online LEED project database. Once the rating system has been determined and the appropriate registration fee has been paid, the project will be immediately accessible in LEED Online. From here the project team is assembled and the documentation process begins”.

2.2.2 Prepare Application

The second step in obtaining LEED certification is to prepare application. GBCI (2011b) describes the step as follows:

“...each LEED credit and prerequisite has a unique set of documentation requirements that must be completed as a part of the application process. While preparing the application, the project team selects the credits it has chosen to pursue and assigns the credits to the responsible team members. The project team should begin to collect
information and perform calculations for all prerequisites and the credits it has chosen to pursue. When the necessary documentation has been assembled, the project team will upload the materials to LEED Online and start the application review process. Before submitting the application, the project team is advised to double check each credit to ensure that project details have been entered accurately and consistently. This will help streamline the review process”.

2.2.3 Submit Application

The third step in obtaining LEED certification is to submit application. GBCI (2011c) describes the step as follows:

“…only the LEED Project Administrator is eligible to submit an application for review. Requirements for a complete application vary according to the review path, but will always include payment of the appropriate certification review fee. Prior to certification, all project teams are required to submit completed documentation requirements for all prerequisites and at least the minimum number of credits required to achieve certification, as well as completed general project information forms. Applications must be received in accordance with GBCI’s established Rating System expiration terms. For all LEED NC 2009 projects, the components of an application for certification are completed via LEED Online version 3. For all 2.2 and some LEED NC 2.1 projects, the components of an application for certification are completed via LEED Online version 2. Some LEED NC 2.1 and all LEED NC 2.0 projects apply through paper submittals”.

2.2.4 Application Review

The fourth step in obtaining LEED certification is the review of the application. GBCI (2011d) describes the step as follows:

“…upon receipt of a completed application for certification, a formal application review will be initiated. The application review process differs slightly for each LEED Rating System and review path”.

2.2.5 Certification

The final step in obtaining LEED certification is getting final certification of the project. GBCI (2011e) describes the step as follows:

“…certification is the final step in the LEED review process. Once the final application review is complete, the project team can either accept or appeal the final decision. LEED certified projects will receive a formal certificate of recognition and also receive information on how to order plaque and certificates, photo submissions, and marketing”.

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2.3 Incentives in green construction

The American Institute of Architects (AIA) has made an effort to provide incentives in various forms to promote green construction, as per the roundtable discussion on December 3, 2007 with various developers at its headquarters in Washington, DC. The meeting included important parties like “…state and local politicians and officials, as well as representatives from within the design and construction industry” (AIA 2009). Their main aim was to integrate green aspects into the standard of building design and provide green incentives as an initial step towards this goal. Some of the incentives that the owner can benefit from by following green techniques are in the form of tax incentives, permit/zone fee reduction, expedited permitting, loans, technical assistance/design assistance, bonus density, rebates and discounts on environmental products, grants, net metering and leasing assistance (AIA 2009).

These incentives also can be classified into various groups, according to whether they are financial or non-financial incentives. Some state and local regulations provide financial incentives, while some provide non-financial incentives, such as expedited permitting and increased density ratio. Some state and local regulations make green building practices mandatory in any new construction, whether public or private (Howe and Gerrard 2010). The owner can choose which incentive to use, depending upon the location of the project, e.g. tax incentives, density/floor area ratio bonuses and many more (AIA 2009). Not every incentive is provided by all jurisdictions. Also, various incentives vary in levels, e.g., city level, county level, state level, etc.
2.3.1 **Types of incentives**

According to the AIA (2009), the most popular incentives are- tax incentives, density/floor area ratio bonuses and expedited permitting.

2.3.1.2 **Tax Incentives.** Tax incentive benefits owners by reducing taxes, depending upon the certification level and the green measures adopted. Builders in cities like Cincinnati, Honolulu, or any of the states within Maryland, New York, Oregon, can benefit from tax incentive. Jurisdiction like “Maryland TAX-GENERAL Code Ann. § 10-722” offer incentive in income tax, “Cincinnati Tax Abatement” and “Honolulu Temporary Tax Exemption” provide incentive in property tax etc (AIA 2009).

2.3.1.2 **Density/Floor Area Ratio Bonuses.** If the project is in a jurisdiction that provides bonuses in density or floor area ratios, then they can get various incentives, e.g., in the height of the building, increased floor/area ratio, less landscaping requirement, etc. Some jurisdictions that provide these kinds of bonuses include the “Seattle Council Bill Number 115524/Ordinance Number 122054;” and “Arlington, Virginia, Green Building Incentive Program” (AIA 2009).

2.3.1.3 **Expedited Permitting.** The other most popular incentive that developers prefer is expedited permitting, where they get the benefit of reduced time in the process of obtaining various permits, e.g., site permits, building permit, etc. The degree of this incentive varies by the level of certification. This incentive can result in cost savings for the owners in several ways. They can begin work faster, which results in an early return on investment. “Hawaii HRS § 46-19.6”, “South Carolina S. 377”, “Santa Monica Ordinance 8.108.050”, “Chicago Green Permit Program” are some examples where jurisdictions provide expedited permitting for green construction (AIA 2009).
For the ultimate success of an incentive program, it should be designed in such a way that is understandable, simple and strong. Also, they should be beneficial to owners, operators, designers, and contractors, so that the demand for the green construction increases (AIA 2009).

2.3.2 Nevada Legislation in Incentives

Nevada has a program that offers tax incentives for the green builders. The LEED® rating system is the base that the Nevada Revised Statute (NRS) employees in order to set the levels of incentives for green projects. Nevada offers tax abatements in a tiered system based on the certification level (Prum 2009). Table 2.1 shows the abatement percentages, based on the LEED certification level along with the points or credits gained for energy conservation. The table also shows the number of years the abatements will be applied for. Nevada was the first state to start a program of providing incentive programs to motivate green construction (Prum 2009). However, it should be noted that Washington, D.C. was the first jurisdiction to start an incentive program.

An owner or developer seeking to benefit from the tax reduction must apply to the Nevada’s Office of Energy within 120 days of receiving approval from the local government to commence construction. The project must be registered for the certification level with the USGBC before applying for the tax abatements. The application for the tax abatements should include various documents (Prum 2009) which are listed below:

1. Proof of registration with the USGBC;

2. Name of the LEED® accredited professional involved in the project team:
3. The applicable LEED standard;

4. Checklist of the level and points anticipated to be achieved for each LEED® category;

5. Type of project: whether the project is considered a campus or multi-building setting; and

6. Schedule of the construction.

The project must be certified with the anticipated LEED® level within 48 months of filing the application, unless extended. The proof should be in the form of a letter from the USGBC or any other evidence that is accepted by Nevada legislation (Prum 2009).

Table 2.1. Nevada Office of Energy’s Regulation R116-07 § 29 Table for Determining Property Tax Abatements on LEED® Certified Buildings after Prum (2009)

<table>
<thead>
<tr>
<th>LEED® Certification Level</th>
<th>Silver</th>
<th>Gold</th>
<th>Platinum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2 points for Energy Conservation from USGBC</td>
<td>NO Abatements</td>
<td>NO Abatements</td>
<td>NO Abatements</td>
</tr>
<tr>
<td>3 points for Energy Conservation from USGBC</td>
<td>25 percent abatement for 5 years</td>
<td>26 percent abatement for 5 years</td>
<td>27 percent abatement for 5 years</td>
</tr>
<tr>
<td>4 points for Energy Conservation from USGBC</td>
<td>25 percent abatement for 6 years</td>
<td>26 percent abatement for 6 years</td>
<td>27 percent abatement for 6 years</td>
</tr>
<tr>
<td>5 points for Energy Conservation from USGBC</td>
<td>25 percent abatement for 7 years</td>
<td>30 percent abatement for 7 years</td>
<td>30 percent abatement for 7 years</td>
</tr>
<tr>
<td>6 points for Energy Conservation from USGBC</td>
<td>25 percent abatement for 8 years</td>
<td>30 percent abatement for 8 years</td>
<td>30 percent abatement for 8 years</td>
</tr>
<tr>
<td>7 points for Energy Conservation from USGBC</td>
<td>25 percent abatement for 9 years</td>
<td>30 percent abatement for 9 years</td>
<td>30 percent abatement for 9 years</td>
</tr>
<tr>
<td>8-10 points for Energy Conservation from USGBC</td>
<td>25 percent abatement for 10 years</td>
<td>30 percent abatement for 10 years</td>
<td>30 percent abatement for 10 years</td>
</tr>
</tbody>
</table>
2.4 Energy savings in green construction

Energy is one of the prime components that play a significant role in making a community sustainable; it also has been a focal point of discussion in a sustainable development. Midilli et al. (2006) defined green energy as:

“...the energy source, which has zero or minimum environmental impact, as more environmentally benign and more sustainable, and produced from solar, hydro, biomass, wind, geothermal, etc. This type of green energy reduces the negative effects of fossil energy resources and the overall emissions from electricity generation, decreases greenhouse gases, and gives an opportunity to take an active role in improving the environment.”

A large amount of research has been conducted to investigate replacing fossil based energy with green energy - in order to make the environment more sustainable. Fossil-based energy is not renewable and can have various negative impacts (Midilli et al. 2006). Dincer and Rosen (2005) developed an outline as shown in Fig. 2.2 which shows the essential factors that impact sustainable development. The outline also showed the interdependence of the factors. As per their findings, sustainable development is the result of four different factors: 1) social sustainability, 2) environmental sustainability, 3) energy and resources sustainability, and 4) economic sustainability.

Fig. 2.2. Factors impacting sustainable development, and their interdependences (Adapted from Dincer and Rosen 2005)
Therefore, because benefit of green energy usage is reduced usage of fossil-based energy, many use energy saving strategies in the new construction as well as renovation projects. Midili and Dincer (2006) also developed a chart shown in Fig. 2.3 showing the effects of using green energy strategies and technologies for sustainable development where they showed the difference as a result of saying yes or no to the sustainable green energy strategies. The chart also shows the results of continuing the use of fossil-based energy and the expected results of the use of green energy in substitution of fossil-based energy. The use of traditional fossil-based energy results in depletion of fossil energy, increase in energy demand, global problems and poverty as a result of high-operating costs, industrial crisis, ozone layer depletion etc. While on the other hand the choice of sustainable green energy strategies could result in high living standards, clean environment, no energy shortage, increased sustainability, low-operating cost resulting in reduced global problems etc (Midilli et al. 2006).

Fig. 2.3. Sustainable development strategies and technologies (Midilli et al. 2006)
Energy savings have been the most marketed fact about green buildings. Owners tend to go green or build green buildings thinking that the green buildings will save energy with its advanced features installed. Not only private owners, but governments are also taking actions in various ways to save energy. There has been a recent statutory change which even mandates governments to conserve energy and water (Silberman 2010). Energy Savings Performance Contracts (ESPCs) have become popular each day among local and state governments. Silberman A.P. (2010) defines ESPCs as:

“...provisions that are authorized by statute and regulation and enable government to obtain energy and water-saving measures through private investments. The government only pays the contractor, or energy savings company (ESCO), to the extent that promised savings are realized.”

2.5 Issues in Green Construction

In an era where the construction industry is already very litigious, green construction is contributing to new types of litigations. These new types of litigation are due to the higher expectations associated with a green building's performance, the innovative ideas included in the process of green construction, and lack of adequate knowledge about the field by all the project stakeholders. Prum and Del Percio (2009) state “A claim against all parties involved in the project becomes highly probable when the outcome falls short of expectations”. Inflated marketing regarding energy savings and the healthy working and living environment provided by green buildings, results in elevated owner and user expectations. These expectations, if not met, may result in a level of dissatisfaction that ultimately results litigation or other adversarial proceedings.

According to Masters and Musitano (2007), claims in green construction mainly arise from two issues. The lack of a universally accepted standard that a green project
team can refer to and the second reason for is the higher expectations from the building’s users who choose green buildings to work and live in.

Liu (2011) sites the lack of proper management systems for green construction projects as another source that can cause issues on green projects. A common problem with the green construction management system may be involvement of people who lack an adequate awareness about green construction and the new technologies involved. The higher costs involved with using proper materials and technologies in green construction also might result in use of substitutes for the materials and technologies resulting in poorer performance of the overall management system. Even the availability of those technologies, products; and techniques are sometimes adopted and are poorly applied. Finally lack of any ideal technical standards and proper management of supervision is one of the hurdles for the successful implementation of techniques in green construction (Liu 2011).

When a green project is initiated, two types of warranties come into play for the service to be provided by various professionals: 1) expressed warranty, and 2) implied warranty (Prum and Del Percio 2009). If not satisfied, both of the warranties can cause different issues for project participants. Expressed warranties generally are the promises made in written format in the contract regarding services and goods to be provided. However, sometimes an oral statement also can be considered as expressed warranty. Implied warranties are not in written format, but are quite obvious, depending upon the professionals and the services they provide. Since this is not in a written format, it is more difficult to resolve an issue which arises due to implied warranties. However for the
warranty claims to succeed, the plaintiff must prove that the service or goods provided by the defendant does not comply with the warranty (Prum and Del Percio 2009).

2.6 Types of claims

According to Masters and Musitano (2007), the liability issues in green construction can include three different types of claims: 1) fraud, 2) negligence, and 3) breach of contract.

2.6.1 Fraud

Fraud in construction is when someone intentionally deceives the other party, generally in the performance of construction work (USLegal 2011). Inflated marketing claims of the project as being ‘green’ by the builders and owners, in order to increase their project’s market value, can result in heightened expectations on the buyer’s behalf; this can be an example of fraud. Therefore, it is very important to be aware of the potential consequences upfront before providing any false information about the project and before promising anything to the buyers regarding materials, energy savings, durability, expected performance, and so forth. The builders and owners are responsible regarding falsification or misinterpretation of information; however the claim should be materialistic and misinterpretation must be proved (Masters and Musitano 2007). Fraud has three components: 1) motives/pressures, 2) opportunities and 3) rationalizations (Allison 2003). Also, if claim for fraud is filed, the plaintiff should be able to prove that the other defendant knowingly intended to deceive (Prum and Del Percio 2009).
2.6.2 Negligence

The legal definition of negligence is conduct that falls below the standards of behavior established by law for the protection of others against unreasonable risk of harm (The Free Dictionary 2012). Construction negligence is defined as a situation which becomes a risk to the construction workers or general public resulting from failure to comply with the safety rules or standards of care (wiseGEEK 2012). Construction negligence followed by damage relating to green elements may result in liability claims against the architect, engineer, contractor, subcontractors or material vendors. Therefore, the standard of care by the design professionals should be very carefully drafted. The lack of standardized practices also plays a major role for claims of this type because the contractors have to rely on design professionals who themselves may be unaware of the risks in green construction (Masters and Musitano 2007). For a negligence claim to occur, there must be four elements: 1) duty, 2) failure to perform, 3) injury, and 4) actual loss or damage (Kelleher et al. 2009). Negligence lawsuits may range from such acts as simple injuries to death (wiseGEEK 2012).

2.6.3 Breach of Contract

When the performance of a party fails to maintain the promises made earlier, this can be referred to as a breach of contract (Prum and Del Percio 2009). The affected party in the case of breach of contract is eligible to choose to terminate the contract depending upon the level of breach (Prum and Del Percio 2009). Failure to certify the building to the certification level initially anticipated or failure to achieve anticipated energy savings may be examples of a claim under breach of contract that can arise under green
construction (Masters and Musitano 2007). Therefore, the designers and contractors should be very careful in defining warranties. All project participants should act according to their standard of care and not try to make unreasonable promises; they also should avoid creating unreasonably high expectations by the other party. A breach of warranty regarding any green aspect may also result in claims.

### 2.7 Various professionals and their risks associated with green construction

This section is intended to present the roles and responsibilities of various professionals involved in green construction and also discuss the risks they possess when involved in green construction.

#### 2.7.1 Owner categories

The owner of a project is a person who initiates the project, provides funds for doing it, and is also the one who actually benefits or looses in terms of the project outcome (BusinessDictionary 2012). The one who owns or bears the full authority to a project is the owner of the project. Hence in the case of public projects, the federal, state or local government responsible for the project is the owner of the project.

Because the owner bears full authority for the project, he/she is responsible for selecting the technical service providers, such as design professionals and contractors, in order to accomplish the project (InnoEngineer 2012). Selection should place a premium on experience for green construction as this type of construction requires more experienced technical providers. Inexperienced technical providers may result in a poor result and issues on the project due to poor post-construction performance.
Before selecting the service providers, owners first should draft a document stating the requirements of the project and expectations from all the technical providers (Prum and Del Percio 2009). This document should incorporate the goals and expectations related to the green aspects of the project as well. If possible, the document should explore all the alternatives available within the stated goals of the project, and consider solutions for any legal issues that may arise in later stages, particularly due to the green aspect of the project, resulting from poor performance of any of the service providers (Prum and Del Percio 2009).

2.7.2 Design professionals

Design professionals are groups of people who provide technical services to fulfill the owners’ project requirements regarding the design of the whole facility, from site planning to design of building utilities. They are the ones who first and foremost work for the owners (Prum and Del Percio 2009). Design professionals can include such professions as architects, engineers (civil, geotechnical, structural, mechanical, electrical, plumbing, fire protection and so forth), interior designers, and landscape architects (University of Colorado 1997).

Frequently, design professionals are frequently the bridge in any project, because they interact with both the owners and the contractors. Because of the various liabilities involved with the profession, design professionals can become one of the most at-risk parties from various other parties in the project (Prum and Del Percio 2009). According to Prum and Del Percio (2009), the liability increases when the project has a green aspects to it because of the ‘ever changing nature of green building standards.’ Hence, a
well qualified design professional would be the one who understands the seriousness and complexities involved in green construction and can provide innovative design solutions (WBDG 2010).

In order to avoid possible claims later, a first step for the design professionals should be to refrain from using the traditional standard form of contract because it does not incorporate all the requirements related to the green aspect of the project (Prum and Del Percio 2009). Also, in the early stages of design, design professionals should discuss with the owners regarding their expectations that they believe are based on information from the design professionals. In particular, they should discuss the roles and responsibilities of the design professionals in achieving the green construction objectives (Prum and Del Percio 2009).

2.7.3 Construction professionals

Constructional professionals are responsible for the execution of converting the design documents to a real facility (Prum and Del Percio 2009). Construction professionals include general contractors, specialty subcontractors and construction managers.

Construction professionals frequently are the party who is banned for many issues regarding delay, negligence, fraud, breach of contract and so forth from the other parties in the project (Prum and Del Percio 2009). If construction professionals fail to perform their job properly, then there is high risk of project failure (Billows 2006).

Most of the time, general contractors hire subcontractors to perform a task that need specialized manpower. While undertaking green projects, it is always better for the general contractors to select subcontractors who have knowledge and experience in green
construction along with financial capability. This will minimize the risks off general contractors getting involved in issues at later stages due to a lack of the required technical knowledge (Prum and Del Percio 2009).

Subcontractors also should be very careful when accepting a job that involves green aspects, from general contractors. Promising to undertake a job without specialized knowledge and experience can cause problems later in the project and result in an issue. According to Prum and Del Percio (2009), it is very necessary to take a proactive approach at all level of construction job, before accepting a contract that involves a green aspects.

As with design professionals, construction professionals also should have a meeting with the owners and design professionals in early stages, to discuss all the expectations that owner and the design professionals have of the contractor. And also particularly discuss the roles and responsibilities of the construction professionals in achieving the green construction project’s objectives (Prum and Del Percio 2009).

2.8 Possible areas of legal issues in green construction

Based on the available literatures, this section analyzes the possible claims in the construction industry due to the green aspect of a project and separates those claims according to one of the three major areas- to which they are related.

