CONTRACTOR ISSUES RESULTING FROM GREEN BUILDING

By

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To my mom and dad

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The green building movement has been around for generations, however, only recently has it gained world wide recognition. Regardless of the reasoning, whether because of the financial benefits or governmental regulation, over the last two decades it has grown at an exponential and record breaking rate. Whether they truly want to or not, contractors are constructing green building projects. As a result, these contractors are experiencing problems specifically because of the green building factors that are involved. The intent of this research was to develop a set of green building factors that are found within a construction project. Furthermore, this research determined the relative importance of the green building factors in regard to negatively impacting the contractor's cost and schedule.

From the perspective of People, Project, and Process, fourteen green building factors were created to describe the characteristics of a green building project. Based on this information, a survey was designed and subsequently distributed to contractors to obtain information about their personal experience with green building projects. The respondents recorded the importance of each factor's occurrence.

The research yielded the following fourteen factors that describe the characteristics of a green building project: *Upper Management, Project Manager, Superintendent, Craftsmen, Materials, Innovation, Design Complexity, Construction Complexity, Scheduling, Estimating, Scope Definition, Expectations, Plans and Specifications,* and *Operating Procedures*. After analyzing the data from the survey, it was determined that the green building factors that most negatively impact the contractor's cost and schedule were the *Project Manager, Materials, Estimating,* and *Operating Procedures*.

CHAPTER 1
INTRODUCTION

The building construction industry is responsible for consuming an enormous amount of the world's natural resources. These natural resources are being consumed at a much faster rate than they are being replenished. This situation has been identified and people and businesses are starting to adopt a more sustainable way of life. One example of sustainability within the building construction industry is green building. Because there has been a shift towards green building, there are organizations that have created certifications that identify, measure, and rate the success of a building's sustainable strategies. As a result, more and more building contractors are encountering projects that are implementing green building strategies as well as green building certification.

Background of the Problem

The green building movement has grown a significant amount in a short period of time. Given its exponential growth rate and its governmental adoption across the county, the green building movement is upon us. For example, from 1998 to 2008, the number of LEED certified buildings has nearly doubled each year in both number and area (Kibert 2008). Furthermore, individual green strategies such as photovoltaics and solar hot water heaters are being implemented at a growing rate also.

Given the combination of the inherent competitiveness of the bidding process and the current state of the economy, building contractors are becoming involved in more and more green building contracts. Regardless of whether or not they want to pursue these green contracts, many companies are forced to bid, simply for the sake of staying in business. In this type of situation, contractors must venture away from their traditional

and familiar markets and methods. During this period of survival and process of adaptation, many risks are taken and many mistakes are made.

Purpose of the Study

Within the building construction industry, contractors are always taking risks; this is simply the nature of the industry. A common type of risk occurs when a contractor agrees to perform a specific job that requires materials or processes that are new or unfamiliar to the contractor. In cases like this, mistakes are made and they must be accounted for and corrected.

This study focused on the issues that arise due specifically to the implementation of green building strategies in regard to the contractor. In order to classify the factors involved, the contractor's entire construction endeavor was broken down into three many categories: People, Project, and Process. Within these three categories, several factors were established to determine their role in respect to the creation of issues related to green building. The relative importance of each factor was determined from the results of a survey. Lastly, suggestions were made for further study.

Aim

The objective of this study was to determine the relative importance of a set of criterion that create issues and have a negative effect on the contractor's cost and schedule, specifically because green building practices were involved.

Hypothesis Statement

The null hypothesis was defined as:

H_o = A common set of green building factors that have a negative impact on the contractor's cost and schedule exist.

Research Objectives

- How can the contractor's entire construction endeavor be categorized in a manner that will help identify the root cause of a green building related issue?
- What types of green building related issues does the contractor encounter?
- Who or what causes the contractor to experience a green building related issue?
- Which factors involved in the construction process deserve the most attention in order to streamline the green building process for the contractor?
- What knowledge or experience is advantageous to a contractor that is entering into a green building contract?

Scope

The study focused on the impacts of green building on the contractor specifically. Currently there is material that aide some of the other parties involved in the construction process, however there is a lack of information directed towards contactors. Also, the individuals within the target audience were employees of large to mid size general contractors and subcontractors. The targeted individuals and companies were both experts and novices within the green building realm.