Although the claims for ordinary buildings and those for green buildings are mostly same, there are some new claims that typically relate to green construction. Lack of proper testing for the new ideas and technologies associated with the green construction plays a major role in the emergence of novel claims in the construction
industry. Hence, one should be aware of the possible claims that could arise in green construction in order to be able to prevent those from occurring or else to properly resolve them if they occurred. Prum and Del Percio (2009) state “a truly green design offers an integrated, interdisciplinary approach to maximize a building’s efficiency and performance, which should ultimately translate into a reduced risk for construction or design related claims.”

The three areas that are most dominant in the green construction literature are:

1. Claims regarding energy savings
2. Claims related to certification
3. Claims related to incentives

Each of the above mentioned areas will be discussed in more detail in later sections. Each can include various types of liability claims, such as fraud, negligence, and breach of contract.

In addition to these three major areas in which green construction problems are most frequently seen, there may be other kinds of issues as well. These may be more general in nature or more specific within certain areas of the green aspect. An example is the litigation discussed by Prum and Del Percio (2009) that was filed by an owner of a project against the architect of the project. The litigation was filed because a tenant of the building asked for a rollback on the rent for not meeting the promise that the building would have healthier air quality. The tenant even claimed that, instead of creating a healthy environment, the building reduced productivity of its workers and increased the number of sick days for its employees.
2.8.1 Claims regarding energy savings

Energy savings are one of the factors used to demonstrate how green the building is. Even after installing many green features, a building cannot be green if it does not utilize energy effectively (Howe and Gerrard 2010). Many efforts are being made in various ways to use green energy to result in energy savings for the buildings. Consequently, claims related to energy savings are expected. Most green buildings have certain level of anticipated energy savings, the building tends to be promoted based on that. If the actual energy savings do not meet the anticipated energy savings, various kinds of issues can emerge (Newsham et al. 2009). The cause for the actual energy savings not meeting the anticipated energy saving may be different. There may have been error in energy calculation or predicted use, faulty installation of the equipment, poor performance of the systems, faulty design, and occupant overload. What is the cause and who will the party blamed varies with each case. Any party to the construction can suffer from litigation if the energy saving issues are not handled properly.

Not only are owners, developers, governments, contractors and designers but an organization such as USGBC is also facing new litigations due to the issues regarding energy savings. Research shows that, on average, the buildings that are LEED® certified use more energy than buildings of comparable size that are not certified (Gifford 2008). As a result in some cases, the resulting structure is just an illusion of a sustainable building, which is not energy efficient in reality (Gifford 2008). When certified buildings that have certain level of anticipated energy savings does not meet the anticipated savings, even USGBC cannot avoid becoming defendant in lawsuits.
On the other hand much research has been conducted to see if LEED® certified buildings actually accomplish the energy savings anticipated. Data has been collected and compared to various standard baselines. Under contract to the USGBC, the New Building Institute (NBI) measured the energy savings of LEED® certified buildings and published a report (Turner and Frankel 2008). The research was conducted with 121 LEED® new construction buildings. Based on the findings from the research, Turner and Frankel (2008) concluded that “on average LEED® buildings are saving energy.” Newsham et al. (2009) used the same data and conducted a reanalysis that found that “on average, LEED® buildings used 18–39% less energy per floor area than their conventional counterparts; however, 28–35% of LEED® buildings used more energy than their conventional counterparts.”

A class-action lawsuit against the USGBC by a mechanical systems designer, Henry Gifford, on behalf of all other similarly situated parties such as taxpayers, consumers, construction professionals etc, is one example of lawsuits faced by the USGBC in relation to energy saving matters (Roberts 2010). Although the allegations filed by Gifford were based on various other claims that the USGBC has made regarding green buildings, the major allegation was the claims made by the USGBC about energy efficiency tied to the NBI study. This case is an example of a lawsuit as a result of fraud. Gifford sued the USGBC for monopolization through fraud, unfair competition, deceptive trade practices, false advertising, wire fraud, and unjust enrichment (Real Life Enterprises 2010). In summary the suit argued that “…USGBC is fraudulently misleading consumers and fraudulently misrepresenting energy performance of buildings certified under its LEED® rating systems, and that LEED is harming the environment by leading
consumers away from using proven energy-saving strategies” (Roberts 2010). The court finally dismissed Gifford’s amended complaint against USGBC on the basis that the case lacked enough standing to maintain their claims (Percio 2010). This case demonstrates the fact that legal issues related to LEED® and energy savings are emerging and even the USGBC is facing lawsuits. One should be very careful while making claims regarding energy savings because it can later result in litigation.

Energy savings cannot be determined until the building is placed in service and the actual energy consumption is measured. Unfortunately, there is very few provisions of conducting post-occupancy evaluations to determine the actual energy savings of the building after it operates. Assertions about energy savings can be made “…in terms of average achieved in comparable buildings as long as, the basis for the projection is clearly explained” (Howe and Gerrard 2010). Also, people should not confuse the LEED® certification level with the level of energy savings, as the certification does not depend on energy savings alone. Also, there may be cases where buildings certified at a lower-level might have obtained more credits in energy savings than buildings certified at higher-levels. Newsham et. al (2009) also stated that “…the measured energy performance of LEED® buildings had little correlation with certification level of the building, or the number of energy credits achieved by the building at design time.”

Various issues can arise due to marketing the green project with a broad statement of environmental benefit. Some owners tend to state that their projects are very energy efficient or their energy source does not deplete. But in fact, there is no source that does not deplete in one way or the other; therefore such broad statements regarding the environmental benefits should be avoided because they are hard to validate (Howe and
In fact, making such a broad assertion about environmental benefits can cause the owner to be held accountable for many issues in later phases when the users/tenants do not get the results as expected or are dissatisfied with the performance of the building. Because of the impracticality of substantiating these assertions, Federal Trade Commission (FTC) restricts broad statements regarding the environmental benefit. Such claims should be avoided if possible and if not then the claims should be more specific (Howe and Gerrard 2010). The FTC examines all possible kinds of general or broad environmental assertions such as “safe for the environment,” “ecologically toxic,” and “practically non-toxic” because these are very broad in nature and are subject to enforcement by FTC (Benjamin 2011). These claims can also be problematic for the manufacturers or distributors of building materials and products for marketing their product as being very green or causing no harm to the environment.

2.8.2 Claims regarding certification

A project may be designed and constructed to achieve a certain level of certification, but sometimes the project does not achieve enough points to be certified at the originally intended level. Many claims can arise because the project fails to achieve the anticipated certification level (Howe and Gerrard 2010). Owners of the project sometimes market their project as certified when it is just registered and the actual certification has not been achieved. If the certification level that the project is marketed at is not achieved, the result is that buyers or end users are dissatisfied which may generate claims. It is never appropriate to market the buildings as certified based only on the fact that the project is registered and the certification level is just anticipated. Only after the completion of the
project can a certification level be determined. It would not be ethical to promote a
project as certified when it is in construction phase. Owners should represent the project
is preregistered for a certain certification level instead of claiming that the project has
already been certified (Howe and Gerrard 2010).

Not all the registered projects are certified (Howe and Gerrard 2010). Registration
of project never ensures its certification. It also can happen that projects fall short of the
actual certification level anticipated, and may be certified at a lower level. For example,
an owner may register a project for LEED® platinum and then start marketing the project
as LEED® platinum certified. This can raise the value of his project, and more tenants
may be attracted to the project. However, during the certification process some credits
that were anticipated may be denied, which may result in only enough credits being
achieved to qualify the project only for LEED® gold or a lower level. In such a case, the
owner can become liable to various tenants for providing false information and also for
misleading them through false marketing. Owners can end up in litigation over fraud and
negligence due to unethical marketing of the project regarding certification.

An example of such a claim is the case of Bain vs. Vertex Architects, LLC;
docket number: 2010-L-012695. The lawsuit was filed by an owner Laurie Ban, against
Vertex Architects LLC for failure to obtain LEED® certification, under LEED® for
Homes, as mentioned by the contract documents (Percio 2011). The major allegation of
the suit was the breach of contract by not fulfilling the contracted duty. The project was
designed to achieve a LEED® certified level from USGBC under LEED® for Homes. The
designer even included many passive solar technologies, such as in-floor hydronic radiant
tubing, cross-ventilation, and a ducted energy recovery ventilator (ERV) to reduce the
energy consumption of the building making it earn the honor for “a fantastic example of how LEED® can be done affordably” (LaFleur 2010). However, the project could not achieve the required number of credits for meeting the anticipated certification level and resulted in a lawsuit against design professional.

2.8.3 Claims related to incentives

Along with a healthy environment and increased marketability, owners of green construction also can benefit from various incentives offered by local and state jurisdictions. Along with the benefits of the increasing incentive programs from various local, state and federal regulations, come some new legal issues. Howe and Gerard (2010) list that among these new issues, some are difficulty in understanding technical components of the regulations and the litigation between owners and contractors due to the inability to meet requirements in order to obtain green building incentives.

A well-known issue due to an incentives program occurred in Nevada when the Nevada Legislature changed its provision in 2007 regarding tax abatements. Previously in 2005, the Nevada Legislature introduced Assembly Bill 3, which provided generous tax abatements, up to 50 percent for a 10-year period, for green projects (Prum 2009). After this legislation was passed, green construction in Nevada started to soar in such a way that the state government had financial crisis. The owners quickly realized that there was a significant financial advantage by adding a green aspect to the projects. They could obtain up to $3 for every $1 spent by building green. The result was that the LEED® projects in Nevada increased from 14 in 2005 to 97 in 2007 (Cheatham 2009). Many owners took advantage of the new legislation and made a significant profit through tax
abatements and incentives. Some of the projects that decided to go green were expensive projects like the $8 billion plus City Center Project (Gregor 2009). Due to the sudden increase in green construction and the cost related to the large and mega projects that decided to go green, the Legislature had to rethink this legislation and in 2007, amended its provisions that reduced property tax abatement percentages for green projects and completely removed the sales tax abatements (Prum 2009). This change decreased the estimated minimum loss of $940 million to state revenue over the next biennium to approximately $493 million (Prum 2009). Due to this change, the legislation faced lawsuits from the owners and real estate developers who were already qualified for the tax abatements.

Another example is the litigation between Southern Builders vs. Shaw Development, which was also the nation’s first reported green building litigation. The case arose when the condominium project failed to obtain a tax incentive under a Maryland state-level incentive program, due to delay in construction (Prum and Del Percio 2009). The case was ultimately settled outside the court; however, it created a concern among owners/developers and the contractors that it is very important to properly translate the process for obtaining tax incentives into the contract documents. Also, this case points out that standard contract document is not sufficient for the procurement of green construction.

Sometimes issues due to certification and issues due to incentives programs may be related or in other words there may be a casual relationship between them. An example can be taken from the various tax incentives programs which offer a variable tax benefit to the project if they achieve a certain certification level. For the owner to receive
such incentives the project must achieve the certification within a certain time frame. So if a project is delayed or fails to receive certification in the required time, then the project cannot obtain the tax incentives or it has to apply over again. This can cause legal issues between contractors and owners because the project did not receive tax incentives due to delay in the construction.

2.9 Projects delivery methods

This section presents the different types of project delivery methods available to choose from.

Project delivery method can be defined as the process of planning how the project will be designed, handled and built. Selected project delivery methods determine the relationships among various parties in the project like the owner, design professionals and construction professionals (Kenig, 2007). Therefore, it is very important to select a project delivery method that is best suited for the project.

2.9.1 Design-Bid-Build (DBB)

Design-Bid-Build (DBB) is the traditional method of project delivery which follows the linear process; that is, a task cannot start without the completion of the previous task (Oberlender 2000). Design and construction professionals are two different entities in this method, and are selected separately by the owner of the project. The design team completes the design process, after which the project is sent out to bidding in order to select the contractor who actually builds the project. The owner will have separate contracts with designer and contractor. This method of project delivery is generally
selected for the projects whose scope is well defined; cost is the principal factor over
schedule (Oberlender 2000).

Since the design and construction professionals, technically, do not have much
interaction with each other, this method is not ideal for green projects as the constructor
does not have input towards the green aspect of the project until the design is complete
(Molenaar et al. 2010). Continuous communication should be maintained as much as
possible between the parties involved, so that all the parties are equally aware and
knowledgeable about the goals of the project (AGC 2004).

2.9.2 Design-Build (DB)

The system in which design and construction professionals form a single entity is called
Design-Build (DB). Therefore, the owner has only one contract with the design-build
entity, which provides both design and construction services of the building. This project
delivery method mostly is used in the projects where schedule is a prime factor that
controls the project (AGC 2004).

DB is more appropriate for green projects than DBB because construction
professionals are more involved in the overall design phase as well, thus making them
part of decision making process for achieving the green aspect of the project (Russ 2012).

2.9.3 Construction Management (CM)

In this method of project delivery method, the owner selects a construction manager
based on the qualifications and experience, who works together with the design team in
the design phase. In this delivery method, the owner of the project has separate contracts
with the construction manager and designer but construction manager serves as owner’s representative in the design phase as well (AGC 2004).

Due to the involvement of construction professionals in the design phase in this project delivery method, it is also suitable for LEED® projects as the design and construction team work in collaboration for the LEED® aspect of the project (Russ 2012).

There are two types of within construction management project delivery methods, depending upon the roles and responsibilities of the construction manager. They are:

1. **Agency Construction Manager**

   In this case, construction manager acts as an agent to the owner and is from separate organization than owner. The construction manager is not involved in the construction work and therefore does not absorb any risk. However, they are responsible for the selection of designer and general contractors with whom owners with have separate contracts (Oberlender 2000).

2. **Construction manager at Risk (CMAR)**

   In CMAR, the construction manager acts both as the project coordinator and the general contractor and also absorbs all liability as the contractor. Therefore, the firm that agrees to be the ‘construction manager at risk’ should be highly knowledgeable about all the projects phases, and have skills and experience to properly execute the work to satisfy owner’s requirements while managing the design and construction team. A less experienced or less knowledgeable constructor in this project delivery method could result in significant damages and result in issues due to the construction manager’s inability to handle the work (AGC 2004). In this project delivery method, construction manager works for owner for a guaranteed maximum price (Knutson et al. 2004).
2.9.4 Integrated Project Delivery (IPD)

Apart from the three project delivery methods listed above, there are other project delivery methods as well which have been evolving in construction industry and are not very common. Integrated project delivery is one of the newest project delivery methods whereby all the parties such as - owner, the prime designer, and the prime constructor work in collaboration from the planning phase to the final project handover (AIA 2007). The management system used in this type of project delivery method is collaborative instead of hierarchical. All the parties involved in the project, share the risk equally, as they are all involved in all phases of the project (Winstanley 2011).

IPD is regarded as the most preferred delivery method for green projects, due to the collaboration of all the professionals in order to get the work done. This helps everyone to be part of the green aspect of the project and work together to achieve the goals of the building. As Dings (2010) stated “IPD is by no means the only way by which LEED® certified buildings can be constructed.”

2.9.5 Engineer Procure Construct (EPC)

In EPC delivery method, a single entity called EPC contractor bears the full responsibility to complete the project at a contracted amount. EPC contractor will be responsible for selecting designer, general contractors and also vendors. In this project delivery method, there are interdependencies of the activities in three different phases- Engineering (E), Procurement (P), and Construction (C) (Yeo and Ning 2002).
2.10 Contract types

The contract types that are used in construction projects are presented in this section and they are: a lump sum, or fixed price, contract; a unit price contract; a cost plus contract; and a guaranteed maximum price contract.

2.10.1 Lump sum or fixed price contract

A lump sum or fixed-price is a contract type where a construction professional agrees to construct a project as described for an agreed amount, which is fixed. This type of contract is mostly suitable for small projects with definite scope; this allows the contractors to properly estimate a fixed price. Generally, a contractor does not have to show a detail breakdown of costs while working in a lump sum contract (Clough and Sears 1994).

2.10.2 Unit price contract

When there are defined items of work and the cost per unit for each item is known, a unit price contract is used. In this type of contract, the price is broken down into various parts representing work to be done. Then, the price is fixed for each work per unit of each item (Clough and Sears 1994). This type of contract is used in projects whose cost cannot be determined with accuracy by the contractor for the lump sum value (Oberlender 2000).

2.10.3 Cost plus contract

Cost plus is a contract type where a contractor gets paid for the actual cost incurred for the labor and material plus an amount that is agreed upon by both parties. The additional
agreed cost could vary depending upon cases. It can be a fixed percentage of the actual cost or a fixed fee. In most cases, cost plus contracts are open-ended because the actual cost of the project for labor and material is not known before the completion of the work (Clough and Sears 1994).

2.10.4 Guaranteed maximum price

A guaranteed maximum price contract type can be referred to as an upgrade to the cost plus contract. Since the actual cost of the project will not be known until the completion of the project, sometimes the contractor and owner agree to a guaranteed maximum price above which the project will not exceed. It is the obligation of the contractor to accomplish the project, within the stipulated price, with full compliance to the drawings and specifications. If the actual price exceeds the guaranteed price, it becomes the contractor’s responsibility (Clough and Sears 1994).
3.1 Introduction
This exploratory research focuses on identifying and analyzing legal issues that are unique to green construction projects. Issues related to both the design and construction processes are included in this research, along with commissioning the project as well as long-term operation and maintenance. The review of the available literature was used to shape the thesis. The research was based on the analysis of data in the form of litigation and also the cases solved outside the court, in order to establish current and possible future areas where problems associated with green construction projects could arise.

This research proceeded with data collection in the form of an online survey via SurveyMonkey®. The research design used in this study was both qualitative and quantitative; however the majority of the design involved qualitative data. Various forms of non-parametric statistical analyses along with the visual display of information using charts and graphs were then done. Based on the results, conclusions and recommendations were made.

3.2 Overview of Research Methodology
This chapter is intended to describe the methodology used in this exploratory research to obtain a successful completion. The methodology followed in this research is presented in Fig. 3.1.
Fig. 3.1. Outline of research methodology
A brief description of each step is provided to understand the overall methodology followed in this exploratory research.

### 3.2.1 Problem Statement

First and foremost, the problem defined was the “Construction industry is experiencing new kinds of legal issues due to added green features and the innovative technologies involved”. The problem was then divided into three basic researchable categories, which are 1) issues regarding energy savings, 2) issues regarding certification; and 3) issues regarding incentive provisions.

### 3.2.2 Define Scope and Objective

After defining the problem, the scope and objective of the research were set in order to limit the area for this research so that it was not very broad in nature. Towards this goal, the background information and the need to consider this problem was investigated in order to determine the depth of research that has been conducted in the field.

### 3.2.3 Literature Review

A literature review was conducted to determine the current trend of issues in the green construction industry and to analyze the potential kinds of current as well as future issues. The literature review also was used to analyze the strategies that had already been out in the market to avoid such claims. Finally it was used to establish a basis upon which to draw conclusions and develop recommendations.

### 3.2.4 Development of Survey Questionnaire

Due to lack of any secondary data in the area of research, the research design chosen for this exploratory research was descriptive and experimental research through data collected from an online survey administered through SurveyMonkey®. A list of
questions was prepared, that would help to answer the research question. A sample of the survey questionnaire is provided in Appendix A.

**3.2.5 Data Collection**

The finalized survey was distributed to potential respondents through various means such as email invitation, announcement through various organizations and distribution through the professional social online network, LinkedIn. The potential respondents for the purpose of this research were the professionals who were involved in construction industry such as designers, owners, contractors, material vendors and so forth. Detail description regarding the data collection process and the collected data can be found in Chapter 4 which is dedicated to data collection.

**3.2.6 Data Coding**

The data collected from the online survey was then number coded in order to conveniently sort the data and perform analysis.

**3.2.7 Analysis of Data**

Collected data were analyzed to get the results. Descriptive statistics was used mostly for this purpose along with some nonparametric statistical tests. Detail about the various tests conducted and the results are presented in Chapter 5-Data Characterization and Analysis.

**3.2.8 Discussion of the results**

Analysis was followed by discussion of the results, as stated in Chapter 6.

**3.2.9 Conclusion and Recommendation**

With the help of results obtained from the analysis, conclusions were drawn. At the end of this research, limitations of this exploratory research are presented and suggestions for future research are put forward to help anyone who wants to expand the research.
3.3 Sample / Participants

The sampling method used for this research is judgment sampling where respondents were selected per the convenience of contacting them but based on judgment of which kind of people should be contacted (StatPac Inc 2012). For example there were no specific requirements about what cities they are in. So firms in every state and every city could be contacted. However, the type of people to be contacted was fixed to those who were professionals involved in construction industry that could represent owners, governments, architects, designers, contractors, construction managers, consultants, specialty subcontractors, material vendors or any others who were directly or indirectly related to construction industry. So the sample included various construction professionals from all over the United States. Occupation was the only factor considered, and no discrimination was made based on any other demographic information of the participants, including age, sex, grade level, race/ethnicity, language, disability, socioeconomic condition, and years of experience.

3.4 Statistical Background

The data collected through the online survey questionnaires were analyzed with various statistical tests using various applications. The data were first transferred to Excel for the convenience of descriptive analysis. Visual charts and graphs were used to analyze the distribution of the data based on various parameters. Most of the analysis included the descriptive statistics of the data. Some other non parametric statistical tests such as Kruksal-Wallis rank test, Wilcoxon rank sum test were also used to conduct hypothesis testing for some questions which are discussed in more detail in Chapter 5. Applications
used by this research for the statistical analyses purpose are Excel, PHStat and SPSS. The details about each kind of tests conducted in this research are discussed below.

3.4.1 Visualizing Data
The general information regarding the data obtained such as location of the projects, organization type of the respondents, project delivery methods used on the projects etc are organized in the research and displayed using visualization tools like various type of charts and other displays as listed below depending upon whether the data are categorical or numerical (Levine et al. 2011):

3.4.1.1 Pie charts
For the categorical data, pie charts are used in the research to show how various categories of the data contribute to form the whole. Among the various types of available pie charts, exploded three-dimensional pie charts are used for an aesthetic purpose.

3.4.1.2 Column/Bar charts
Column/bar charts are also used for the categorical data. Column/bar charts are used in this research to compare different categories using individual columns/bars to represent each category. The length of the column/bar can represent various things like amount, percentage or frequency depending upon how the data are analyzed.

3.4.1.3 Side-by-Side Column/Bar charts
Side-by-side column/bar charts are similar to the column/bar charts but use sets of columns/bars to show the joint responses from two or more different categorical variables
instead of a single column/bar for each different category. This type of charts is used to compare two different categories based on a single parameter.

3.4.1.4 Histogram
When the data are numerical instead of categorical, histograms are used by his research for visually displaying the data. The histogram also looks like bar chart but does not have space between the bars. Vertical bars in histogram represent the frequencies or percentages in each group and the horizontal axis displays the variable of interest in numerical form.

3.4.2 Descriptive Statistics
Descriptive statistics are used to summarize and describe numerical data regarding the sample population of the study. There are various ways to describe the data using descriptive statistics such as measure of central tendency, variation; and shapes of each numerical variable. The measures used by this research are described below:

3.4.2.1 Mean
The mean or the arithmetic mean or also called the average is the most general measure of central tendency in which all the values play an equal role. Mean is calculated by adding together all the values in a data set and then dividing the total by the number of values in the data set. The mean is calculated using formula given in Eq. 3.1.

\[
\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n}
\] (3.1)
where, $\bar{X}$ = sample mean

$$n = \text{number of values or sample size}$$

$$X_i = \text{$i^{th}$ value of the variable X}$$

$$\sum_{i=1}^{n} X_i = \text{summation of all $X_i$ values in the sample}$$

The mean value is greatly affected by the presence of a value that differs from the others greatly. So in the case of presence of such values, the mean should not be used as the measure of central tendency.

3.4.2.2 Median

The median is also the measure of the central tendency of a data set. It is the middle value in an ordered array of data which is ranked in increasing order i.e. from smallest to largest value. Median can be used as a measure of central tendency even if there are values in the data set which are extremely different. Since the median is the value that lies exactly in the middle position in an array of values, half the values are larger or equal to the median and half of the values are smaller or equal to the median. The formula used to calculate the median is given in Eq. 3.2.

$$\text{Median} = \frac{n+1}{2} \text{ ranked value} \quad (3.2)$$

In case of an odd number values in the data set, the median is the measurement associated with the middle-ranked value and in case of even numbers values in the data set, the median is the measurement associated with the average of the two middle-ranked values.
3.4.2.3 Variance and Standard Deviation

Variance and standard deviation are the two measures of variation that take into account how all the values are distributed and clustered between the extremes. Variance and the standard deviation statistics measure the average scatter around the mean. The standard deviation is square root of the variance. Variance ‘$S^2$’ and the standard deviation ‘$S$’ is calculated using the formulas given in Eq. 3.3 and 3.4 respectively.

\[
S^2 = \frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1} \tag{3.3}
\]

\[
S = \sqrt{S^2} = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}} \tag{3.4}
\]

3.4.2.4 Range

Range is the type of descriptive statistics which measures the variation of a data set. It is the simplest measure and is basically the difference between the largest value and the smallest value in the data set. Range is also highly affected by the extreme values. Eq. 3.5 shows formula to calculate range.

\[
\text{Range} = X_{\text{largest}} - X_{\text{smallest}} \tag{3.5}
\]

3.4.3 Confidence Interval Estimation for the Proportion

Confidence interval for the proportion is used when estimating the proportion of items in a population having a certain characteristic of interest. Confidence interval can be calculated for mean or for proportion depending upon the type of data available. With categorical data, confidence interval estimation for the proportion is appropriate. In order to estimate the confidence interval, sample proportion ‘$p$’ is used which is given by
\( p = \frac{X}{n} \), where \( n \) is the sample size and \( X \) is the number of items in the sample having the same characteristics of interest or also called the number of success. So, using the sample proportion ‘\( p \)’, confidence interval for the population proportion is calculated using Eq. 3.6. But, to use this equation, both ‘\( X \)’ and ‘\( n-X \)’ should be greater than 6.

\[
p \pm Z_{\alpha/2} \sqrt{\frac{p(1-p)}{n}}
\]

\[
p - Z_{\alpha/2} \sqrt{\frac{p(1-p)}{n}} \leq \pi \leq p + Z_{\alpha/2} \sqrt{\frac{p(1-p)}{n}}
\]  \hspace{1cm} (3.6)

where, \( p = \) sample proportion = \( \frac{X}{n} \)

\( X = \) the number of items in the sample having the same characteristics

\( n = \) sample size

\( \pi = \) hypothesized population proportion

\( Z_{\alpha/2} = \) critical value from the standardized normal distribution

**3.4.4 Wilcoxon Rank Sum Test**

When there are two independent populations and the data are non-parametric, Wilcoxon rank sum test is used to perform the statistical analysis which tests the difference between the median of two group of population, with sample size \( n_1 \) and \( n_2 \). The Wilcoxon rank sum test does not depend on the assumption of normality for the two populations. The null hypothesis which is tested by Wilcoxon rank sum test is

\[
H_0 : M_1 = M_2
\]

Against the alternative i.e.

\[
H_1 : M_1 \neq M_2
\]
For performing this analysis, the data has to be ranked unless the data contains ranks originally. Rank 1 is given to the smallest value of the total data combining both the groups. If more than one data has the same values, each should be assigned the average of the ranks that otherwise would have been assigned if there were no ties in the values of the data. The highest rank will be rank \( n \) given the \( n \) is the total number of data and is given by \( n = n_1 + n_2 \). In case the sample size is unequal, \( n_1 \) represents smaller and \( n_2 \) represents larger sample. The accuracy of the ranking can be checked by using the Eq. 3.7.

\[
T_1 + T_2 = \frac{n(n+1)}{2}
\]  

(3.7)

Where, \( T_1 = \) Wilcoxon rank sum test statistics equals sum of ranks assigned to the \( n_1 \) values in the smaller sample

\( T_2 = \) Wilcoxon rank sum test statistics equals sum of ranks assigned to the \( n_2 \) values in the larger sample

For larger sample size (\( n_1 \) and \( n_2 \) both \( \geq 10 \)), the test statistic \( T_1 \) is approximately normally distributed, with the mean, \( \mu_{T1} \), and the standard deviation, \( \sigma_{T1} \), which are given by

\[
\mu_{T1} = \frac{n_1(n+1)}{2}
\]

\[
\sigma_{T1} = \sqrt{\frac{n_1n_2(n+1)}{12}}
\]

Standardized Z test statistic which approximately follows a normal distribution is then calculated using the Eq. 3.8.
Now using the value of the $Z_{\text{STAT}}$, hypothesis testing is done. Based on the level of significance, $\alpha$, null hypothesis is rejected if the $Z_{\text{STAT}}$ falls in the rejection area as seen in the Fig 3.2.

\[
Z_{\text{STAT}} = \frac{T_1 - \frac{n_1(n+1)}{2}}{\sqrt{\frac{n_1n_2(n+1)}{12}}} \tag{3.8}
\]

Fig. 3.2. Regions of rejection and non-rejection using the Wilcoxon rank sum test (Levine et al. 2011)

3.4.5 Kruksal-Wallis Rank Test: Nonparametric Analysis for the One-way ANOVA (Analysis of Variance)

Kruksal-Wallis rank test is an extension of the Wilcoxon rank sum test and compares the difference of medians among more than two groups as opposed to Wilcoxon rank sum test which compares medians between two groups. Hence, Kruksal-Wallis rank test has the same benefit over non-parametric data as in one-way ANOVA has over parametric data. The null hypothesis which is tested by Kruksal-Wallis rank test is

\[ H_0: M_1 = M_2 = \ldots = M_c \]

Against the alternative i.e.

\[ H_1: \text{Not all } M_j \text{ are equal (where } j = 1, 2, \ldots, c) \]

Where, $c =$ number of groups to be compared
Also, the data should be in the form of rank to perform Kruksal-Wallis rank test. So if necessary, the values in the \( c \) samples in the data should be replaced with the combined ranks. Rank 1 is given to the smallest value of the total data combining both the groups. If more than one data has the same values, each should be assigned the average of the ranks that otherwise would have been assigned if there were no ties in the values of the data. The highest rank will be rank \( n \) given the \( n \) is the total number of data (where, \( n = n_1 + n_2 + n_3 + \ldots + n_c \)).

Kruksal-Wallis test statistic ‘\( H \)’ is calculated as shown in Eq. 3.9.

\[
H = \left[ \frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)
\] (3.9)

where, \( n \) = total number of values over the combined samples

\( n_j \) = number of values in the \( j^{th} \) sample (\( j = 1,2,\ldots,c \))

\( T_j \) = sum of the ranks assigned to the \( j^{th} \) sample

\( T_j^2 \) = square of the sum of the ranks assigned to the \( j^{th} \) sample

\( c \) = number of groups

The critical value \( X^2 \) can be calculated using chi-square distribution with \( c-1 \) degree of freedom for the assumed value of \( \alpha \). Hence if the computed value of the Kruksal-Wallis test statistic, \( H \), is greater than the upper-tail critical value as shown in Fig. 3.3, we reject the null hypothesis.

![Fig. 3.3. Regions of rejection and non-rejection using the Wilcoxon rank sum test (Levine et al. 2011)](image-url)
3.4.6 Simple Linear Regression

Regression analysis is used for quantitative data in order to predict the values of dependent variable based on the values of the independent variable. Along with predicting values, regression analysis also helps to predict the mathematical relationship that could exist between the two types of variables (Levine et al. 2011).

There are many possible relationship that can exist between the dependent and independent variables. The simple one of them is linear relation and the analysis of the linear relation is called simple linear regression. Simple linear regression is used to analyze the value of dependent variable based on single numerical independent variable (Levine et al. 2011). Fig. 3.4 shows the linear relationship between the two variables.

![Simple linear relation between dependent and independent variables](image)

**Fig. 3.4.** Simple linear relation between dependent and independent varaibles (Levine et al. 2011)

The model used to predict the simple linear relationship between the dependent variable and independent variable is given by Eq. 3.10.

\[ Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \]  

(3.10)

where, \( \beta_0 = Y \) intercept for the population

\( \beta_1 = \) slope for the population

\( \varepsilon_i = \) random error in \( Y \) for \( i \) observation
\[ Y_i = \text{dependent variable for } i \text{ observation} \]
\[ X_i = \text{dependent variable for } i \text{ observation} \]

From the results of the calculation, various kinds of relation between the dependent and independent variable can be seen depending upon the nature of the data. Fig. 3.5 represents the result that represents that positive relation exist between two variables. Fig. 3.6 represents the negative relation between two variables. Results such as in Fig. 3.7 shows that there exist no relationship between the two variables.

**Fig. 3.5.** Representation of positive linear relationship (Levine et al. 2011)

**Fig. 3.6.** Representation of negative linear relationship (Levine et al. 2011)

**Fig. 3.7.** Representation of no relationship (Levine et al. 2011)
4.1 Introduction

Chapter 4 describes the measurement instrument and the methodology employed to collect the data for this exploratory research effort.

Initially, sources for secondary data were sought for this research, but none could be identified. Therefore, a primary data collection effort was required to execute this research. By using primary data, the specific data that was deemed necessary to answer this thesis’s hypotheses, could be collected.

Data collection for this research was originally intended to be limited to Nevada as it is the state with the largest number of LEED® certified projects per capita. It was thought that sufficient data could be obtained within Nevada to satisfy the needs of the exploratory research. Extremely low response levels were experienced in the early data collection phase. This led to the conclusion that limiting the scope of the research to state of Nevada in all likelihood would not achieve a response rate necessary to conduct this research. A decision was made to expand the geographic scope of the research to include all of the United States.

Various social network organizations on LinkedIn were used to expand the geographic scope of the distribution of the survey instrument. As a result of this method, some international data were also received. Even with this effort, the response level remained low.
One hundred and thirty three responses were received during the five months of continuous effort during the data collection phase. The number of responses obtained is deemed acceptable for the purpose of conducting the exploratory research reported in this thesis.

4.2 Survey Instrument

The measurement instrument used to collect data was a survey questionnaire. The survey instrument was located online and used the survey tool ‘SurveyMonkey®’ to collect data. The survey had questions asking for information related to issues in green design and construction. Since the topic of this research is a previously un-researched topic, the best approach was to collect primary data through direct interaction with professional members of the owner, designer and construction communities who are potentially involved in green construction projects.

The first version of the measurement instrument was created and then reviewed by the construction management (CEM) faculty who are members of the thesis Advisory Committee members. An early test of the survey instrument, preceding the deployment of the online survey instrument, was in the form of paper survey created by the researcher. The paper survey was distributed at the September 6, 2011 USGBC Southern Nevada Chapter meeting. Approximately 45 individuals were in attendance at this meeting. From this sample population only 10 responses were obtained of which none of the respondents indicated that they had encountered any legal issues. Following this test, the survey instrument was reevaluated. Changes in questions, addition of questions, and organization changes of the survey instrument were undertaken. The survey instrument was then
further revised and reviewed in detail by Dr. David Shields, Dr. Pramen Shrestha, Professor Opfer, Dr. KaWa Chui; and Mr. Patrick Murch, Esq. Mr. Murch was the first attorney in Nevada to become accredited as a LEED® AP.

The paper survey was then converted to an online survey in order to increase the convenience for survey participants to respond. The online administration of the survey instrument had the additional convenience of providing data in a near ready-to-analyze format that required limited manipulation to perform analysis. The validity of the online survey was determined through a pilot study in the form of “beta-testing” of the survey. The survey was initially sent out to Dr. Shields, Dr. Shrestha, Dr. Chui, Professor Opfer, Mr. Murch and two graduate student colleagues for review in terms of spelling, grammar, clarity and reliability of the questions to answer the necessary research questions posed by the thesis’s hypotheses. Corrections and further fine tuning were completed and approval granted by my Thesis Advisor to distribute the survey instrument.

The initial online survey instrument had three parts: Part A which required general information from the respondents, Part B which required detailed information regarding the projects that experienced some legal issues; and Part C a recommendation section regarding the training and familiarity of various parties with green construction. Following the investigation of the responses of the early respondents a critical observation was made. It appeared that respondents - who had no legal issues and therefore did not complete Part B of the survey, also did not continue further on and left Part C of the survey unanswered. Part C was not dependent upon whether the respondent had legal issues on a project. Since Part C was independent of Part B, the survey was restructured such that questions in Part C were moved into part A. The survey instrument
in its final form had only two parts. This restructuring of the ordering of the survey instrument resulted in significantly more respondents completing the questions that were previously included in Part C. A sample of the final survey instrument is provided in Appendix A.

4.3 Data Collection Record

Access to the online survey instrument commenced on October 15, 2011. The first response was received October 20, 2011. The last response was received on March 18, 2012. Fig. 4.1 shows the cumulative response record of when the responses were received. The milestones in Fig. 4.1 are explained later in this section and Table 4.1.

![Fig. 4.1. Cumulative response record (n=133)]
The early invitations to participate in completing the survey instrument were observed to be producing an exceedingly low level of response as can be observed in Fig. 4.1. Upon making this observation, new methods of distributing the survey instrument were considered that would increase the number of responses received. The actions taken included- requesting that organizations re-solicit their members to participate. Nevada has the greatest number of LEED® certified buildings and as such it seemed logical that surveying those in Nevada would produce sufficient results for exploratory research. This did not succeed in practice as early response rates were exceedingly poor. A critical decision was made to increase the geographic scope of the survey in hope of obtaining sufficient responses to complete this exploratory research.

At this juncture in the research the question was how to increase the geographic scope quickly and reach as many possible potential respondents.

With the advent of professional social networking there is the potential for near-instantaneous communication with a large audience. An approach was adopted to use LinkedIn, a popular professional social networking website, to accomplish the goal of quickly reaching a large geographic sample population of individuals involved in green construction. Table 4.1 presents the detail of the activities to solicit participants. Each activity is referred to as a milestone. Table 4.1 is a chronological record of the milestones.