Research Methodology

As mentioned above, the construction project was analyzed from three different aspects: People, Project, and Process. Within these three aspects, a total of fourteen green building factors were created from a review of literature. Then, a survey was sent out to general contractors and subcontractors to determine the importance of the fourteen green building factors. The importance was rated according to the participants past experience with issues related to each green building factor. An "issue" was defined as any unplanned loss in time or money in regard to the contractor that directly resulted from a green building practice.

Limitations

Limited range of sample. The questionnaires were sent to contractors with varying degrees of green building experience. The reason for this approach was to gain insight about different types of issues occurring with different types of contractors: novices and experts.

Limited size of sample. The results of this study are based on a relatively small portion of the construction industry. A much larger sample would produce varying results.

Subjectivity of the topic. The information was collected from building contractors. Within the scope of this study, the perception of the “issue” is seen through the contractor’s eyes. Therefore, some answers could be biased as the contractor may take a defensive position. Likewise, a contractor may be hesitant to divulge the fact that an issue could have been created internally.

CHAPTER 2
LITERATURE REVIEW

One of the goals of this review of literature was to give the reader a clear understanding of the term green building and the concepts behind its practice. However, before one can truly understand green building and its global movement, one must fully understand the impacts that the building construction industry has on the environment. In this review, as the history of the green building movement approaches the recent past, there are separate sections that describe certain topics in more detail (e.g., green legislation and building assessment systems). Also, speculations are made through a comprehensive research about the future trends of LEED. Lastly, a study that was influential on the development of this research is described.

The Environmental Impacts of Buildings

When dealing with the building construction industry and natural resources, the quantitative effect can be broken down into three main categories: Energy, Water and Materials.

Energy. Buildings consume 38.9% of the primary energy use (includes fuel input for production) in the U.S. and 72% of the electricity consumption (USGBC 2010). Also, buildings in the U.S. emit a significant portion of the climate changing greenhouse gas emissions. To be specific, they are responsible for 38% of all CO2 emissions (USGBC 2010).

Water. Buildings represent 13.6% of the entire potable water consumption in this country, which equates to fifteen trillion gallons of water every year (USGBC 2010).

Materials. Buildings and building components use six billion tons of basic material for production each year (Kibert 2008). Also, it is estimated that in the year 2003, one

hundred and seventy million tons of building-related construction and demolition debris was produced in the U.S. and 61% was created by nonresidential sources while the remaining 39% came from residential sources (USGBC 2010). Lastly, it is estimated that the U.S. produces almost two hundred and ten million tons of municipal solid waste each year (USGBC 2010).

Sustainable Construction and Green Building

Often times the terms sustainable construction and green building are used interchangeably. However, there is a distinct difference and relation between the two terms. On one hand, the term sustainable construction is a broader term that applies across the entire life cycle of construction, from planning, design and construction to operation, maintenance and deconstruction, and how these processes interact with the surrounding community. “Sustainable construction most comprehensively addresses the ecological, social, and economic issues of a building in the context of its community” (Kibert 2008, pg. 6). On the other hand, the term green building refers to the structure that is created under the concept of sustainable construction. More specifically, it refers to the actual quality and characteristics of the physical structure that was created using the principles and methodologies of sustainable construction (Kibert 2008). Sustainable construction is the system as a whole, while green building is a product of the system.

Potential Benefits of Green Building

The building construction industry is huge and therefore has an equally enormous impact on the country's economy. According to the USGBC (2010), the construction industry accounts for 13.4% of the thirteen trillion dollar U.S. GDP. Therefore, many of the advantages of practicing green building involve financial benefits; however, many health benefits also exist.

Green buildings save money, they consume less energy and fewer resources, and they create a healthier and more productive environment for the occupants. On average, an upfront investment of 2% towards design will yield a life cycle savings of 20% of the total construction costs (Kats 2003). Additionally, according to the GAS Public Buildings Service (2008), when compared to the average commercial building, green buildings consume 26% less energy while having 13% lower maintenance costs, 27% higher occupant satisfaction, and 33% less green house gas emissions.

Furthermore, numerous studies have proven that occupant productivity is greater in a green building. One such study by the Heschong Mahone Group (1999) showed that students with the most day-lighting in their class rooms progressed 20% faster on math tests and 26% faster on reading tests in one year than those with less day-lighting.

According to Alder et al. (2006), this is a list of the potential benefits of green building:

- Reduced capital cost
- Reduced operating costs
- Marketing benefits (free press and product differentiation)
- Valuation premiums and enhanced absorption rates
- In some cities, streamlined approvals by building and zoning departments
- Reduced liability risk
- Health and productivity gains
- Attracting and retaining employees
- Staying ahead of regulations
- New business opportunities
- Satisfaction from doing the right thing

History of the Green Building Movement

Green building has gained a great deal of momentum in the last ten to fifteen years. This sudden growth can cause some people to believe that green building is a new concept. However, there is obvious evidence that proves green building has been

in existence for much longer than a couple decades. In fact, some recent evidence dates back to the early eighteen hundreds where examples of passive systems such as roof ventilators and under ground air-cooling chambers were utilized in London's Crystal Palace and Milan's Galleria Vittorio Emanuele II (Cassidy 2003). These systems passively moderated the indoor air temperature of their structures. Then, in the early nineteen hundreds, New York City became home to several influential buildings that implemented green building practices. For example, the Flatiron Building and the New York Times Building were designed with deep set windows (Cassidy 2003). The depth of these types of windows acted as a shading device to protect the building from infiltration of the sun's rays through the building envelope. As the century went on, other buildings continued to incorporate similar concepts. In 1932, Rockefeller Center employed operable windows and sky gardens. Also, the Wainwright Building in St. Louis and the Carson Pirie Scott Building in Chicago both featured retractable awnings (Cassidy 2003).

In the early 1970s, in the wake of the OPEC oil embargo, the American Institute of Architects formed an energy conservation task force. Eventually, in 1975 this task force became the AIA Committee on Energy. The committee focused on two main areas: passive systems and technological solutions (Cassidy 2003). In order to cover a much broader spectrum of environmental concern, in 1989 the AIA division changed its name to COTE, which stands for the Committee on the Environment (Cassidy 2003). In the meantime, the practice of green building continued to grow.

By the late 1970s, architect Norman Foster designed the Willis-Faber and Dumas head office building in Ipswich, England. This influential building was designed with a

grass roof, a day-lighted atrium, and a façade made entirely of bronze-tinted glass (Watkin 2005). Among other things, these three green design strategies passively and naturally insulated the building, lit the interior space, and reduced solar heat gain.

During this period, the U.S. government began to set an example for the rest of the country. In California, eight state office buildings incorporated green building concepts such as photovoltaics, under-floor rock-store cooling systems, and area climate-control mechanisms (Cassidy 2003). Concurrently, many different organizations with similar environmental concerns continued to form throughout the U.S. In 1977, the Solar Energy Research Institute was founded in Golden, Colorado, while the Department of Energy was founded by the U.S. government (Cassidy 2003). Eventually, the Colorado organization later became known as the National Renewable Energy Laboratory, whose research focused on energy technologies.

As the U.S. began to establish itself within the green building arena, other countries were doing the same. Internationally, Germany, Malaysia and the U.K. were revolutionizing the movement with prefabricated energy-efficient wall systems, water-reclamation systems, and modular construction units that reduced construction waste (Cassidy 2003). Also, the Scandinavian government passed legislation for workspaces that set minimums for occupant access to daylight and operable windows (Cassidy 2003). Further international movement was coming from the UN World Commission on Environment and Development. The commission formally defined the term *sustainable development* as that which “meets the needs of the present without compromising the ability of future generations to meet their own needs,” (Cassidy 2003, pg. 5). The need for this formal definition proves the growing importance of the green building movement.