Many of the organizations and their members were solicited as many as three times to participate in the survey. Even with this intense level of effort, an extremely low level of response was obtained.
Table 4.1. Data Collection Milestones

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oct. 15, 2011</td>
<td>Email invitation to local architecture firms - First call</td>
</tr>
<tr>
<td>2</td>
<td>Nov. 9, 2011</td>
<td>Email to members of U.S. Green Building Council (USGBC), Southern Nevada Chapter - First call</td>
</tr>
<tr>
<td>3</td>
<td>Nov. 10, 2011</td>
<td>Email to members of National Electrical Contractors Association (NECA), Southern Nevada Chapter – First Call</td>
</tr>
<tr>
<td>4</td>
<td>Nov. 11, 2011</td>
<td>Email to members of American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE), Southern Nevada Chapter – First Call</td>
</tr>
<tr>
<td>5</td>
<td>Nov. 17, 2011</td>
<td>Email invitation to local construction firms - First call</td>
</tr>
<tr>
<td>6</td>
<td>Nov. 23, 2011</td>
<td>Email to members of USGBC, Southern Nevada Chapter - Second call</td>
</tr>
<tr>
<td>7</td>
<td>Dec. 2, 2011</td>
<td>Email to members of American Institute of Architects (AIA), Nevada Chapter – First Call</td>
</tr>
<tr>
<td>8</td>
<td>Dec. 5, 2011</td>
<td>Email to members of Construction Management Association of America (CMAA), Southern NV chapter</td>
</tr>
<tr>
<td>9</td>
<td>Dec. 11, 2011</td>
<td>LinkedIn - First call</td>
</tr>
<tr>
<td>10</td>
<td>Dec. 12, 2011</td>
<td>Email to members of American Society of Civil Engineers (ASCE), Nevada Section, Southern Nevada Branch - First call</td>
</tr>
<tr>
<td>11</td>
<td>Dec. 21, 2011</td>
<td>Email invitation to local architecture firms - Second call</td>
</tr>
<tr>
<td>12</td>
<td>Dec. 23, 2011</td>
<td>Email invitation to local construction firms - Second call</td>
</tr>
<tr>
<td>13</td>
<td>Jan. 3, 2012</td>
<td>Email invitation to architecture firms outside of Nevada- First call</td>
</tr>
<tr>
<td>14</td>
<td>Jan. 13, 2012</td>
<td>Email invitation to Construction firms outside of Nevada</td>
</tr>
<tr>
<td>15</td>
<td>Jan. 14, 2012</td>
<td>Telephone calls to local firms</td>
</tr>
<tr>
<td>16</td>
<td>Jan. 16, 2012</td>
<td>Announcement to members of ASCE, Nevada Section, Southern Nevada Branch - Second call</td>
</tr>
<tr>
<td>17</td>
<td>Jan. 23, 2012</td>
<td>Email invitation to Architecture firms outside of Nevada-Second call</td>
</tr>
<tr>
<td>18</td>
<td>Jan. 28, 2012</td>
<td>LinkedIn - Second call</td>
</tr>
<tr>
<td>19</td>
<td>Feb. 13, 2012</td>
<td>Announcement to members of ASCE, Nevada Section, Southern Nevada Branch - Third call</td>
</tr>
<tr>
<td>20</td>
<td>Mar. 4, 2012</td>
<td>LinkedIn - Third call</td>
</tr>
<tr>
<td>21</td>
<td>Mar. 18, 2012</td>
<td>Data collection complete</td>
</tr>
</tbody>
</table>

4.4 Solicitation for Participation

As mentioned earlier, the survey instrument was placed online at SurveyMonkey®. After the survey instrument was confirmed as working as intended at the SurveyMonkey® website, it was ready for distribution. The online survey was then distributed to various LinkedIn professional groups whose members were geographically diverse. Various other
methods were adopted to distribute the survey to make sure that as many potential respondents were reached. These other methods are described in the following sections.

4.4.1 Announcement to the members of professional societies

One of the methods being used for survey instrument distribution was through mass emailing to the members of local various professional societies from the head of the respective local chapters. Local officers in the professional societies were contacted and requested to contribute to the research by distributing the web-link to the online survey to their members through mass email announcements. The local professional societies that assisted in this research are:

- American Society of Civil Engineers (ASCE), Nevada Section, Southern Nevada Branch,
- American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE), Southern Nevada Chapter, and
- Construction Management Association of America (CMAA), Southern Nevada Chapter.

4.4.2 Announcement to the members of professional trade associations

The survey instrument was also distributed through mass emailing to the members of local trade associations from the head of the respective local chapter. Local Officers in the trade associations were contacted and requested to contribute to the research by distributing the web-link to the online survey to their members through mass email announcements. The local trade associations that assisted in this research are:
- National Electrical Contractors Association (NECA), Southern Nevada Chapter, and

- United States Green Building Council (USGBC), Southern Nevada Chapter,

4.4.3 Request to members of LinkedIn®

The other method used for distributing the survey was through the professional social network website, LinkedIn®. LinkedIn® is a “website geared towards companies and industry professionals looking to make new business contacts or keep in touch with previous co-workers, affiliates, and clients” (HudsonHorizons 2012). LinkedIn even has profiles of various different groups which one can join if he/she already has an account in LinkedIn. So those groups, which were related to green aspects of projects were used for data distribution in this research. A request for participation was posted on the “wall” of each qualifying group in LinkedIn with the link to the online survey. Thirty-six total LinkedIn groups were contacted.

Three different attempts were made to reach the members of LinkedIn groups. The first attempt was conducted in December 2011, the second in January 2012 and the third and final in March 2012. Table 4.2 lists of the groups that were contacted and the responses received from each group. The table also shows the total number of members in each group which indicates the possible number of people in each group that might have been reached through this attempt of survey distribution.
Table 4.2. Groups Contacted via LinkedIn with the Total Number of Members in Each Group and Number of Responses from Each Group

<table>
<thead>
<tr>
<th>No.</th>
<th>LinkedIn Groups</th>
<th>Number of Members</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>American Institute of Architects</td>
<td>2,525</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ARCHITECT</td>
<td>29,697</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Architects, Engineers &amp; Constructors Network (AEC)</td>
<td>1,553</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Architectural Woodwork Institute [AWI]</td>
<td>3,044</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Architecture and Interiors</td>
<td>15,404</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>American Society of Civil Engineers (ASCE)</td>
<td>47,232</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>ASCE: Construction Management</td>
<td>1,514</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Building Green, a Sustainability Group</td>
<td>15,756</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Construct IN</td>
<td>6,627</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>CONSTRUCTION</td>
<td>1,872</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Construction Management</td>
<td>33,296</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Construction Networking</td>
<td>8,837</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Construction Professionals Forum</td>
<td>31,081</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>CONSTRUCTION PROJECT MANAGERS</td>
<td>1,048</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>CSI - Construction Specifications Institute</td>
<td>3,894</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Design and Construction Network</td>
<td>28,734</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Green</td>
<td>128,623</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>Green &amp; Sustainability Innovators &amp; Innovation Network</td>
<td>18,710</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Green Builders Group</td>
<td>640</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Green Building</td>
<td>5,082</td>
<td>1</td>
</tr>
<tr>
<td>21</td>
<td>Green Building Connect</td>
<td>6,566</td>
<td>2</td>
</tr>
<tr>
<td>22</td>
<td>Green Real Estate</td>
<td>9,989</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>LEED Accredited Professional</td>
<td>29,505</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>LEED AP NETWORK</td>
<td>2,221</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Linking CONSTRUCTION</td>
<td>60,088</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Nevada Sustainable Design Build</td>
<td>131</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>Sustainability</td>
<td>5,128</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Sustainability Professionals</td>
<td>39,164</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>Sustainability Working Group</td>
<td>7,023</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>Sustainable Bid Practices</td>
<td>247</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>Sustainable Brands</td>
<td>4,278</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Sustainable construction and planning</td>
<td>10,637</td>
<td>2</td>
</tr>
<tr>
<td>33</td>
<td>The Architects Alliance</td>
<td>2,799</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>The Renewables Energy Network</td>
<td>12,010</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>U.S. Green Building Council (USGBC)</td>
<td>28,711</td>
<td>2</td>
</tr>
<tr>
<td>36</td>
<td>USGBC group for LEED Professional</td>
<td>5,549</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>609,215</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>
The group with highest number of members was “Green” with 128,623 members and the group with lowest number of members was “Nevada Sustainable Design Build” with 131 members. Out of the 36 different groups in LinkedIn, that were contacted, responses were received from 23 different groups with the total number of responses being 36. The number of responses from different groups ranged from 1 to 4. The group from which the highest numbers of responses were received was “Architects, Engineers & Constructors Network (AEC)”. 

One note of caution regarding the total number of members presented in Table 4.2. It is highly likely that the total number of members is significantly overestimated. The overestimation is due to an individual being a member of more than one group and being counted as different individual in each group in the summation of total members. There is no way to easily calculate an accurate value of individuals contacted through the LinkedIn groups.

4.4.4 Email invitation to various professionals

The last method used to distribute the survey was through direct email to industry professionals. Email addresses for industry professionals like architects, engineers, contractors, construction managers, and sub-contractors etc were collected through internet research from the company’s website or from other online indexes like architectusa.com, dexknows.com, yellowpages.com, etc. An email was then sent to all the addresses collected either directly through personal email or through email invitation via SurveyMonkey®.
4.5 Data Entry Process

For the purpose of conveniently summarizing data and performing analysis of the data, the survey responses were entered into a Excel spreadsheet. Entered data were then analyzed in various ways to obtain good results and meaningful conclusions. When entering the data into the spreadsheet, the responses were given a certain number code. The number code made the data easier to sort. For instance, the response to the question where respondents had to identify their organization type, numbers as shown in Table 4.3 were assigned to each different option of responses:

Table 4.3. Number Coding for the Type of Organization of the Respondent

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>1</td>
</tr>
<tr>
<td>Government (Federal / State / Municipal)</td>
<td>2</td>
</tr>
<tr>
<td>Architect</td>
<td>3</td>
</tr>
<tr>
<td>Engineer</td>
<td>4</td>
</tr>
<tr>
<td>Architect / Engineer</td>
<td>5</td>
</tr>
<tr>
<td>Contractor</td>
<td>6</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>7</td>
</tr>
<tr>
<td>Consultant</td>
<td>8</td>
</tr>
<tr>
<td>Specialty Subcontractor</td>
<td>9</td>
</tr>
<tr>
<td>Material Vendor</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
</tr>
<tr>
<td>No Response</td>
<td>0</td>
</tr>
</tbody>
</table>
5.1 General data description

This section deals with the general description of the data such as locations of the project and demographic distribution of the responses by organization type. Although 133 responses were received, only responses which contained all the required detail information pertaining to this research’s issue were used for data analysis. One of the methods of distributing the survey instrument was through LinkedIn which is an international, business-related social networking website. As a result of using LinkedIn, several international responses were obtained. As the geographic scope of the research was limited to United States, the international responses were excluded from the data analysis.

5.1.1 Project locations:

In this section the responses are classified by the location of the projects into three divisions:-(i) within the state of Nevada, (ii) the United States excluding Nevada; and (iii) outside United States. Out of the 133 response collected, only 114 responses provided the location of the project. Providing location information was optional as it may be of a sensitive nature or respondents may not want to divulge the location due to legal concerns. Out of the 114 responses that provided location information, 38 of them were from within Nevada, 68 were from outside the state of Nevada but within United States. Eight of the responses were from outside United States. Fig. 5.1 shows the
distribution of respondents by geographic location. The map of the United States in Fig.
5.2 shows the location and number of respondents by state.

![Map of the United States showing the distribution of respondents by state](image)

**Fig. 5.1.** Distribution of respondents by geographic location (n=133)

![Pie chart showing the distribution of respondents by geographic location](image)

**Fig. 5.2.** Location and number of respondents by state (n=125)
Since the geographic scope of the research was limited to United States, the international responses are excluded in further sections for data analysis. Apart from the location information provided by the respondents, recognition of international data was based also on the examination of responses in each section by the respondents. Only eight international respondents were identified. Therefore, total number of responses used for the purpose of analysis by this research in further sections is 125.

5.1.2 Data distribution by organization type:

The survey questionnaire asked the respondents to identify the type of organization that he/she represented. Based on the respondent’s answer, the organizational demographics for the respondents were developed. There were 125 respondents, of which 124 identified their organization. The breakdown of the respondents is: 10 project owners, eight represented government (which included federal, state and municipal), 39 were from architectural firms, 12 were from engineering firms, nine were from A/E firms i.e. organizations that provided both architectural and engineering services, 16 were from contractor firms, eight were from project construction managers, 10 were consultants to the project, three were from subcontractors, three were from material vendors; and six represented other type of organizations other than those specifically identified in the questionnaire. The other types of organizations included two law firms, one non-profit organization, one historic preservation firm, one specification consultant; and one landscape architect. The distribution of respondents by organization type is shown in Fig. 5.3.
Fig. 5.3. Distribution of respondents by type of organization (n=125)

There were 39 responses just from architects which represented 31% of the total responses. The owner category was the second largest category which included owners and government at 14%. The third largest group represented was contractors at 13%. If the data were sorted by the category, the design category of organizations which would include architecture, engineering, and A/E represented almost half of the respondents at 48%.

5.2 Issues in green/sustainable/LEED projects
This section classifies the respondents based upon their experience with green projects. Out of 125 respondents, 120 of them provided response to the question which asked, “Has your company been involved in any green / sustainable / LEED design or construction work?” One hundred and nine of respondents indicated that they or their company had been involved in green construction and eleven of the respondents said they or their companies were not involved in any green construction project. Fig. 5.4 shows the breakdown of involvement of the respondents in green construction.
The data has also been classified on the basis of the green construction project experienced any issues or problems. The next question asked if the respondents who had experience with green projects, faced any kinds of issues in those projects. Out of the 109 respondents who had experience with green projects, four respondents did not provide an answer to this question and 48 said that they did not experience any issues in the project. Fifty-six respondents answered the question in the affirmative that they had experienced issues in the projects they had been involved with. Out of this 56 respondents who answered in affirmative, three respondents did not provide answer to questions in Part B which needed the detail information about the projects that actually experienced any issue. Therefore, considering number of affirmative response to this question and provision of responses to the Part B of the survey, results in a total of 53 respondents who actually had issues on green projects. The distribution of data according to issues experienced on the green construction project is shown in Fig. 5.5.
Fig. 5.5. Data distribution according to issues experienced by respondents on the green construction projects (n=109)

Fifty-three projects that experienced issues represented 48 percent of the total respondents. The green projects with issues are distributed by their geographic location. Out of the 53 green projects with issues, locations were identified for 51 projects. Fig. 5.6 shows the reported geographic location by state of the green projects with issues.

Fig. 5.6. Location by state of green projects with issues (n=53)
5.3 Detailed analysis of green projects which experienced issues

Part B of the survey contained questions pertaining to the detail of the issues/problems that the green projects faced. The response rate to this part of the survey is very small relative to Part A where respondents had to only provide general information. Part B of the survey required detailed project information. The low response is likely due to two possible reasons. The first reason is that respondents are reluctant to share information because they consider it confidential, proprietary, or sensitive. The second reason is that the respondent does not have access to the information or did not want to spend the time to access the information. Also, since the answers to all the questions were optional, not all respondents who responded to this section have responded to each and every question. Therefore there are many variations in the number of responses to each different question.

All 53 respondents who had project issues, provided a response to some of the questions in Part B of the survey. The survey allowed a respondent to provide data on up to two projects that had experienced issues. However, none of the 53 respondents provided data on more than one project. The 53 projects were reviewed to ensure that none of the projects were duplicate submissions of the same project. Locations were not provided on many projects therefore only partial determination of duplication could be attempted based on location. The other data investigated to determine duplication was the issues provided by the respondents. No duplication of issues was found. Based on location and issue data, it was concluded that the likelihood of duplication of any of the projects was extremely low to nonexistent. There were many variations in the number of
questions that each of the 53 respondents answered in part B. The maximum response to a question in Part B was 53 and some questions had only 25 responses.

5.3.1 Data distribution by project type

Question 3 from Part B of the survey was about the project type which experienced issues. All respondents who experienced issues provided response to this question. Based on the 53 responses, 32 were in the Building – New Construction category which contributes 60% of the total and is the highest number among all categories. Eight responses were Building – Tenant Improvement / Renovation category, one was in the Industrial / Power / Manufacturing category, four responses were Residential – New Construction category, four were in the Residential – Renovation category; and four were in the government / public works category. No responses were received on Heavy Civil / Infrastructure projects. The lack of responses on Heavy Civil / Infrastructure projects is not surprising as this is an area that is in its infancy in developing green / sustainable design and construction standards and approaches. The distribution by type of projects which experienced issues is shown in Fig. 5.7.

![Fig. 5.7. Distribution of green projects that experienced issues by type (n=53)](image_url)
5.3.2 Data distribution by the type of project delivery method for projects with issues

This section divides the green projects that experienced any issues according to the project delivery method used for the project. Fifty-two out of 53 respondents with issues provided a response to the question which asked which type of project delivery method was used for the project. Out of the 52 responses, 21 of the projects used Design-Bid-Build (DBB), 17 of the projects used Design-Build (DB), one project used Agency Construction Manager, five of them used Construction Manager at Risk (CMAR), three of the projects used Integrated Project Delivery (IPD), one used Engineer-Procure-Construct (EPC); and four of them used some other types of project delivery methods that were not listed in the options. The four projects indicated the use of another kind of project delivery method used: (1) Design Assist, (2) DBB with MEP (mechanical, electrical, and plumbing) and foundation being done as DB, (3) Plan and Specification MEP DB; and (4) Consult-Manage-Implement. The distribution by the type of project delivery method for the green projects is shown in Fig. 5.8.

Fig. 5.8. Distribution of projects that experienced issues by type of project delivery method (n=53)
5.3.3 *Data distribution by the type of contract used in the project*

This section divides the green projects that experienced any issues according to the type of contract used in the project. Fifty-two out of 53 respondents with issues provided an answer to this question. According to the 52 responses, 14 of the projects used a Lump Sum Contract, 11 of the projects used a Unit Price Contract, 10 used Cost Plus Contract with fixed or variable fee; and 17 of the projects used Guaranteed Maximum Price in the project. The distribution of data, according to the contract type used in the green projects that experienced issues, is shown in Fig. 5.9.

![Pie chart showing distribution of contract types](image)

**Fig. 5.9.** Distribution of green projects that experienced issues by contract type (n=53)

The data for the type of project delivery method and the type of contract used for the green projects with issues were compared. Fig. 5.10 shows the distribution of the four contract types used for each of the project delivery methods.
5.3.4 Data distribution according to the project phase in which the green project experienced the issues

Question 6 from Part B of the survey asked the respondents, “The legal issue pertaining to the Green / Sustainable / LEED aspect occurred in which project phase?” Only 44 responses were provided to this question. Eight of the green projects experienced issues in the design phase, 22 of the projects experienced issues in the construction phase, eight of the projects had issues in the commissioning phase which can also be called start up phase; and six of the projects experienced issues in the operation and maintenance phase. The distribution of the phase in which the green project experienced issues, is shown in Fig. 5.11.
Fig. 5.11. Distribution by project phase in which issues occurred on green projects $(n=53)$

5.3.5 Data distribution according to the impact of the issues on the schedule of the project

This section divides the number of green projects that experienced issues according to their impact on the project’s schedule- whether the issues caused a delay impact on the schedule or if it caused acceleration in the schedule. Forty respondents answered this question. According to the 40 responses, none of the projects experienced project schedule acceleration due to the issue. Twenty-two projects experienced delay impact on the schedule due to an issue. One project experienced both acceleration and delay in the schedule. Seventeen projects did not experience any schedule impact. The distribution of schedule impacts is shown in Fig. 5.12.

Fig. 5.12. Distribution of project schedule impact for green projects with issues $(n=53)$
5.3.6 Data distribution depending on how the issues in the green projects were resolved:

The data are also distributed depending upon how the issues in the green projects were resolved. There were thirty-seven responses to the question number 10 of Part B of the survey. The question asked about the method used by the project participants to resolve the issue on the green projects. Six of the projects used the alternative dispute resolution (ADR) procedure to resolve the issue. Seven projects were resolved by cost being absorbed by the party/parties. Nine projects resolved their issues by informal resolution procedures. Five projects adopted other adversarial proceedings. Ten projects resolved their issues with change orders. None of the issues went to court and none of the issues that were reported in this survey were resolved with litigation. The distribution of how the issues were resolved is shown in Fig. 5.13.

![Pie chart showing distribution of how issues were resolved](image)

**Fig. 5.13.** Distribution of how issues were resolved (n=53)
5.3.7 Data distribution depending on whether or not the issues were addressed in the contract document:

This section divides the data depending upon whether the issues arose from the stipulations in the contract. Only 36 respondents provided information regarding this question. Twenty-five responses indicated that the issues arose from stipulations in the contract and remaining. Eleven responses indicated that the issues were not due to any stipulations in the contract. The distribution of whether or not the contract document addressed the issues is shown in Fig. 5.14.

![Pie chart showing distribution of whether contract document addressed issues](image)

**Fig. 5.14.** Distribution of whether contract document addressed the issues (n=53)

5.3.8 Data distribution depending on whether or not the issues were resolved according to the contract document:

This section divides the 25 responses in section 5.3.7 which said that the issues were addressed in the project’s contract documents. The responses are divided based on whether the issues that were addressed in the contract documents were resolved according to the procedure mentioned in the contract documents. Seventeen of the issues were resolved according to the contract documents. Five issues were not resolved as per the contract document. Three of the respondents did not provide answer to this question.
The distribution of whether the issues were resolved according to the contract documents is shown in Fig. 5.15.