Organizations began to publish material about the growing movement. In 1992, a guide to building products based on life cycle analysis was published called the AIA Environmental Resource Guide. Together, COTE and the AIA Scientific Advisory Committee on the Environment received funding from the Environmental Protection Agency to compile this list of product evaluations (Cassidy 2003). This was the first assessment guide in the U.S. to be based on life cycle analysis. This new tool forced product manufactures to at least consider more environmentally friendly practices. Later that year, in Rio de Janeiro, the UN Conference on Environment and Development attracted one hundred and seventy-two government representatives and two thousand and four hundred representatives from other organizations (Cassidy 2003). Also known as Earth Summit, this conference passed Agenda 21, which contained statements on forest principals, climate change, biodiversity, and other topics regarding global sustainability (Cassidy 2003). This document became known as the Rio Declaration on Environment and Development. With the momentum from the Earth Summit, sustainability was the chosen theme of the 1993 UIA/AIA World Congress of Architects in Chicago. This resulted in the signing of the Declaration of Interdependence for a Sustainable Future (Cassidy 2003). Dubbed the Architecture at the Crossroads convention, this event and its declaration was a monumental milestone for the green building movement.

The movement had garnered so much merit that the federal government began participating in a major way. On Earth Day in 1993, the greening of the White House was the first of many federal buildings to join in the movement. To begin, The Department of Energy and the Environmental Protection Agency conducted an energy

audit on the two hundred year old building. Also, almost one hundred environmentalists, design professionals, engineers, and government officials participated in several design charettes to come up with energy efficient alternatives by using off-the-shelf technologies (Cassidy 2003). After three years of constructing, renovating, and remodeling, the White House ended up saving three hundred thousand dollars worth of energy and water savings, landscaping expenses, and solid waste costs annually (Cassidy 2003). Furthermore, the residence reduced its atmospheric emissions by eight hundred and forty-five tons of carbon per year (Cassidy 2003).

Many other government buildings and organizations followed suit after the greening of the White House. Similar actions were taken in regard to the Pentagon, the Presidio, and fittingly the U.S. Department of Energy Headquarters as well as the Grand Canyon, Yellowstone, and Denali national parks (Cassidy 2003). Meanwhile, historical green legislation was being passed by the current president.

As soon as the idea about greening the White House became a reality, President Clinton issued Executive Order 12852, which established the President's Council on Sustainable Development. This council consisted of twenty-five people, each of whom was experienced in industrial, environmental, governmental, or not-for-profit organizations, whose function was to advise the president on sustainable development (Exec. Order No. 12852 1993). With the release of a final report in 1999, the council's work was over. The report described one hundred and forty actions that would improve the nation's environment; many of which were related to building sustainability (Cassidy 2003).

Right before the Council on Sustainable Development released its findings, President Clinton was making plans to pass a series of green legislative proceedings. Between 1998 and 2000, Clinton issued three executive orders that helped continue the green movement. The first was entitled Executive Order 13101, *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition*. It stated that every executive agency must incorporate a waste prevention and recycling plan and help expand the market of environmentally preferred products, including building materials (Exec. Order No. 13101 1998).

The second was entitled Executive Order 13123, *Green the Government Through Efficient Energy Management*. It stated that it will promote energy efficiency, water consumption, and the use of renewable energy products, and help foster markets for emerging technologies through the design, construction, and operation of federal buildings (Executive Order 13123 1999). Years later in 2007, the existing goals of this order were strengthened and the scope was extended to include transportation (Executive Order 13423 2007).

The third was entitled Executive Order 13148, *Greening the Government Through Leadership in Environmental Management*. It stated that environmental accountability must be incorporated into the daily decision making and long term planning processes of all government agencies (Executive Order 13148 2000).

As time went on, many other government agencies continued to take on pilot projects similar to what the White House underwent. The General Services Administration greened a Federal Courthouse in Denver and the Environmental Protection Agency greened Research Triangle Park in North Carolina. Also, the Navy

boldly took on eight greening projects, one of which included the Naval Facilities Engineering Command headquarters at the Washington Navy Yard. The results involved reducing energy consumption by 35% with an annual savings of fifty-eight thousand dollars on a one hundred and fifty-six thousand square foot structure that was one hundred and fifty years old (Cassidy 2003). As a result of the presidential orders describe above, by 2005, organizations such as the Department of Health and Human Services, Department of State, Environmental Protection Agency, National Park Service, and the Army, Navy, and Air Force were all major participants in the green building movement (Adler et al. 2005).