![Pie Chart](chart.png)

**Fig. 5.15.** Distribution of whether the issues were resolved according to the contract documents \( (n=25) \)

5.3.9 *Data distribution based on which project member absorbs the cost associates with the issues on green projects*

Based on the responses collected from the survey, Fig 5.16 shows the distribution of project members who absorb the cost associated with the issues on green project.

Question 14 in Part B asked “Who was responsible for the cost incurred due to issue?” Thirty-six respondents provided information to this question. Based on those 36 responses, which had single or multiple answers, the percentage was calculated for which different project members were responsible to pay the cost incurred due to the issues, also called settlement cost. According to the data, most frequently contractors were responsible for the settlement cost at 33 percent of the time. Nineteen percent of the time, architects were responsible for the settlement cost. Owners were responsible for the 14 percent of the time. Engineers were responsible 13 percent of the time. Construction managers, consultants, specialty subcontractors, material vendors; and government agencies were responsible for settlement cost in less than five percent of the cases.
Fig. 5.16. Data distribution showing the percentage for which the different professionals were responsible for the settlement cost of the issues in the green project

5.4 Settlement cost vs. Total project cost

Settlement cost is the amount of money required to resolve an issue with additional costs incurred on a project. The settlement cost may be equal to the actual cost incurred or it may be a negotiated value which parties agree to and it may be less than the actual cost incurred above the amount authorized by the project contract. When a project experiences any kind of issue, there is frequently extra cost associated with the issue. The additional cost must be absorbed by the parties involved in the project contract. In an ideal situation the party responsible for the issue would bear the burden of the additional cost. In construction there are frequently multiple parties involved with an issue and a negotiated settlement cost may be arrived at by the parties where they all share in covering the cost of the issue. Most of the respondents did not provide information to this session. This may be due to the survey respondent may not being aware of the exact or approximate settlement cost, be able to divulge the settlement cost. Only 34 out of the 53 respondents provided the settlement cost due to the issue in the project.
Table 5.1. Comparison of Settlement Cost and Total Project Cost Provided by the Respondents

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Settlement cost</th>
<th>Total Cost</th>
<th>Cost Ratio/Green Liability Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$70,000</td>
<td>$7,000,000</td>
<td>1.00%</td>
</tr>
<tr>
<td>2</td>
<td>$600,000</td>
<td>$10,000,000</td>
<td>6.00%</td>
</tr>
<tr>
<td>3</td>
<td>$500,000</td>
<td>$4,500,000</td>
<td>11.11%</td>
</tr>
<tr>
<td>4</td>
<td>$200,000</td>
<td>$20,200,000</td>
<td>0.99%</td>
</tr>
<tr>
<td>5</td>
<td>$100,000</td>
<td>$20,000,000</td>
<td>0.50%</td>
</tr>
<tr>
<td>6</td>
<td>$60,000</td>
<td>$800,000</td>
<td>7.50%</td>
</tr>
<tr>
<td>7</td>
<td>$25,000</td>
<td>$400,500</td>
<td>6.24%</td>
</tr>
<tr>
<td>8</td>
<td>$65,000</td>
<td>$450,000</td>
<td>14.44%</td>
</tr>
<tr>
<td>9</td>
<td>$30,000</td>
<td>$300,000</td>
<td>10.00%</td>
</tr>
<tr>
<td>10</td>
<td>$50,000</td>
<td>$70,000,000</td>
<td>0.07%</td>
</tr>
<tr>
<td>11</td>
<td>$15,000</td>
<td>$150,000</td>
<td>10.00%</td>
</tr>
<tr>
<td>12</td>
<td>$65,000</td>
<td>$500,000</td>
<td>13.00%</td>
</tr>
<tr>
<td>13</td>
<td>$110,000</td>
<td>$2,000,000</td>
<td>5.50%</td>
</tr>
<tr>
<td>14</td>
<td>$8,000,000</td>
<td>$30,000,000</td>
<td>26.67%</td>
</tr>
<tr>
<td>15</td>
<td>$4,000</td>
<td>$40,000</td>
<td>10.00%</td>
</tr>
<tr>
<td>16</td>
<td>$20,000</td>
<td>$12,900,000</td>
<td>0.16%</td>
</tr>
<tr>
<td>17</td>
<td>$15,000</td>
<td>$1,500,000</td>
<td>1.00%</td>
</tr>
<tr>
<td>18</td>
<td>$80,000</td>
<td>$50,000,000</td>
<td>0.16%</td>
</tr>
<tr>
<td>19</td>
<td>$1,000,000</td>
<td>$250,000,000</td>
<td>0.40%</td>
</tr>
<tr>
<td>20</td>
<td>$1,000,000</td>
<td>$150,000,000</td>
<td>0.67%</td>
</tr>
<tr>
<td>21</td>
<td>$50,000</td>
<td>$5,000,000</td>
<td>1.00%</td>
</tr>
<tr>
<td>22</td>
<td>$15,000</td>
<td>$150,000</td>
<td>10.00%</td>
</tr>
<tr>
<td>23</td>
<td>$80,000</td>
<td>$1,000,000</td>
<td>8.00%</td>
</tr>
<tr>
<td>24</td>
<td>$250,000</td>
<td>$5,000,000</td>
<td>5.00%</td>
</tr>
<tr>
<td>25</td>
<td>$30,000</td>
<td>$300,000</td>
<td>10.00%</td>
</tr>
<tr>
<td>26</td>
<td>$400,000</td>
<td>$50,000,000</td>
<td>0.80%</td>
</tr>
<tr>
<td>27</td>
<td>$100,000</td>
<td>$7,000,000</td>
<td>1.43%</td>
</tr>
<tr>
<td>28</td>
<td>$40,000</td>
<td>$10,000,000</td>
<td>0.40%</td>
</tr>
<tr>
<td>29</td>
<td>$20,000</td>
<td>$110,000</td>
<td>18.18%</td>
</tr>
<tr>
<td>30</td>
<td>$35,000</td>
<td>$3,500,000</td>
<td>1.00%</td>
</tr>
<tr>
<td>31</td>
<td>$300,000</td>
<td>$12,000,000</td>
<td>2.50%</td>
</tr>
<tr>
<td>32</td>
<td>$100,000</td>
<td>$10,000,000</td>
<td>1.00%</td>
</tr>
<tr>
<td>33</td>
<td>$50,000</td>
<td>$2,000,000</td>
<td>2.50%</td>
</tr>
<tr>
<td>34</td>
<td>$75,000</td>
<td>$650,000</td>
<td>11.54%</td>
</tr>
<tr>
<td></td>
<td><strong>$13,554,000</strong></td>
<td><strong>$737,450,500</strong></td>
<td></td>
</tr>
</tbody>
</table>
The green liability index was created to express the relationship between settlement cost and project cost. The green liability index is defined in the following equation.

$$Green\ Liability\ Index = \frac{Settlement\ Cost}{Total\ Project\ Cost} \times 100\%$$

The total project cost provided does not include the settlement cost. Table 5.1 shows the settlement cost, the total project cost, and the green liability index for the 34 projects.

Based on the data for the 34 projects as shown in Table 5.1, the average green liability index is 2 percent as shown in the following calculation.

$$Average\ Green\ Liability\ Index = \frac{$13,554,000}{737,450,500} \times 100\% = 2\%$$

As the sample for the green liability index only has 34 points, it is considered to be at the limit for being able to perform linear regression analysis for the green liability index and the total project cost. The result of a simple linear regression was performed is shown in the Fig. 5.17. The result indicated that a relationship between the green liability index and the total project cost does not exist for this research’s data. The coefficient of determination is extremely low with a value of 0.08. A significantly larger data set is required to reliably evaluate whether there is a relationship or not.
5.4.1 Analysis of data that contains settlement cost

This section is intended to analyze the settlement cost and total project cost based on various variables like project type, project delivery method used, contract type, phase of occurrence of the issue etc. The ratio of settlement cost and the total project cost is referred to as green liability index for the purpose of this research study. Out of total 53 respondents with issue, only 34 of them provided the settlement cost involved in the green project due to any kinds of issues in the project. Taking information of only those 34 responses, green liability index is compared in various ways, taking different variables as the basis of comparison. The tables below shows the liability index associated with the green projects depending upon various variables.

Table 5.2. Green Liability Index Comparison Based on Project Location

<table>
<thead>
<tr>
<th>Project Location</th>
<th>Number of Samples (n)</th>
<th>Average Green Liability Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Outside NV</td>
<td>18</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 5.3. Green Liability Index Comparison of Different Project Types

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Number of Samples (n)</th>
<th>Average Green Liability Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building - New Construction</td>
<td>22</td>
<td>1</td>
</tr>
<tr>
<td>Building - Tenant Improvement / Renovation</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Residential - New Construction</td>
<td>3</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Residential - Renovation</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Government / Public Works</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.4. Green Liability Index Comparison of Different Project Delivery Methods

<table>
<thead>
<tr>
<th>Project Delivery Method</th>
<th>Number of Samples (n)</th>
<th>Average Green Liability Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-Bid-Build</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Design-Build</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Agency Construction Manager</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Construction Manager at Risk (CMR)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Integrated Project Delivery (IPD)</td>
<td>3</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 5.5. Green Liability Index Comparison of Different Types of Contracts

<table>
<thead>
<tr>
<th>Contract Type</th>
<th>Number of Samples (n)</th>
<th>Average Green Liability Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump Sum</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Unit Price</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Cost Plus (Fixed / Variable Fee)</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Guaranteed Maximum Price</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 5.6. Green Liability Index Comparison Based on Phase in Which Issues Occurred

<table>
<thead>
<tr>
<th>Project Phase in which issue occurred</th>
<th>Number of Samples (n)</th>
<th>Average Green Liability Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Phase</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Construction Phase</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Commissioning / Start up Phase</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Operation / Maintenance Phase</td>
<td>5</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Unidentified</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Due to small sample size, it is difficult to draw any meaningful conclusions from these comparisons.
5.5 Comparison of various parties’ awareness of the legal issues in green construction

Question 4 in part A of the survey allows respondents to rate various parties’ awareness of legal issues which may arise due to selection of Green / Sustainable / LEED design and construction approach. The respondents also have to rate their own party along with others. The various parties or organizations whose awareness has been rated include Owner, Government (Federal / State / Municipal), Architect, Engineer, Contractor, Construction Manager, Specialty Subcontractor, Consultant; and material vendor.

Based on the data available, this section analyzes various parties’ awareness of legal issues. As is seen from the literature review, the issues in green construction industry are increasing along with the popularity of green construction. So the participants or the parties involved in the project should be aware of the possible issues that could arise in the project in later stages. This helps them to act more carefully and prepare themselves beforehand.

The sample of the survey questions, in the format it was distributed, can be seen in Appendix A. The rating was based on their experience with those parties in the construction industry. A 5-point Likert scale was used to rate the parties’ awareness which followed the following format:

5 = Strongly Agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly Disagree
Out of 125 survey respondents, 96 provided a response to some portion of the categories included in the question. The highest number of ratings that any party received was 95 and lowest was 91.

5.5.1 **Overall ranking of parties’ awareness based on mean rating**

Based on the respondents rating, Table 5.7 below shows the ranking of the parties’ awareness of the legal issues in green construction based on the mean rating for all responses on a given party.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Party</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Architect</td>
<td>3.98</td>
</tr>
<tr>
<td>2</td>
<td>Engineer</td>
<td>3.94</td>
</tr>
<tr>
<td>3</td>
<td>Consultant</td>
<td>3.79</td>
</tr>
<tr>
<td>4</td>
<td>Construction Manager</td>
<td>3.77</td>
</tr>
<tr>
<td>5</td>
<td>Contractor</td>
<td>3.65</td>
</tr>
<tr>
<td>6</td>
<td>Government (Federal / State / Municipal)</td>
<td>3.56</td>
</tr>
<tr>
<td>7</td>
<td>Owner</td>
<td>3.49</td>
</tr>
<tr>
<td>8</td>
<td>Specialty Subcontractor</td>
<td>3.16</td>
</tr>
<tr>
<td>9</td>
<td>Material Vendor</td>
<td>3.01</td>
</tr>
</tbody>
</table>

From the data, it can be seen that Architects were rated as having highest awareness of the legal issues in green construction with a mean rating of 3.98. Material Vendors have the lowest awareness with a mean rating of 3.01. The ranking of the parties in ascending order based on the mean rating from all the responses is shown in Fig. 5.18.
Fig. 5.18. Rank of various parties’ awareness based on mean rating from all responses

5.5.2 Analysis of each party’s rating for various other parties’ awareness of legal issues in green construction

The data collected were sorted by the respondents’ organization type. The average values of the ratings were then calculated according to the respondent’s organization type for each different party’s awareness. Fig. 5.19 through Fig. 5.30 below shows the average value ratings provided by various types of respondents to all other organizations. It should be noted that the number of respondents in some party are very small. The number of respondents in different party ranges from 33 to one. The results are very sensitive for cases where there a small numbers of respondents. The cases with a low number of respondents may not be representative of even slightly larger sample sizes or those of a large sample size. Table 5.8 presents the number of responses/rating that each different party received from other parties.
Table 5.8. Number of Responses/Rating that Each Different Party Received from Other Parties

<table>
<thead>
<tr>
<th></th>
<th>Owner</th>
<th>Government</th>
<th>Architect</th>
<th>Engineer</th>
<th>Contractor</th>
<th>Construction Manager</th>
<th>Specialty Subcontractor</th>
<th>Consultant</th>
<th>Material Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Government</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Architect</td>
<td>31.00</td>
<td>31.00</td>
<td>33.00</td>
<td>31.00</td>
<td>30.00</td>
<td>30.00</td>
<td>29.00</td>
<td>30.00</td>
<td>30.00</td>
</tr>
<tr>
<td>Engineer</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>8.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Architect/Engineer</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Contractor</td>
<td>15.00</td>
<td>15.00</td>
<td>15.00</td>
<td>15.00</td>
<td>15.00</td>
<td>14.00</td>
<td>15.00</td>
<td>14.00</td>
<td>15.00</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Specialty Subcontractor</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Consultant</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Material Vendor</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Law firm</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Specification Consultant</td>
<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Fig. 5.19. Owner’s mean rating of various parties’ awareness of legal issues in green construction (n=7)

In the view of the respondents who represent owners they thought that architects had the greatest awareness of legal issues. The owner respondents rated engineers, consultants and themselves awareness as equal, and just slightly less than architects. The owner respondents rated specialty subcontractors’ awareness the lowest of all parties. Both the contractor and the construction were rated second lowest in awareness.

Fig. 5.20. Government bodies’ mean rating of various parties’ awareness of legal issues in green construction (n=4)
In the view of the respondents who represent government they thought that contractor and construction manager had the greatest awareness of legal issues. The government respondents rated engineers and themselves equal in awareness and in the second highest position. The government respondents rated material vendor’s awareness the lowest of all parties. They rated consultants as second lowest in awareness.

![Bar chart showing mean ratings of various parties' awareness of legal issues in green construction](image)

**Fig. 5.21.** Architect’s mean rating of various parties’ awareness of legal issues in green construction ($n=33$)

With a respondent sample size of 33, input from architects was the greatest. They rated themselves as the most aware of legal issues in green construction. Architects rated engineers as second most aware and just slightly below themselves. The consultants and construction managers were rated as third most aware. Material vendors were rated as least aware. Specialty contractors were rated second from the bottom in awareness.
Fig. 5.22. Engineer’s mean rating of various parties’ awareness of legal issues in green construction ($n=8$)

Architects had the highest awareness of legal issues in green construction as rated by the respondents who represented engineers. They rated governments, contractors, construction managers and consultant’s awareness to be second highest among all. They rated themselves as third and slightly less aware. Engineers rated specialty subcontractor slightly less aware than themselves and in forth position. Owners were again slightly less aware than specialty subcontractor and in fifth position. They rated material vendors to be least aware.

Fig. 5.23. Architect/Engineer’s mean rating of various parties’ awareness of legal issues in green construction ($n=7$)
There were seven respondents who represented Architect/Engineer firm. They rated architects as most highly aware of the legal issues in green construction. They rated engineers and construction managers’ awareness to be equal and slightly less than architects. Consultants were rated as third highest in their awareness. Specialty contractors were rated to be least aware and material vendors as second from the bottom line.

![Bar Chart](image)

**Fig. 5.24.** Contractor’s mean rating of various parties’ awareness of legal issues in green construction ($n=15$)

Respondent who represented contractors were the second largest group with a sample size of 15. In the view of the respondents who represent contractors, they thought that engineers had the greatest awareness of legal issues. They rated architects just slightly less than engineers and contractor just slightly less than architects in the third position. They rated material vendors’ awareness the lowest of all parties. Specialty subcontractors were rated second lowest in awareness.
Fig. 5.25. Construction Manager’s mean rating of various parties’ awareness of legal issues in green construction (n=8)

In the view of the respondents representing construction managers, they thought engineers were the most aware of legal issues in green construction. Governments were second most aware and just slightly below engineers. Architects, consultants and themselves were rated as third most aware. Material vendors were rated as least aware. Specialty contractors were rated second from the bottom in awareness.

Fig. 5.26. Specialty Subcontractor’s mean rating of various parties’ awareness of legal issues in green construction (n=3)
Respondents who represent specialty subcontractor, they rated owners as having the greatest awareness of legal issues. They rated construction managers’ awareness in the second highest position. Government, architect and consultants were rated to be of equal in their awareness and in third position. They rated material vendor’s awareness the lowest of all parties. Contractors and themselves were second from the bottom line in the awareness of legal issues in green construction.

![Bar chart](chart.png)

**Fig. 5.27.** Consultant’s mean rating of various parties’ awareness of legal issues in green construction \((n=7)\)

Group of respondents who represented consultants rated themselves as the most aware of legal issues in green construction. Architects were rated as second most aware. The contractors and construction managers were rated as third most aware. Specialty subcontractors and owners were both rated as least aware. Material vendors were rated second least aware of legal issues in green construction.
In the view of the respondents who represent material vendors, they thought that owner, architects, engineers and themselves as equally aware of the legal issues in green construction and were the highest in their awareness. They rated governments and consultant’s awareness as equal and second highly aware. Contractors, construction managers and specialty subcontractors were rated to have equal awareness and were rated to be third highly aware and were also the lowest.

The survey questionnaire had a category designated as other for the parties that were not specifically identified in questionnaire. Two parties responded in the other category for this question but then went on to identify themselves as a law firm and specialty consultant these two responses are shown in Fig. 5.29 and Fig. 5.30. No conclusions are drawn from these to responses because both categories contain only one data point each. The one response from the lawyer in that he rated design professionals quite high and owners, contractors, specialty subcontractors and material vendors at the bottom and equal in their unawareness. The lawyers view is significantly different in character than the ratings provided by other parties.
Fig. 5.29. Law Firm’s mean rating of various parties’ awareness of legal issues in green construction ($n=1$)

Fig. 5.30. Specification Consultant’s mean rating of various parties’ awareness of legal issues in green construction ($n=1$)

Fig. 5.40 shows the rating provided by each party to all the listed parties in a single graph.
Fig. 5.31. Parties mean rating of various parties’ awareness of legal issues in green construction
Based on the results presented in Fig. 5.29 through Fig. 5.30, Table 5.9 and Table 5.10 have been created which lists the party with highest and lowest awareness respectively and the respondent’s organization providing the rating.

**Table 5.9. Summary Showing the Party with Highest Awareness of Legal Issues in Green Construction and the Respondent Organization Providing the Rating**

<table>
<thead>
<tr>
<th>Respondent's Organization</th>
<th>Sample Size (n)</th>
<th>Party with Highest Awareness</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>7</td>
<td>Architect</td>
<td>4.14</td>
</tr>
<tr>
<td>Government</td>
<td>4</td>
<td>Contractor/Construction Manager</td>
<td>4.50</td>
</tr>
<tr>
<td>Architect</td>
<td>33</td>
<td>Architect</td>
<td>4.06</td>
</tr>
<tr>
<td>Engineer</td>
<td>7</td>
<td>Architect</td>
<td>4.14</td>
</tr>
<tr>
<td>Architect / Engineer</td>
<td>7</td>
<td>Architect</td>
<td>4.29</td>
</tr>
<tr>
<td>Contractor</td>
<td>15</td>
<td>Engineer</td>
<td>4.13</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>8</td>
<td>Engineer</td>
<td>4.00</td>
</tr>
<tr>
<td>Specialty Subcontractor</td>
<td>3</td>
<td>Owner</td>
<td>3.67</td>
</tr>
<tr>
<td>Consultant</td>
<td>7</td>
<td>Consultant</td>
<td>4.43</td>
</tr>
<tr>
<td>Material Vendor</td>
<td>2</td>
<td>Owner/Architect/Engineer/Material Vendor</td>
<td>4.00</td>
</tr>
<tr>
<td>Law Firm</td>
<td>1</td>
<td>Architect/Engineer/Consultant</td>
<td>5.00</td>
</tr>
<tr>
<td>Specification Consultant</td>
<td>1</td>
<td>Manager</td>
<td>3.00</td>
</tr>
</tbody>
</table>

**Table 5.10. Summary Showing the Party with Lowest Awareness of Legal Issues in Green Construction and the Respondent Organization Providing the Rating**

<table>
<thead>
<tr>
<th>Respondent's Organization</th>
<th>Sample Size (n)</th>
<th>Party with Lowest Awareness</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>7</td>
<td>Specialty Subcontractor</td>
<td>3.14</td>
</tr>
<tr>
<td>Government</td>
<td>3</td>
<td>Material Vendor</td>
<td>3.00</td>
</tr>
<tr>
<td>Architect</td>
<td>30</td>
<td>Material Vendor</td>
<td>3.10</td>
</tr>
<tr>
<td>Engineer</td>
<td>7</td>
<td>Material Vendor</td>
<td>2.86</td>
</tr>
<tr>
<td>Architect / Engineer</td>
<td>7</td>
<td>Specialty Subcontractor</td>
<td>3.00</td>
</tr>
<tr>
<td>Contractor</td>
<td>15</td>
<td>Material Vendor</td>
<td>2.73</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>8</td>
<td>Material Vendor</td>
<td>2.63</td>
</tr>
<tr>
<td>Specialty Subcontractor</td>
<td>3</td>
<td>Material Vendor</td>
<td>1.67</td>
</tr>
<tr>
<td>Consultant</td>
<td>7</td>
<td>Specialty Subcontractor</td>
<td>3.14</td>
</tr>
<tr>
<td>Material Vendor</td>
<td>2</td>
<td>Owner/Construction Manager/Specialty Subcontractor</td>
<td>3.00</td>
</tr>
<tr>
<td>Law Firm</td>
<td>1</td>
<td>Subcontractor/Material Vendor/Owner/Architect/Specialty</td>
<td>3.00</td>
</tr>
<tr>
<td>Specification Consultant</td>
<td>1</td>
<td>Subcontractor/Consultant/Material Vendor</td>
<td>2.00</td>
</tr>
</tbody>
</table>
5.5.3 Analysis of rating of awareness of legal issue received by various parties form all other parties/organization

This section is intended to show the individual parties’ awareness of the legal issues in green construction according to average rating provided to them by various other parties or organization. Fig. 5.32 through Figure 5.40 are provides as another way of presenting the data that was presented in Fig. 5.19 through Fig. 5.30. Some individuals may find this alternative presentation more beneficial for their purposes.

![Bar Chart]

**Fig. 5.32.** Various parties’ mean rating of Owners’ awareness of legal issues in green construction
**Fig. 5.33.** Various parties’ mean rating of Governments’ awareness of legal issues in green construction

**Fig. 5.34.** Various parties’ mean rating of Architects’ awareness of legal issues in green construction
Fig. 5.35. Various parties’ mean rating of Engineers’ awareness of legal issues in green construction

Fig. 5.36. Various parties’ mean rating of Contractors’ awareness of legal issues in green construction
Fig. 5.37. Various parties’ mean rating of Construction Managers’ awareness of legal issues in green construction

Fig. 5.38. Various parties’ mean rating of Specialty Subcontractors’ awareness of legal issues in green construction
Fig. 5.39. Various parties’ mean rating of Consultants’ awareness of legal issues in green construction

Fig. 5.40. Various parties’ mean rating of Material Vendors’ awareness of legal issues in green construction
5.5.4 Analysis of respondents’ rating of awareness of legal issues to the organization they belong to

After the analysis of the data to obtain the mean rating for awareness by various parties according to the organization type of the respondents and also the rating received by each party from all other parties; this section presents the mean score of each different party, based on the responses by members of the same organization. Basically this section presents the mean rating of an organization by members of that organization and the results are provided in Table 5.11.

<table>
<thead>
<tr>
<th>Respondent's Organization</th>
<th>Self-Awareness Rating (average)</th>
<th>Sample Size (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>4.00</td>
<td>7</td>
</tr>
<tr>
<td>Government</td>
<td>4.00</td>
<td>4</td>
</tr>
<tr>
<td>Architect</td>
<td>4.06</td>
<td>33</td>
</tr>
<tr>
<td>Engineer</td>
<td>3.63</td>
<td>8</td>
</tr>
<tr>
<td>Contractor</td>
<td>3.93</td>
<td>15</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>3.63</td>
<td>8</td>
</tr>
<tr>
<td>Specialty Subcontractor</td>
<td>2.33</td>
<td>3</td>
</tr>
<tr>
<td>Consultant</td>
<td>4.43</td>
<td>7</td>
</tr>
<tr>
<td>Material Vendor</td>
<td>4.00</td>
<td>2</td>
</tr>
</tbody>
</table>

The mean self-rating of awareness by architects and consultants were the greatest. However, the sample size of consultants is very small and the rating should be viewed with caution. Owners and government rated themselves very high in awareness achieving a value of 4.00. The combined sample size of owners and government is 11. The construction managers and engineers rated themselves fairly low achieving a value of 3.63 for a sample size of 15 and 8 respectively.
5.5.5 Nonparametric one-way ANOVA analysis for the median comparison of the various parties’ awareness of the legal issues in green construction

In this section, the data from Part A question 4 of the survey are analyzed to compare the median rating of awareness of each party, as per the respondents’ rating. Since the data are nonparametric, a non-parametric one-way ANOVA was performed which is also called Kruksal-Wallis rank test (Kruksal and Wallis 1952). The test compared whether there was any significant difference in the various parties’ awareness of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project.

If the result was significant from the Kruksal-Wallis rank test, post-hoc analysis was conducted to do the pair wise comparisons of each group with every other group to determine which two parties’ awareness was actually significantly different with each other. The Wilcoxon rank sum test results of the groups whose results were significant are also presented in this section. The hypothesis that is tested in this section is:

**Research hypothesis:** There is significant difference in the awareness, across the categories of parties, of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project.

i.e. $H_1$: Not all $M$ are equal

**Null hypothesis:** There is no significant difference in the awareness, across the categories of parties, of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project.

i.e. $H_0$: $M_{owner} = M_{government} = M_{architects} = M_{engineers} = M_{contractor} =$

$M_{construction manager} = M_{consultant} = M_{specialty Subcontractor} = M_{material Vendor}$
Table 5.12 shows descriptive statistics of the data of the respondent's ratings provided to rate various parties of their awareness of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction. Out of 125 respondents, 96 attempted this question but only 87 of them provided a complete response. Hence there are variations in number of respondents who provided a rating to each different party.

Table 5.12. Descriptive Statistics of the Respondent’s Rating of Awareness of All the Parties

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Parties</th>
<th>Number of Respondents</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Mode</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Owner Government (Federal / State / Municipal)</td>
<td>95</td>
<td>3.49</td>
<td>4</td>
<td>4</td>
<td>1.138</td>
</tr>
<tr>
<td>2</td>
<td>Architect</td>
<td>95</td>
<td>3.98</td>
<td>4</td>
<td>4</td>
<td>0.887</td>
</tr>
<tr>
<td>3</td>
<td>Engineer</td>
<td>94</td>
<td>3.94</td>
<td>4</td>
<td>4</td>
<td>0.878</td>
</tr>
<tr>
<td>4</td>
<td>Contractor</td>
<td>92</td>
<td>3.65</td>
<td>4</td>
<td>4</td>
<td>1.021</td>
</tr>
<tr>
<td>5</td>
<td>Construction Manager</td>
<td>91</td>
<td>3.77</td>
<td>4</td>
<td>4</td>
<td>0.870</td>
</tr>
<tr>
<td>6</td>
<td>Specialty Subcontractor</td>
<td>91</td>
<td>3.16</td>
<td>3</td>
<td>3</td>
<td>0.981</td>
</tr>
<tr>
<td>7</td>
<td>Consultant</td>
<td>91</td>
<td>3.79</td>
<td>4</td>
<td>4</td>
<td>0.850</td>
</tr>
<tr>
<td>8</td>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>3</td>
<td>1.070</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>833</td>
<td>3.60</td>
<td>3.67</td>
<td>3.67</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Kruskal-Wallis rank test was performed, at 0.05 alpha level significance, to compare the median rating of all the parties to test the null hypothesis that there is no significant difference in the awareness across the categories of parties, of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project. The results of the test are as follows:

\[ H_{STAT} = 69.63 \text{ and } p\text{-value} < 0.01^{**} \]

From the chi-square distribution table, critical value, \( X^2 \), at 0.05 level of significance, is 15.5.
Since, $H_{STAT} > X^2$, we reject the null hypothesis that there is no significant difference in the awareness across the categories of parties, of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project. So, there is significant difference in awareness of legal issues among at least two different parties.

Since the null hypothesis is rejected, the median rating of at least two parties is significantly different from each other. To find which parties were actually different, pairwise comparison of each group was conducted using post-hoc analysis. Hence the research hypothesis that is tested by the pairwise post-hoc analysis is

**Research Hypothesis:** There is significant difference in the awareness of any two different parties, of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project.

$H_1: M_i \neq M_j$

**Null Hypothesis:** There is no significant difference in the awareness of any two different parties, of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project.

$H_0: M_i = M_j$

where, $i$ and $j$ can represent any group among the Owner, Government, Architect, Engineer, Contractor, Construction Manager, Specialty Subcontractor, Consultant; and Material Vendor.

The result of the post-hoc analysis for the pairwise comparison each party’s awareness to every other party is found in Appendix B. Tables 5.13 through 5.26 show
the results of the pair wise comparisons using the Wilcoxon rank sum test of the parties whose awareness of the legal issues was significantly different with each other.

Table 5.13. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Owner

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-2.79</td>
<td>0.005 **</td>
</tr>
<tr>
<td>Owner</td>
<td>95</td>
<td>3.49</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.14. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Government

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-3.12</td>
<td>0.001 **</td>
</tr>
<tr>
<td>Government</td>
<td>93</td>
<td>3.56</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.15. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Architect

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-6.1</td>
<td>&lt; 0.001 **</td>
</tr>
<tr>
<td>Architect</td>
<td>95</td>
<td>3.98</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.16. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Engineer

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-5.63</td>
<td>&lt; 0.001 **</td>
</tr>
<tr>
<td>Engineer</td>
<td>94</td>
<td>3.94</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.17. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Contractor

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-3.88</td>
<td>&lt; 0.001 **</td>
</tr>
<tr>
<td>Contractor</td>
<td>92</td>
<td>3.65</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 5.18. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Construction Manager

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size ($n$)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>$Z_{STAT}$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-4.6</td>
<td>$&lt; 0.001^{**}$</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>91</td>
<td>3.77</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5.19. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Material Vendor vs. Consultant

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size ($n$)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>$Z_{STAT}$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Vendor</td>
<td>91</td>
<td>3.01</td>
<td>3</td>
<td>-4.8</td>
<td>$&lt; 0.001^{**}$</td>
</tr>
<tr>
<td>Consultant</td>
<td>91</td>
<td>3.79</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5.20. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Specialty Subcontractor vs. Architect

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size ($n$)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>$Z_{STAT}$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty Subcontractor</td>
<td>91</td>
<td>3.16</td>
<td>3</td>
<td>-5.53</td>
<td>$&lt; 0.001^{**}$</td>
</tr>
<tr>
<td>Architect</td>
<td>95</td>
<td>3.98</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5.21. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Specialty Subcontractor vs. Engineer

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size ($n$)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>$Z_{STAT}$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty Subcontractor</td>
<td>91</td>
<td>3.16</td>
<td>3</td>
<td>-5.04</td>
<td>$&lt; 0.001^{**}$</td>
</tr>
<tr>
<td>Engineer</td>
<td>94</td>
<td>3.94</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5.22. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Specialty Subcontractor vs. Contractor

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size ($n$)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>$Z_{STAT}$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty Subcontractor</td>
<td>91</td>
<td>3.16</td>
<td>3</td>
<td>-3.22</td>
<td>$0.001^{**}$</td>
</tr>
<tr>
<td>Contractor</td>
<td>92</td>
<td>3.65</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5.23. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Specialty Subcontractor vs. Construction Manager

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size ($n$)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>$Z_{STAT}$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty Subcontractor</td>
<td>91</td>
<td>3.16</td>
<td>3</td>
<td>-3.95</td>
<td>$&lt; 0.001^{**}$</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>91</td>
<td>3.77</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5.24. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Specialty Subcontractor vs. Consultant

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty Subcontractor</td>
<td>91</td>
<td>3.16</td>
<td>3</td>
<td>-4.16</td>
<td>&lt; 0.001**</td>
</tr>
<tr>
<td>Consultant</td>
<td>91</td>
<td>3.79</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.25. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Owner vs. Architect

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>95</td>
<td>3.49</td>
<td>4</td>
<td>-2.79</td>
<td>0.005**</td>
</tr>
<tr>
<td>Architect</td>
<td>95</td>
<td>3.98</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.26. Results of Wilcoxon Rank Sum Test of Rating of Awareness of Owner vs. Engineers

<table>
<thead>
<tr>
<th>Parties</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>95</td>
<td>3.49</td>
<td>4</td>
<td>2.46</td>
<td>0.01**</td>
</tr>
<tr>
<td>Engineer</td>
<td>94</td>
<td>3.94</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at alpha level 0.05 (2-tailed)
** Significant at alpha level 0.01 (2-tailed)

5.5.6 Comparison of awareness of legal issues between respondents with and without experience of legal issues

The analyses done to this point showed the awareness of the parties in multiple ways, regardless of their experience with any legal issues. This section sorts the respondents based on their experience with legal issues on green projects. The two groups of respondents were then compared to show the proportion of the respondents who agree that the parties are aware of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project. Fig. 5.41 and Fig. 5.42 show the difference in population proportion of the respondents with or without legal issues, who agree or disagree with the parties’ awareness of legal issues.
From the comparison of the two groups of respondents, it can be seen that a higher proportion of the respondents who have experience with legal issues, agree that the parties involved in green construction are aware of the legal issues which may arise due to selection of the Green / Sustainable / LEED design and construction approach for a project. Sixty-six percent of respondents with legal issues provided a positive response, which includes strongly agree and agree, compared to 52 percent of respondents without legal issues.
5.6 Importance of three different areas to make Green / Sustainable / LEED practice more sound and effective

In Part A question 5 of the survey allows respondents to rate the importance of three different areas in making the Green / Sustainable / LEED practice more sound and effective:

1. Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects,
2. Education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED projects; and
3. Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction.

The following section analyzes the responses of the respondents in various ways to compare the importance of these three areas.

5.6.1 Overall ranking of importance of the three areas

Table 5.27 shows the overall ranking of the importance of the three areas in making the Green / Sustainable / LEED practice more sound and effective, based on the mean rating of the respondents. With the highest mean rating of 4.40, it is clear that education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects is the most important to make green practice more sound and effective. With a mean rating score of 4.34, the second highest is education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED projects. And, relatively the least important area is developing a standard contract
document that specifically deals with Green / Sustainable / LEED construction with a mean rating score of 3.93.

Table 5.27. Ranking of the Importance of the Three Areas to Make the Green / Sustainable / LEED practice More Sound and Effective

<table>
<thead>
<tr>
<th>Rank</th>
<th>Areas</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects.</td>
<td>4.40</td>
</tr>
<tr>
<td>2</td>
<td>Education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED projects.</td>
<td>4.34</td>
</tr>
<tr>
<td>3</td>
<td>Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction.</td>
<td>3.93</td>
</tr>
</tbody>
</table>

5.6.2 Nonparametric one-way ANOVA for the median comparison of the importance of the three areas to make the green / sustainable / LEED practice more sound and effective

In this section, nonparametric one-way ANOVA called Kruksal-Wallis rank test was conducted to test whether there was any significant difference in the importance of the above mentioned three areas to make the Green / Sustainable / LEED practice more sound and effective. The test was followed by post hoc analysis where pair wise comparison was conducted to see which areas were actually significantly different from each other. The hypothesis that is tested in this section is:

**Research hypothesis:** There is significant difference in the importance of the above mentioned categories of areas to make the Green / Sustainable / LEED practice more sound and effective.

i.e. $H_1$: Not all $M$ are equal
Null hypothesis: There is no significant difference in the importance of the three categories three areas to make the Green / Sustainable / LEED practice more sound and effective.

i.e. $H_0: M_1 = M_2 = M_3$

Table 5.28 shows the descriptive statistics of the data of the respondent’s ratings provided to rate the importance of the three areas. Out of 125 respondents, 100 responded to this question completely. However the total number of responses for this section considering the partial responses as well is 102.

**Table 5.28. Descriptive Statistics of the Respondent’s Rating of Importance of the Three Areas**

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Areas</th>
<th>Number of Respondents</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Mode</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects.</td>
<td>102</td>
<td>4.40</td>
<td>5</td>
<td>5</td>
<td>0.847</td>
</tr>
<tr>
<td>2</td>
<td>Education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED projects. Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction.</td>
<td>100</td>
<td>4.34</td>
<td>5</td>
<td>5</td>
<td>0.768</td>
</tr>
<tr>
<td>3</td>
<td>Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction.</td>
<td>100</td>
<td>3.93</td>
<td>4</td>
<td>5</td>
<td>1.130</td>
</tr>
</tbody>
</table>

Kruksal-Wallis rank test at 0.05 level of significance was performed to test the null hypothesis that there is no significant difference in the importance of three categories of areas to make the Green / Sustainable / LEED practice more sound and effective. The results of the test are as follows:

$H_{STAT} = 9.23$ and $p$-value $= 0.009**$

From the chi-square distribution table, critical value, $X^2$, at 0.05 level of significance, is 5.99.
Since, $H_{STAT} > X^2$, we reject the null hypothesis that there is no significant difference in the importance of all three categories of areas to make the Green / Sustainable / LEED practice more sound and effective. So, there is significant difference in importance of at least two of the three areas.

Since the null hypothesis is rejected, it is clear that the median rating of at least two areas is significantly different from each other. To find which areas were actually different, pair wise comparison of each group was conducted using post-hoc analysis. Hence the research hypothesis that is tested by the pair wise post-hoc analysis is

**Research Hypothesis:** There is significant difference in the importance of any two of the three categories of areas to make the Green / Sustainable / LEED practice more sound and effective.

$H_1: M_i \neq M_j$

**Null Hypothesis:** There is no significant difference in the importance of any of the three categories of areas to make the Green / Sustainable / LEED practice more sound and effective.