Internationally, the movement continued to grow. In 1998, the Green Building Challenge held its first conference in Vancouver, British Columbia. The challenge was to create an international assessment tool that addresses the Triple Bottom Line: regional and national environmental, economic, and social equity conditions (Cassidy 2003). The first conference attracted representatives from fourteen countries: Austria, Canada, Denmark, Finland, France, Germany, Japan, the Netherlands, Norway, Poland, Sweden, Switzerland, the U.K., and the U.S. (Cassidy 2003).

As this narrative reaches the recent past, a more detailed examination of the different areas of the green building movement is required. Therefore, separate sections have been created to discuss building assessment systems and green building legislation throughout the U.S.

Building Assessment Systems

Building assessment systems determine the sustainability of a building's design, construction, and operation by rating it according to different criteria. All assessment systems have differences among them; however, for the most part they are very similar.

Some of the general areas that are considered are environmental impacts, resource consumption, and occupant health. The environmental effects can be evaluated at several different scales: locally, regionally, nationally, and globally (Kibert 2008). The resource consumption can be measured in several different units: mass, energy, volume, parts per million, density, and area (Kibert 2008). The health of the building is determined by the amount of chemicals and biological substances in relation to circulating air. The anticipated health and well being of the occupants is also evaluated.

LEED

The first building assessment program to be developed and implemented in the U.S. was founded by the United States Green Building Council (USGBC) in 1998. The USGBC is a non-profit, non-governmental organization whose members consist of people from industry, academia, and government as well as other public and private sector organizations (Kibert 2008). LEED's mission is to encourage and accelerate a global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria (USGBC 2010).

The first version of LEED, which is now called LEED-New Construction 3.0, was originally developed for office buildings, but is now used for all types of buildings. In response to its popularity, the USGBC has developed an entire suite of rating systems that apply to specific types of projects:

- LEED-EB: Existing Buildings Operations
- LEED-CI: Commercial Interiors Projects
- LEED-CS: Core and Shell Projects
- LEED-H: Homes
- LEED-ND: Neighborhood Development

Also, the USGBC has created application guides for use on specific building types within each LEED product (e.g., healthcare facilities, lodging, volume building programs, multifamily residences, campuses, retail stores, and laboratories) (Kibert 2008).

As of 2009, the majority of LEED certified projects are earned under LEED for New Construction (LEED-NC), while LEED for Commercial Interiors (LEED-CI) holds the second largest amount of registered projects (Fuerst 2009). Within the LEED-NC 2.2 product, there are six categories with sixty-nine total possible points. As shown in Table 2-1, the categories are Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation and Design Process. Lastly, as shown in Table 2-2, the level of certification is dependent on the number of points earned. The possible ratings are Certified, Silver, Gold, and Platinum.

Green Globes

Created by the Green Building Initiative (GBI), it is a variation of the Canadian certification called The Building Research Establishment Energy and Environmental Assessment Method, which is abbreviated as BREEAM (Smith et al. 2006). According to the same source, Green Globes aims to satisfy some of the criticisms of the LEED process; meaning that it is more flexible, user friendly, and inexpensive. Also, in 2005, the GBI was accredited as a standards developer by the American National Standards Institute (ANSI). This made them the first green building organization to obtain an accreditation of this type and the GBI subsequently began establishing Green Globes as an official ANSI standard (Kibert 2008).

The rating levels range from one to four Green Globes, which is dependent on the percentage of points that the project achieves out of a maximum of one thousand

possible points. The categories within the rating system are Energy, Indoor Environment, Site, Water, Resources, Emissions, and Project/Environmental Management. Both of these Green Globe characteristics are shown in Table 2-3 and Table 2-4.

Foreign Building Assessment Systems

LEED and Green Globes are predominately used in North America. However, throughout the world, other countries have developed their own rating system. Some of the more popular ones are BREEAM, Green Star, CASBEE, and BCA Green Mark Scheme.