$H_0: M_i = M_j$

where, $i$ and $j$ can represent any of the three areas mentioned above.

Form the pair wise comparison of each categories of areas, it was found that there is significant difference in the importance of ‘Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction’ compared to other two areas which are ‘Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects’ and ‘Education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED
project’. Table 5.29 and Table 5.30 shows the result of the pair wise comparison using Wilcoxon rank sum test, of the two groups of areas whose importance was significantly different from each other.

**Table 5.29. Results of Wilcoxon Rank Sum Test of Rating of Importance of the First and Third Area**

<table>
<thead>
<tr>
<th>Area</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects.</td>
<td>102</td>
<td>4.4</td>
<td>5</td>
<td>-2.86</td>
<td>0.004**</td>
</tr>
<tr>
<td>Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction.</td>
<td>100</td>
<td>3.93</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at alpha level 0.05 (2-tailed)  
** Significant at alpha level 0.01 (2-tailed)

From the mean rating of the awareness of the two areas, it can be concluded that ‘Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects’ is more important than ‘Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction’.

**Table 5.30. Results of Wilcoxon Rank Sum Test of Rating of Importance of the Second and Third Area**

<table>
<thead>
<tr>
<th>Area</th>
<th>Sample Size (n)</th>
<th>Mean Rating</th>
<th>Median Rating</th>
<th>Z_{STAT}</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED projects.</td>
<td>100</td>
<td>4.34</td>
<td>5</td>
<td>2.2</td>
<td>0.027*</td>
</tr>
<tr>
<td>Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction.</td>
<td>100</td>
<td>3.93</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at alpha level 0.05 (2-tailed)  
** Significant at alpha level 0.01 (2-tailed)

From the mean rating of the awareness of the two areas, it can be said that ‘Education to raise awareness to unique characteristics embodied in the construction of
Green / Sustainable / LEED projects’ is more important than ‘Developing a standard contract document that specifically deals with Green / Sustainable / LEED construction’.

5.6.3 Comparison of importance of three areas to make the Green / Sustainable / LEED practice more sound and effective between respondents with and without experience of legal issues

In this section, respondents were sorted into two groups: who experienced legal issues and those who did not experience any legal issues. The importance of the three different areas to make the Green / Sustainable / LEED practice more sound and effective, were then compared independently among those two groups of respondents.

Fig 5.43 and Fig 5.44 show the difference between the proportions of two groups respondents who agree that the education to raise awareness to the unique characteristics embodied in the design of Green / Sustainable / LEED projects is important to make the Green / Sustainable / LEED practice more sound and effective. From the comparison, it is seen that the proportion of positive responses from the first group of respondents i.e. respondents with experience in legal issues, is greater than the second group of respondents i.e. respondents without experience in legal issues.

**Fig. 5.43.** Proportion of respondents with legal issues who agree that area 1 is important to make the Green / Sustainable / LEED practice more sound and effective (n=53)
Fig. 5.44. Proportion of respondents without legal issues who agree that area 1 is important to make the Green / Sustainable / LEED practice more sound and effective ($n=49$)

Fig. 5.45 and Fig. 5.46 shows the difference between the proportions of two groups of respondents who agree that the education to raise awareness to the unique characteristics embodied in the construction of Green / Sustainable / LEED projects is important to make the Green / Sustainable / LEED practice more sound and effective. From the comparison, it is seen that the proportion of positive responses from the first group of respondents, is greater than the second group of respondents. As shown in Fig. 5.53, the first group of respondents had no negative responses.

Fig. 5.45. Proportion of respondents with legal issues who agree that area 2 is important to make the Green / Sustainable / LEED practice more sound and effective ($n=53$)
**Fig. 5.46.** Proportion of respondents without legal issues who agree that area 2 is important to make the Green / Sustainable / LEED practice more sound and effective \((n=47)\)

Fig 5.47 and Fig 5.48 show the difference between the proportions of the two groups of respondents who agree that developing a standard contract document that specifically deals with Green / Sustainable / LEED construction is important to make the Green / Sustainable / LEED practice more sound and effective. The positive response from respondents with legal issues is slightly highly greater compared to the response from respondents without legal issues. The negative response from the second group is significantly larger than the first group at 19 percent and 8 percent respectively.

**Fig. 5.47.** Proportion of respondents with legal issues who agree that area 3 is important to make the Green / Sustainable / LEED practice more sound and effective \((n=53)\)
Fig. 5.48. Proportion of respondents without legal issues who agree that area 3 is important to make the Green / Sustainable / LEED practice more sound and effective (n=47)
6.1 Organization Type

From the distribution of the data collected by organization type, it may be seen that architecture firms represent the dominant organization in this research with 31 percent of the respondents. Among the organization types specified in the survey questionnaire, those with the lowest number of respondents were material vendor and specialty subcontractor firms, each at two percent. Contractor organizations were the second largest number of respondents, but were almost a third less than architecture firms. These two categories accounted for 43 percent of the total respondents. Fig. 6.1 shows a rank ordered graph of the participation in this research by organization type.

![Graph showing respondents ranked order by organization type (n=125)](image)

**Fig. 6.1.** Respondents ranked order by organization type (n=125)
The results presented in Fig. 6.1 may have been affected by the additional effort placed on obtaining responses from architectural and construction firms as detailed in section 4.4. In the survey instrument under organization type the category ‘other’ received seven responses. The bottom six organization types in Fig. 6.1 account for those who responded to the ‘other’ category.

### 6.2 Respondents’ involvement in green/sustainable/LEED construction

In section 5.2, it was shown that 109 out of 125 respondents or their organizations were involved in green / sustainable / LEED design and construction.

Respondents with and without involvement in green construction are sorted by the organization type and presented in Fig. 6.2.

![Graph showing respondents' involvement in green construction by organization type](image)

**Fig. 6.2.** Respondent’s involvement in green construction by organization type (n=125)
As the survey instrument was distributed primarily to a population that would have been involved in green construction, a bias is created. Therefore, the results of Fig. 6.2 are not likely to accurately represent the owner and the construction industry populations’ involvement in green construction. Fig. 6.2 indicates that the research was largely successful in reaching a population who was involved in green construction. As one of primary purposes of the research was to determine the characteristics of legal issues involved in green construction the research would have been unsuccessful had not this population be reached.

From the data provided by the respondents who had been involved in green construction the number of green projects each respondent or their organization were involved ranged from as low as 1 to as high as 500. Fig. 6.3 shows the number of green projects each respondent or their organizations have been involved with. If the responses for each organization type and their associated green projects reported are summed the value obtained is 3130 projects. However, this does not mean that there are 3130 different green projects represented in this data. As multiple organization types could have been involved on one specific project and this specific project would be in each of their responses. For instance the owner, architecture firm, engineering firms, contractor, construction management firm, consultant, three specialty subcontractors, and three material vendors could have all responded in the affirmative about one particular project. In the total this would have accounted for 14 projects when in actuality it really represents only on project. Therefore, summing the respondents to ascertain a total number of green projects is invalid. Organizations involved in design and construction of green projects would be involved in significantly more projects that would owners and
government entities. Each owner project or government entity project could have multiple other organization types involved in each of their projects.

Fig. 6.3. Respondent’s or their organization’s involvement in green projects
6.3 Experience of legal issues in green construction

As shown in Fig. 5.5, 48 percent of the respondents or their organizations had experienced any litigation, alternative dispute resolution, informal resolution procedures or other adversarial proceedings pertaining to the green aspect of the projects.

From the data provided by the respondents who had been involved in green construction and experienced legal issues, the number of green projects each respondent or their organization reporter ranged from 1 to 20. If the total number of green projects that were reported to have issues are summed the value obtained is 223 projects. Again, as with total number of green projects, we cannot conclude that there are 223 different green projects with issues represented in this data. As multiple organization types could have been involved on one specific project and this specific project would be in each of their responses, summing the respondents to ascertain a total number of green projects with issues is invalid.

However, it is valid to assume that only one architect would be involved in one project. Following this assumption, the ratio of total number of green projects with issues and total number of green projects respondents representing architects or their organization had been involved with is calculated as

\[
\frac{\text{Number of green projects with legal issues}}{\text{Total number of experienced green projects}} = \frac{44}{334} \times 100\% \approx 13\%
\]

From the calculation of available data that represented architects, 13 percent of the reported green projects experienced any litigation, alternative dispute resolution, informal resolution procedures or any other adversarial proceedings pertaining to the green aspect of the projects.
Similarly, the ratio of total number of green projects with issues and total number of green projects is calculated for the data that represented contractors with the assumption that only one contractor organization would be involved in one project.

\[
\frac{\text{Number of green projects with legal issues}}{\text{Total number of experienced green projects}} = \frac{18}{121} \times 100\% \approx 15\%
\]

From the calculation of available data that represented contractors, 15 percent of the reported green projects experienced any litigation, alternative dispute resolution, informal resolution procedures or any other adversarial proceedings pertaining to the green aspect of the projects.

Using the total number of green projects, architects and contractors were involved and the total number of green projects that experienced any legal issue, confidence intervals have been calculated as shown in Table 6.1 to estimate the chances of architects and contractors to experience legal issues within the sample of green projects that experience issues.

**Table 6.1. 95% Confidence Interval of Architects and Contractors to Experience Legal Issues**

<table>
<thead>
<tr>
<th>Organization Type</th>
<th>Total Number of Green Projects</th>
<th>Number Green Projects with Issues</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower Limit Upper Limit</td>
</tr>
<tr>
<td>Architects</td>
<td>334</td>
<td>44</td>
<td>10% 17%</td>
</tr>
<tr>
<td>Contractors</td>
<td>121</td>
<td>18</td>
<td>9% 21%</td>
</tr>
</tbody>
</table>

**6.4 Projects delivery methods used in green projects with issues**

Information on project delivery methods was only collected on green projects that experienced issues. From Fig. 5.8, it can be seen that conventional Design-Bid-Build method was most frequently encountered on green projects with issues at 39 percent. The second most encountered project delivery method with issues was Design-Build at 32 percent. These two project delivery methods accounted for 71 percent of the green
projects with issues. Recently Construction Manager at Risk (CMAR) has been gaining popularity as a project delivery method (Huang 2011) and it was encountered on nine percent of the projects. Integrated project delivery (IPD) which is the newest of the project delivery methods (Winstanley 2011) accounted for six percent of the projects.

6.5 Contract types used in green projects with issue

Information on contract type was only collected on green projects that experienced issues. From Fig. 5.9, it can be seen that the guaranteed maximum price (GMP) contract type that was used for the majority of green projects with issues at 32 percent. The lump sum contract type was the second most preferred contracting type at 26 percent. The remaining two contract types – unit price and cost plus seem to be almost equally preferred for use on green projects at 21 percent and 19 percent respectively.

6.6 Confidence interval calculation of green projects to experience any legal issues based on three different variables

Section 5.3 provides various descriptive statistics of green projects with issues, like type of the project, type of project delivery method, and type of contract. Using this data, this section calculates the confidence interval based on number of projects for each variable. A confidence level of 95% is considered for all the calculations of confidence interval. Confidence intervals have been calculated to estimate the chances of project types, project delivery method types, and contract types to experience legal issues within the sample of green projects that experience issues. Table 6.2, 6.3 and 6.4 show the 95%
confidence interval of the green projects to experience legal issues based on project types, types of project delivery method and contract types respectively.

**Table 6.2.** 95% Confidence Interval of Projects with Issues to Experience Legal Issues Based on Project Type (n=53)

<table>
<thead>
<tr>
<th>Types of Project</th>
<th>Number of Projects</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building - New Construction</td>
<td>32</td>
<td>47% 74%</td>
</tr>
<tr>
<td>Building - Tenant Improvement / Renovation</td>
<td>8</td>
<td>5% 25%</td>
</tr>
<tr>
<td>Industrial / Power / Manufacturing</td>
<td>1</td>
<td>0% 6%</td>
</tr>
<tr>
<td>Residential - New Construction</td>
<td>4</td>
<td>0% 15%</td>
</tr>
<tr>
<td>Residential - Renovation</td>
<td>4</td>
<td>0% 15%</td>
</tr>
<tr>
<td>Government / Public Works</td>
<td>4</td>
<td>0% 15%</td>
</tr>
</tbody>
</table>

**Table 6.3.** 95% Confidence Interval of Projects with Issues to Experience Legal Issues Based on Type of Project Delivery Method (n=53)

<table>
<thead>
<tr>
<th>Types of Project Delivery Method</th>
<th>Number of Projects</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-Bid-Build</td>
<td>21</td>
<td>26% 53%</td>
</tr>
<tr>
<td>Design-Build</td>
<td>17</td>
<td>20% 45%</td>
</tr>
<tr>
<td>Agency Construction Manager</td>
<td>1</td>
<td>0% 6%</td>
</tr>
<tr>
<td>Construction Manager at Risk (CMR)</td>
<td>5</td>
<td>2% 17%</td>
</tr>
<tr>
<td>Integrated Project Delivery (IPD)</td>
<td>3</td>
<td>0% 12%</td>
</tr>
<tr>
<td>Engineer Procure Construct (EPC)</td>
<td>1</td>
<td>0% 6%</td>
</tr>
</tbody>
</table>

**Table 6.4.** 95% Confidence Interval of Projects with Issues to Experience Legal Issues Based on Contract Types (n=53)

<table>
<thead>
<tr>
<th>Types of Contract</th>
<th>Number of Projects</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump Sum</td>
<td>14</td>
<td>15% 38%</td>
</tr>
<tr>
<td>Unit Price</td>
<td>11</td>
<td>10% 32%</td>
</tr>
<tr>
<td>Cost Plus (Fixed / Variable Fee)</td>
<td>10</td>
<td>8% 29%</td>
</tr>
<tr>
<td>Guaranteed Maximum Price</td>
<td>17</td>
<td>20% 45%</td>
</tr>
</tbody>
</table>

### 6.7 Project phase in which the issue occurred

Fig. 5.11 shows the distribution of the projects with issues based on the project phase in which the issue was experienced. From the distribution, it can be seen most of the issues occurred in construction phase at 42 percent, which represents almost half of the projects with issues. There was equal number of green projects with issues that experienced issues
in design phase and commissioning/start up phase, each at 15 percent.

Operation/maintenance phase represented the project phase with lowest number of issues at slightly lower percentage than the second highest phase, i.e. at 13 percent. One possible explanation of why the operation/maintenance phase is fairly low is that most of the projects are relatively new. However, over time the number of issues in this phase would be expected to increase as the project ages.

### 6.8 Impact of legal issues on project schedule

Fig 5.12 presents distribution of the data based on project schedule impact for projects with issues. Forty-one percent of the projects with issues incurred a schedule delay due to an issue associated with the green aspect of the project. Thirty-two percent of the projects with issues did not experience any schedule impact due to issues. Two percent of the projects experienced both acceleration and delay impacts on their schedule. None of the projects experienced only acceleration in the project schedule due to legal. Based on the data, it can be concluded that the major impact that can be expected on the project schedule due to legal issues associated with the green aspect of the project, is delay impact.

Confidence intervals have been calculated to estimate the chances of a green project with issue to experience various schedule impacts and is shown in Table 6.5.

<table>
<thead>
<tr>
<th>Schedule Impact</th>
<th>Number of Projects</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Limit</td>
</tr>
<tr>
<td>Delay</td>
<td>22</td>
<td>28%</td>
</tr>
<tr>
<td>Both Acceleration and Delay</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>None</td>
<td>17</td>
<td>20%</td>
</tr>
</tbody>
</table>

Table 6.5. 95% Confidence Interval of Green Projects with Issues to Experience Different Types of Schedule Impact Upon Experience of Legal Issues (n=53)
6.9 Resolution of legal issues in green construction

From the results in the section 5.3.6, none of the issues went court and none were solved with litigation. Other procedures like alternative dispute resolution, cost absorbed by the parties, informal resolution procedure, other adversarial proceedings’ and contract change orders were used to resolve issues.

It may be concluded that although new kinds of issues are emerging in the design and construction industry due to the green/ sustainable / LEED aspects of a project, most of them have not reached court yet and the parties involved are choosing to settle it outside court. The resolution procedure most often employed is ‘contract change orders’ which is reported by 19 percent of the respondents or their organizations.

6.10 Categories of Issues

In this section, various issues as reported by the respondents are categorized into different groups in order to compare the frequency of occurrence of each types of issue. The categories developed to sort the issues are represented by the following areas:

1. Certification,
2. Construction,
3. Contractual,
4. Cost Increase,
5. Design,
6. Energy,
7. Incentive,
8. Material; and

The reported issues were distributed to the categories listed above. Using these categories, frequency of occurrence of each type of issue was calculated. The frequency distribution was also used to create the hierarchy of different types of issues based on their occurrence. When assigning a category to an issue it was possible for the issue to be related to more than one category. When an issue was related to more than one category it was assigned to all of the categories to which it related. Fig. 6.4 shows the hierarchy of the issues based upon their frequency of occurrence.

![Hierarchy of issues based upon their frequency of occurrence](image)

**Fig. 6.4.** Hierarchy of issues based upon their frequency of occurrence

The categories of performance, construction certification and design were the dominant issues. DuBose (2012) presents results from a USGBC study that shows that slightly less than 50 percent of the LEED® projects investigated failed to achieve their expected performance.
CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusion

A sample population was successfully obtained that was large enough to conduct this exploratory research. It required significant effort over a five-month period to obtain this modest small sample of 125 respondents. As 109 respondents were involved in green construction the proper target audience was reached for participation in this research.

Individuals associated with architecture firms were the dominant organization type participating, representing 31 percent of the respondents. Fifty-four percent of the respondents were from the design community. Twenty-three percent of the respondents were from the construction community. Fourteen percent of the respondents were from the owner community. The remaining nine percent of the respondents could have worked been working in either the design or construction communities. However, there was insufficient detail to identify what community they were responding in their response.

Forty-eight percent of the respondents with experience on green projects had experienced legal issues due to the green/sustainable/LEED aspect of the project. Construction projects for new buildings accounted for 60 percent of the green projects that experienced issues. The design-bid-build project delivery method was most frequently encountered among the projects that experienced issues with the green/sustainable/LEED aspect of the project. The design-bid-build projects accounted for 39 percent of the projects with issues. The design-bid-build project delivery method is the method that most frequently encounters claims and disputes (AGC, 2004). Therefore,
it is not surprising that the design-bid-build project delivery method accounted for the project delivery method experiencing associated with projects experiencing problems. The guaranteed maximum price contract type was most frequently associated with green projects that experienced issues. Thirty-two percent of the projects with issues used guaranteed maximum price contract type. Of the projects with issues forty-two percent were associated with the construction phase.

None of the reported issues were resolved by litigation. A much larger sample needs to be investigated to determine whether this was an artificial manifestation particular to this data or is litigation really minimal when associated with the green/sustainable/LEED aspect of the project. The present data clearly indicates the parties involved in the green construction are choosing to settle the issues outside the court through various means such as alternative dispute resolution, cost being absorbed by the parties, informal resolution procedure, other adversarial proceedings and contract change orders. The most preferred resolution procedure, as indicated by the survey respondents, was with contract change orders. Also, issues arising due to green aspect of the projects mainly cause delay impact to the project’s schedule at 41 percent.

Contractors were, most of the time, responsible for the additional cost incurred in the project as a result of any issues at 33 percent. From the analysis of all the data points which provided both settlement cost and the total project cost, average green liability index is 2 percent of the total project cost.

Categorization of issues showed that performance issues with the delivered project are the area which most frequently occurs; with 31 percent of the projects with issues in this category. Construction and certification are the second highest categories
with issues, each at 25 percent. The design category was fourth highest at 22 percent. The percentages associated with the other categories were less than 10 percent.

There were 34 green projects that had issues that provided project cost information. The cost ranged from a low of $40,000 to a high of $250 million as shown in Fig. 7.1. The average cost of the 34 projects was approximately $21.7 million. Thirty percent of the 34 projects were less than or equal to $650,000. This 30 percent represents extremely small construction projects. If the lower 32 percent of the projects, projects less than $1 million, are removed the average project cost is approximately $32 million. Most commercial construction is significantly above the cost of the lower cost 32 percent of these projects. The $32 million average cost seems to better represent commercial construction project cost. A much larger data set using a cutoff of $1 million or $2 million is needed to adequately represent the cost of commercial construction.

![Fig. 7.1. Project cost (n=34)](image-url)
Analysis of respondents rating provided to various parties involved in the construction industry, in order to rate the parties’ awareness of legal issues in green construction, showed that architects are the organization or party with highest awareness of legal issues in green construction. Material vendors and specialty subcontractors were rated to have least awareness of legal issues in green construction based on average rating received by each party and also based on the rating categorized according to the organizations represented by the respondents.

7.2 Research Limitation and Recommendations for further research

The topic of this research has not been previously investigated. Thus the exploratory nature of this research is to determine if further in-depth research should be conducted. Data collection for sensitive issues with project performance has always been challenging because parties tend not want to be associated with the negative aspects of project delivery. Additionally, as these issues generally involve increased cost, parties are even more reluctant to provide data for research purposes. Many times in negotiated settlements there may be non-disclosure clauses which prohibit any release of data, making the collection of this type data even more difficult. In the data collected in this research it was evident that respondents, who initiated the survey, did not answer questions like the cost involved during settlement of the issue. The data contained 53 projects that had issues with the green construction. Only 64 percent of those projects provide project cost and settlement cost data.

The data collection effort is this project was very difficult as was detailed in section 4.3. Multiple requests were sent to solicit participation. Various methods were
adopted by this research for the solicitation of the participants such as email invitation, distributing the survey via LinkedIn, announcement to the members of various local organizations, but still resulted in a moderately small sample. The inclusion of using LinkedIn groups associated with green construction increased the number of respondents by approximately 17 percent. Given the large audience reached through LinkedIn, the response rate was extraordinarily small. The conclusion is that the use of professional networking groups such as LinkedIn was marginally effective. However, research on how to conduct surveys using these online professional networking groups would be helpful. Even with all the effort expended to obtain responses from within Nevada, only 29 percent of the respondents were from Nevada. The additional effort to solicit and re-solicit participation outside Nevada by direct emailing contributed to reaching the final level of respondents. This research can be further extended in the future by working directly with national professional society trade groups, owner groups, etc. to obtain significantly larger sample size. However, working at the national level would be very time consuming and many connections would need to be established within the national community to make this strategy successful.

Additionally, this research was conducted as unfunded research. If an effort to obtain a national level sample, a source of funding would be required to accomplish the larger effort.

In the course of data analysis, improvements in the survey instrument were identified. Some questions were identified which could have benefited from a hierarchal skip logic. Some questions could have benefitted from using a ranking algorithm for establishing a forced approach to ranking between questions.
For example, Part A question 5 from the survey instrument asked respondents to rate the importance of three different areas to make Green / Sustainable / LEED practice more sound and effective. The setting of the survey instrument was such that the respondents could give same rating to all three areas. During analysis, it was determined this question should have required some method that required prioritization of the areas. In other words respondent would only be allowed to provide a response at a given value of importance only once. So if an area received a rating of extremely important, then the other areas would receive a different rating than extremely important. This would allow the researcher to better compare the importance of the three areas.

This thesis collected detail data, only regarding the projects that experienced issues. For future research, it is recommended data should be collected for projects both with and without issues. It would assist in making valid statement regarding relation of issues due to green factor with various aspects of the projects such as project delivery methods, contract types, and project types.

In further research on this topic, it is recommended that more information regarding the green / sustainability / LEED characteristics of the projects be identified. This would help to compare the issues in green construction in multiple classifications. Another benefit of this would be to distinguish whether the reported issues involved a certification issue or not. The following are a set of questions that could be helpful for the purpose:

- Is the project seeking certification or already certified under a given certification program?
- If the previous question is answered in the affirmative then- what was the planned level of certification?
  - LEED Certified®
  - LEED Silver®
  - LEED Gold®
LEED Platinum®
One Green Globe™
Two Green Globes™
Three Green Globes™
Four Green Globes™
Other

- If the certification is already achieved, what was the achieved level of certification?
  Still not certified
  LEED Certified®
  LEED Silver®
  LEED Gold®
  LEED Platinum®
  One Green Globe™
  Two Green Globes™
  Three Green Globes™
  Four Green Globes™
  Other

- Was the project designed to a certification level but certification not sought? If so indicate the certification level it was designed for:
  Not Applicable
  LEED Certified®
  LEED Silver®
  LEED Gold®
  LEED Platinum®
  One Green Globe™
  Two Green Globes™
  Three Green Globes™
  Four Green Globes™
  Other
  Was not designed to a specific certification level but principles of green / sustainable / LEED were employed in design

- What is your present status with regard to LEED accreditation by the USGBC, Select all that apply
  None
  LEED Green Associate®
  LEED AP®
  LEED AP BD+C®
  LEED AP ID+C®
  LEED AP O+M®
  LEED AP ND
  LEED AP for Homes®

- How many years have you held a LEED accreditation?________________________

- How many years have you been accredited at your highest LEED® level?_________
Based upon the results of the literature review and some of the observations made in this research a list of recommendations has been developed which could help project participants reduce their risk on green projects. These recommendations are provided in Appendix C.
APPENDIX A

SAMPLE OF FINAL SURVEY INSTRUMENT

Cover Page.................................................................144
Part A.................................................................146
Part B.................................................................149
All data collected by this survey will be held in the strictest confidence. Access to the research data is limited to the following individuals: Ms. Namrata Shrestha, Researcher; Dr. David Shields, Advisor; Thesis Committee Members: Dr. Pramen Shrestha, Professor Neil Opfer, and Dr. Nasser Daneshvary; and Adjunct Faculty Dr. Calvin Chui. A security protocol to access the data is being established and the data will be maintained in a secure manner. These individuals will not divulge the names of any companies or individuals who complete the survey questionnaire and supply data. The thesis and any subsequent conference papers or journal papers using data from this research will not divulge the names of any companies or individuals who complete the survey questionnaire and supply data. Specific project names will not be divulged.

The data collected by this survey will support Ms. Shrestha's Master of Science Thesis in the UNLV Construction Management Graduate Program. The objective of the research is to determine if Green/Sustainable/LEED construction experiences greater use of litigation to resolve issues than do conventional projects. By completing this survey, you can make a significant contribution towards the success of this research. The length of this survey is approximately 10 minutes for one project and slightly longer for two projects.

Your participation and response will be greatly appreciated.

Sincerely,
David R. Shields, Ph.D., P.E.
Associate Professor
Department of Civil & Environmental Engineering
University of Nevada, Las Vegas
And
Namrata Shrestha, M.ARCH., LEED® AP BD+C
Graduate Research Assistant
Legal Issues in Green / Sustainable / LEED Construction

Part A. General Information:

1. Organization Information (optional):
   Name: 
   Address: 

2. Type of organization:
   - Owner
   - Government (Federal / State / Municipal)
   - Architect
   - Engineer
   - Architect / Engineer
   - Contractor
   - Construction Manager
   - Consultant
   - Specialty Subcontractor
   - Material Vendor
   - Other (Please specify) 

3. Please provide the optional following information. This information will only be used should we need to seek clarification with regard to your survey response. During the review of your response a list will be compiled of any items needing clarification. Contacting you for clarification will be deliberately undertaken only as a last resort and you will be contacted once and only once.
   Email: 
   Phone: 

4. Please rate the following parties’ awareness of legal issues which may arise due to
selection of the Green / Sustainable / LEED design and construction approach for a project.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

Owner

Government (Federal / State / Municipal)

Architect

Engineer

Contractor

Construction Manager

Specially Subcontractor

Consultant

Material Vendor

Other (specify below)

Other (please specify)

5. How important are the following areas to make Green / Sustainable / LEED practice more sound and effective.

<table>
<thead>
<tr>
<th>Extremely Important</th>
<th>Very Important</th>
<th>Important</th>
<th>Somewhat Unimportant</th>
<th>Unimportant</th>
</tr>
</thead>
</table>

Education to raise awareness to unique characteristics embodied in the design of Green / Sustainable / LEED projects.

Education to raise awareness to unique characteristics embodied in the construction of Green / Sustainable / LEED projects.

Developing a
standard contract
document that
specifically deals
with Green /
Sustainable / LEED
corstruction.
Other (specify below)

Describe other

6. Has your company been involved in any green / sustainable / LEED design or construction work?
   Yes
   No

7. List the number of green / sustainable / LEED projects that you or your employer have been involved with?

8. List the number of projects that experienced any litigation, alternative dispute resolution, informal resolution procedures or any other adversarial proceedings pertaining to the green / sustainable / LEED aspect of the projects.

Powered by SurveyMonkey
Create your own free online survey now!
Part B. Project Information

Please provide information regarding the project which experienced the most significant issue pertaining to Green / Sustainable / LEED aspect of the project.

1. Project Name (optional):
Note: this information will be used to identify projects that may have been submitted by more than one company or individual and are on the same issue on the project. This will ensure that the research is not biased due to entering data on the same project's issue more than once.

2. General project location:
City: ____________________________
State: __________________________

3. Type of project:
- Building - New Construction
- Building - Tenant Improvement / Renovation
- Industrial / Power / Manufacturing
- Heavy Civil / Infrastructure
- Residential - New Construction
- Residential - Renovation
- Government / Public Works
- Other (please specify)

4. Type of project delivery method used in the project:
- Design-Bid-Build
- Design-Build
- Agency Construction Manager
- Other (please specify)
- Construction Manager at Risk (CMR)
- Integrated Project Delivery (IPD)
- Engineer Procure Construct (EPC)
5. Type of contract used in the project:

- Lump Sum
- Unit Price
- Cost Plus (Fixed / Variable Fee)
- Guaranteed Maximum Price

6. The legal issue pertaining to the Green / Sustainable / LEED aspect occurred in which project phase?

- Design
- Construction
- Commissioning / Start up
- Operation / Maintenance

7. What was the legal issue experienced pertaining to the use of the Green / Sustainable / LEED approach?


8. Did the issue impact the schedule?

- Acceleration
- Delay
- Both Acceleration and Delay
- None

9. How was the issue resolved?

- With Litigation
- Alternative Dispute Resolution
- Cost Absorbed by Party / Parties
- Informal Resolution Procedures
- Other Adversarial Proceedings
- With Contract Change Order(s)
- Other (please specify)

10. If resolved with litigation, litigation was filed by (may select multiple answers):

- Owner
- Construction Manager
- Government (Federal / State / Municipal)
- Specialty Sub-Contractor
- Architect
- Consultant
- Engineer
- Material Vendor
- Contractor
- Other (please specify)
11. Litigation was filed against (may select multiple answers):
   - Owner
   - Government (Federal / State / Municipal)
   - Architect
   - Engineer
   - Contractor
   - Other (please specify)

12. Were the duties, responsibilities and legal obligations, governing the issue, stipulated in the contract document?
   - Yes
   - No

13. If yes to question 12, was the issue resolved in accordance with the contract document?
   - Yes
   - No

14. Who was responsible for the cost incurred due to the issue? (select as many as apply)
   - Owner
   - Architect
   - Engineer
   - Contractor
   - Construction Manager
   - Consultant
   - Specialty Subcontractor
   - Municipal / Government
   - Material Vendor

15. What was the approximate cost involved in resolving the issue?

16. Please provide the approximate cost for the following:
17. Do you wish to provide information regarding another or the same project which experienced a very significant issue, other than the one mentioned in this part of the survey, pertaining to the Green / Sustainable / LEED aspect of the project.

Yes
No
## APPENDIX B

### POST-HOC ANALYSIS RESULTS OF ONE-WAY ANOVA

<table>
<thead>
<tr>
<th>(I) party</th>
<th>(J) party</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>Government</td>
<td>-0.06440</td>
<td>0.14227</td>
<td>1.000</td>
<td>-0.3069</td>
<td>-0.5069</td>
<td>0.3781</td>
</tr>
<tr>
<td>Architect</td>
<td>.48421</td>
<td>-0.14227</td>
<td>0.079</td>
<td>0.022</td>
<td>-0.8623</td>
<td>-0.9243</td>
<td>-0.0441</td>
</tr>
<tr>
<td>Engineer</td>
<td>-.44143</td>
<td>0.14981</td>
<td>0.500</td>
<td>0.002</td>
<td>-0.8827</td>
<td>-0.9243</td>
<td>0.0441</td>
</tr>
<tr>
<td>Contractor</td>
<td>-.15744</td>
<td>0.14266</td>
<td>0.974</td>
<td>0.601</td>
<td>-0.6011</td>
<td>-0.5069</td>
<td>0.3781</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>-.27444</td>
<td>0.14306</td>
<td>0.601</td>
<td>0.7194</td>
<td>0.1704</td>
<td>-0.7194</td>
<td>0.3781</td>
</tr>
<tr>
<td>Specialty Subcontractor</td>
<td>.32990</td>
<td>0.14306</td>
<td>0.340</td>
<td>0.1150</td>
<td>0.7748</td>
<td>-0.3781</td>
<td>0.3781</td>
</tr>
<tr>
<td>Consultant</td>
<td>-.29647</td>
<td>0.14306</td>
<td>0.493</td>
<td>0.7414</td>
<td>0.1485</td>
<td>-0.7414</td>
<td>0.3781</td>
</tr>
<tr>
<td>Material Vendor</td>
<td>.48375</td>
<td>0.14306</td>
<td>0.021</td>
<td>0.0388</td>
<td>0.9287</td>
<td>-0.3781</td>
<td>0.3781</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(I) party</th>
<th>(J) party</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>Owner</td>
<td>.06440</td>
<td>0.14227</td>
<td>1.000</td>
<td>-0.3781</td>
<td>0.5069</td>
<td></td>
</tr>
<tr>
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* The mean difference is significant at the 0.05 level.
APPENDIX C

RECOMMENDATIONS FOR GREEN BUILDERS

The green movement has provided numerous benefits to the design and construction industry. The green movement is an effort to reduce various kinds of negative environmental impacts by introducing measures like reducing greenhouse gas emission, reducing volatile organic compounds, increasing energy efficiency, water use reduction etc. The projects that are incorporating green aspects are using their resources more efficiently and effectively. At this point in time the goal is that if the elements of green design and construction are used correctly, benefits will be produced that protect the environment and decrease the use on non-renewable resources. But there are certain obstacles that must be overcome in order to obtain the full advantage. The examples include lack of universal international environmental law, matching expectations and actual project performance, defining roles and responsibilities of each party in achieving the goal of the green project.

This section is intended to provide some recommendation for a successful green construction practice. Based on the literature studies and the some findings of the data analysis, some recommendations are put forward which could be utilized to avoid possible issues in green construction. Development of risk management strategies would be beneficial to every organization because there is a great likelihood that a project will face some issue due to involvement of new and innovative techniques or materials. So all the possible circumstances must be considered upfront and risk management strategy
development for each. The information in this section can be utilized by all project participants to prepare risk management strategies.

The cause may be different in each case but so far this research shows that green construction is adding a new class of issues for the construction industry to resolve. High expectations are associated with green constructions. When an outcome does not meet the expectation, it produces a claim. The number of issues in green construction are rising quickly. Therefore, it is very important to take actions to avoid such issues on a project. Development of a risk management strategy or planning upfront seems to be a best idea to avoid issues in later stages. According to Masters and Musitano (2007), the plan hence created should be comprehensive and integrated. In building construction, the plan should include every stage in the project development starting from design to the tenant agreement.

The following are some of the recommendations listed to facilitate professionals involved in the construction industry to make green / sustainable / LEED practice sound and effective.

1. Owner’s Project requirement
A good start for a risk management strategy would be for owner to create their own documents that illustrates their green building goals for the project they are building (Prum and Del Percio 2009). This would illustrate what is actually needed in the project and what is not. This would also clarify owners’ performance expectations for the design professionals.
2. Incorporating green into contracts

When a project is planning to achieve certification, it is always safe to incorporate all the responsibilities of each project party in the contract clearly so that there is written legal obligation that everyone is aware of. Often times it is seen that when any issues occur in area that is new to construction and is not stipulated in the contract documents, it is difficult to simply resolve the issue.

3. Disclosures

The contract should clearly identify all the responsibilities of all parties. Disclosures can be important risk mitigation tool (Masters and Musitano 2007). If everything is clear upfront in the contract and everything is properly described, then the individual liabilities will decrease. For instance, contractors should specifically state in the contract that they will deliver building in accordance to plans and specifications provided and are not promising that a LEED® project will be delivered unless that is the result from construction the building in accordance with plans and specifications. Then the contractor’s work which is fully compliant with the plans and specifications is all that is required to eliminate contractor’s liability later if the project fails to achieve LEED® certification due to any condition.

4. Avoid inappropriate and early marketing

Marketing, when it is not done at the proper time and in a proper way, can result in various issues from various parties. Green construction has many features such as certification, energy savings; healthy indoor environment and so forth that builders and
owners use to do marketing of their projects in order to get better return on investment from the project. It is not wrong to do marketing of green projects if it is done at a proper time and state only true information.

For instance, it is never appropriate to market the building as certified based only on the fact that the project is registered and certification is anticipated. A better action for the developer would be to claim truthfully that the project is pre-registered for a certain certification level, instead of claiming that the project is already certified (Howe and Gerrard 2010).

5. Do not run after points

Usually it is seen that people try to achieve credits for all the sustainable techniques they are using on a project. Mostly owners are building a LEED® building so that they can promote the LEED aspect of the building to tenants and achieve a better return on investment, rather than the altruistic goal of building a sustainable building. Sustainable strategies should rather be the standard of care for each architect and engineer than incorporating sustainability elements just for credits. Otherwise it ends up wasting a great deal of time and money on sustainability elements that are obvious but may be inappropriate. A result may be a building with LEED certification but does not save energy. According to Lstiburek and Eng (2008) “Chasing green points don’t get you good buildings that are truly green.”
6. Identify control points for project

It is very essential to identify and specify control points of green construction and on-site construction process (Liu 2011). Similar to a setting milestone for any kind of work, control points also imply the same. It is very convenient to track a project if there are some control points.

7. Avoid broad claims

Project participants should avoid making broad claims including oral representations, regarding environmental benefits. Broad claims open up the parties for more disputes because they are overstating their service by making such claims. The federal Trade commission (FTC) even restricts the broad claim regarding the environmental benefit. Such claims should be avoided if possible and if not then the claims should be more specific in nature because it is practically impossible to find any materials or product which has no negative effect on the environment (Howe and Gerrard 2010). For instance, the claim saying that the building will be more energy efficient due to controllability systems incorporated will be more specific in nature compared to just saying that the building will by more energy efficient.
AGC. (2004). *Project delivery systems for construction.* Associated General Contractors of America, Arlington, VA.


WBDG. (2010). "Select appropriate design professionals."


wiseGEEK. (2012). "What constitutes construction negligence?"

VITA

Graduate College
University of Nevada, Las Vegas

Namrata Shrestha, M.ARCH, LEED® AP
Damauli-10, Tanahun
Nepal

Degrees:
  Bachelor of Architecture, 2007
  Tribhuvan University

  Master of Architecture, 2010
  Southern Illinois University, Carbondale

Thesis Title: Legal Issues in Green Construction

Thesis Examination Committee:
  Chairperson, David R. Shields, Ph.D., P.E.
  Committee Member, Neil Opfer
  Committee Member, Pramen P. Shrestha, Ph.D., P.E.
  Graduate Faculty Representative, Scott R. Abella, Pd.D.