Building Research Establishment Environmental Assessment Method (BREEAM) was implemented in 1988 by the Building Research Establishment (BRE) in the United Kingdom. This building assessment system has been around the longest and according to Kibert (2008), prior to the existence of LEED, BREEAM was the most successful system. As stated on their website, BREEAM is available in the U.K., the Gulf, and Europe. With over one hundred and ten thousand buildings certified and over five hundred thousand registered, it is the most widely used green building assessment method (BREEAM 2009).

Green Star was implemented in 2003 by the Green Building Council of Australia (GBCA). It covers the same fundamental areas that LEED and BREEAM cover and similarly, it has specific products for different types of projects. For example, there are tools for education, healthcare, multi-unit residential, industrial, office, office interiors and retail projects (BGCA 2010). Also, the GBCA is currently in the process of developing different tools for each phase of the building's life cycle. Currently, office

design is in its second version while convention centre design is it its pilot stage (BGCA 2010).

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was implemented in 2001 by the Japan Green Build Council (JaGBC) and the Japan Sustainable Building Consortium (JSBC). New Construction, Existing Buildings, and Renovation are three assessment tools that are currently being implemented on office, residential, academic, industrial, and governmental buildings throughout Japan and Asia (CASBEE 2009). They also have a pre-design tool; however it is still under development. Lastly, they have created areas of concentration that can be applied to each of the tools. For instance, there are options that address heat island effect and regional impact specifically (CASBEE 2009).

Green Mark Scheme was implemented in 2005 by the Building and Construction Authority (BCA) of Singapore. The Green Mark Scheme offers many of the same tools as the other assessment systems; however, it does explore some new areas. There are tools for new and existing parks, infrastructure, and district projects (BCA 2006).

Green Legislation

Presently, more than fifty cities and several states across the country have mandated standards based on the LEED rating system (Fuerst 2009). Some of the major municipalities include Atlanta, Austin, Boston Boulder, Chicago, Dallas, Los Angeles, Portland, San Diego, San Francisco, San Jose, and Seattle (City of New York 2005). Some of the states include California, Connecticut, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island (City of New York 2005).

Washington D.C.

The Green Building Act of 2006 made Washington D.C. the first major U.S. city to require private projects to earn LEED certification. The act incorporated high-performance building standards into the current local building codes by mandating several LEED products and ENERGY STAR. The goals of this act were:

> To establish high-performance building standards that require the planning, design, construction, operation, and maintenance of building projects; to establish a green building incentives program that includes an expedited construction documents review program; to establish a Green Building Fund, and to establish the Green Building Advisory Council; to amend the Construction Codes Approval and Amendments Act of 1986 to provide for the revision of the Construction Codes and to include green building practices; and to amend the Office of Property Management Establishment Act of 1998 to require priority leasing of buildings that meet certain green building standards. (District of Columbia 2006, pg. 1)

In summary, this act aimed to create a comprehensive green building standard that would alter the building codes and property management laws. It also includes the establishment of an advisory council that, among other things, manages the process, the funds, and the incentive program.

New York City

In 2005, New York City passed Local Law No. 86, which basically required all projects that are paid for in whole or in part by the city treasury to be LEED certified. Because most of their electricity is produced locally, the goal of this regulation was to reduce local emissions of sulfur dioxide, nitrogen oxide, carbon dioxide, mercury, and particulate matter as well as reduce their dependence on “dirty, inefficient power plants…and foreign oil” (City of New York 2005, pg. 1).

This legislation was not New York’s first step toward green building. Certain government departments were already implementing green building practices prior to

the Local Law 86 (e.g., the Battery Park City Authority, the Department of Design and Construction, the New York City Transit Authority, the Lower Manhattan Development Corporation, and the Port Authority of New York and New Jersey). This involved green building guidelines for all residential and commercial construction in Battery Park and all new transit facilities and libraries throughout the city. “Environmental planning” was even designated as one of the five general requirements for the World Trade Center site (City of New York 2005).

> Each capital project with an estimated construction cost of two million dollars ($2,000,000) or more…shall be designed and constructed to comply with green building standards not less stringent than the standards prescribed for buildings in accordance with the LEED green building rating system to achieve a LEED silver or higher rating, or, with respect to buildings classified in occupancy groups G or H-2, to achieve a LEED certified or higher rating. (City of New York 2005, pg. 4-5)

According to Kibert (2008), these are the goals of high-performance buildings according to the City of New York Department of Design and Construction:

- Raise expectations for the facility’s performance among the various participants.
- Ensure that capital budgeting design and construction practices result in investments that make economic and environmental sense.
- Mainstream these improved practices through (1) comprehensive pilot high-performance building efforts and (2) incremental use of individual high-performance strategies on projects of limited scope.
- Create partnerships in the design and construction process around environmental and economic performance goals.
- Save taxpayers money through reduced energy and material expenditures, waste disposal costs, and utility bills.
- Improve the comfort, health, and well-being of building occupants and public visitors.
- Design buildings with improved performance, which can be operated and maintained within the limits of existing resources.

- Stimulate markets for sustainable technologies and products. (Kibert 2008)

Gainesville

In 2002, Florida adopted its first green building assessment tool via an ordinance called the Gainesville Green Building (GGB) program. The GGB program utilizes LEED on institutional and commercial buildings and it utilizes Green Home Designation Standard from the Florida Green Building Coalition for residential buildings. The program is required for all city-owned civic and office buildings; however, it is optional for city-owned residential buildings. It is also optional for private sector commercial and residential projects. However, as encouragement for voluntary participants, the ordinance includes an incentive program.

For all projects participating, both mandatory and voluntary, building permits will be fast tracked and the permitting fee will be reduced by 50% while funds are available (City of Gainesville 2002). The money that is saved from the permitting fee is usually enough to pay for the green building certification fee. Therefore, it does not have to come out of the developer's original funds. However, in order to receive these incentives, the project must be certified by an independent third party. The program also offers incentives through website and press release marketing and by erecting participation signage at the jobsite. Lastly, an annual award is issued to one participant in each category that exemplifies commitment to the program (City of Gainesville 2002).

As mentioned above, this was the first green building assessment tool to be adopted by Florida. It proved to be very influential because almost two and a half years after Gainesville passed its GGB program, the city of Sarasota passed its own green building code. Except for a few changes in declaration in order to meet the needs of the city, the language of Sarasota's legislation was almost identical to Gainesville's.

LEED Investment Trends

As the green building movement continues to gain momentum throughout the world and specifically in this country, it is receiving more and more media coverage. However, despite the relatively fast growth rate and the general perception of the publicity, buildings that have earned a green building certification actually hold an insignificant portion of the overall commercial real estate market (Fuerst 2009). As described above, more and more federal, state, and local governments continue to mandate green standards into their building codes and legislation. Regardless of the hype or the regulation, the current numbers prove that certified green buildings actually make up much less than 1% of the overall market (Fuerst 2009). This section of the research studies the recent history of LEED investment trends in an attempt to draw clues about what to expect from future development.

As described earlier in this chapter, the USGBC has four different products within the LEED program. Figure 2-1 shows the distribution of shares that each of these products possess. By far, New Construction is the most popular with 67% of the LEED market, followed by Commercial Interiors holding 21% of the shares. Lastly, Core and Shell and Existing Buildings hold equal amounts of the remaining 12% of LEED certified buildings. Fuerst (2009) points out that when one considers the amount of effort that is devoted to climate change, it is interesting that existing building only make up about 6% of all projects. However, Yudelson (2008) speculates that this is due to the investment cost of the certification process combined with the potential for modifications. Furthermore, when renovating or remodeling an existing building there is a relatively limited scope when compared to new construction (Yudelson 2008).

Regardless of which LEED product is chosen, there are four different levels of certification that a building can earn: Certified, Silver, Gold, and Platinum. Figure 2-2 shows that as of 2009, Certified, Silver, and Gold hold about the same percentage of buildings, with only about 5% earning Platinum. Recently, an empirical study was conducted to determine if there is a correlation between certification level and energy consumption. After studying one hundred LEED certified buildings, Newsham et al. (2009) discovered that there was in fact a correlation; however it was very weak. It was also determined that about one-third of the LEED certified buildings used more energy than comparable non-certified buildings (Newsham et al. 2009).

Additional observations can be made when studying the certification level compared to the number of credits achieved. Figure 2-3 shows that there is not an even distribution of credits across the levels of certification. In fact, there is tendency for projects to earn fewer credits as they approach the upper limits of the certification level. Fuerst (2009) made two assumptions about this data. One possible explanation is that the organization seeking certification takes the easiest and most inexpensive route possible in order to obtain the desired level. Another possible explanation is that at some point during the certification process, the organization discovers that the next level is achievable and therefore they invest additional funds so as not to “waste” any points between certification levels. However, Fuerst (2009) admits that further research between investment and certification level could yield other possibilities.

Over the years, LEED has been criticized for the reported lack of improvement that the lower levels of certification actually have on environmental factors; especially in relation to the level of certification (Fuerst 2009). In response to these criticisms, it has

been said that the USGBC has raised the bar in regard to the environmental performance standards. With this in mind, the data in Figure 2-4 shows a steady decrease in the number of LEED projects earning the Certified level from 2000 to 2008. At the same time, the amount of Gold and Silver certified buildings increased while Platinum has remained steady. Fuerst (2009) suggests this could indicate a lower public acceptance of “barely green” buildings and/or organizations are showing more green ambition.

The figure discussed in the previous paragraph describes the proportional distribution of the levels of certification. A different appreciation can be gained when absolute numbers are applied to same eight year time span. Based on the information in Figure 2-5, Fuerst (2009) makes the following statement:

> A possibly important clue for the future of development of eco-certification for buildings is the fact that the current recession, which according to most sources began around December 2007, has no visible impact on the exponential growth of building certification. (Fuerst 2009, pg. 291)

However, due to the fact that some projects may have already been in progress when the recession hit, he goes on to state that it may be too early to extrapolate this data with a strong sense of confidence.

Some critics believe that the green building certification market could not survive without the legislation and incentives from the private sector (Fuerst 2009). When studying the clients seeking LEED certification in Figure 2-6, it is apparent that the amount of private developers and corporate clients has been increasing a significant amount in the last eight years. Fuerst (2009) believes this data indicates that an increasing number of private organizations are viewing LEED as a valuable investment.

Characteristics of a Construction Project

This study identified several green building project characteristics that cause time and money issues for the contractor. The overall structure of the characteristics was adapted from James Diekmann and Matthew Girard (1995). Their work sought to identify several project characteristics that were thought to have an effect on the potential for disputes to arise. These project characteristics were used to determine if some construction projects are more prone to contract disputes than others. Diekmann and Girard's (1995) project characteristics are described below. The reason this information is included in the literature review is because it was influential in the development and design of this green building survey and research.

People

The people aspects are noted to be extremely important due to the number of organizations, relationships, roles and responsibilities involved in the building process. "Do the organizations involved have the personnel resources to manage the process adequately and … in a cooperative manner?" (Diekmann and Girard 1995, pg. 355). The people aspect, which is divided into three sections, is illustrated in Figure 2-7.

Within the contractor and owner sections, *Capable Management* is the upper management who are responsible for the success of the project via a home-office or corporate level that they have long-term obligations. *Effectiveness of Responsibility* is the internal structure of the people who are responsible for making decisions. *Experience with that Type of Project* deals with the entire organization's experience with similar projects' as oppose to the individuals experience. *Success of Past Projects* is defined as the data from measurable project outcomes though analyzing schedules, budgets, quality, and disputes on previous projects. *Experience and Competence* deals

with individuals that actually manage the construction of the project (e.g., project managers, project engineers, superintendents). *Motivation* considers the individual's reasoning behind being motivated to avoid and resolve disputes; whether it is direct, tangible, and/or personal. *Interpersonal Skills of the Individuals* is described as the training and the types of experiences that these skills have evolved from (Diekmann and Girard 1995).

Within the business relationship section, *Team Building* deals with the effort put forth by each party to approach the endeavor as a team. *Working History* is defines the history of the two organizations. *Power Balance* considers the financial, experiential, and technical power of one party over the other during a dispute. *Expectations of Further Work* describes how organization can affect how disputes are actually handled (Diekmann and Girard 1995).

Project

The project aspect considers the degree of technical complexity of the project. Once the project is defined in the plans and specifications it cannot be substantially changed. It is said by the authors that, because of this fact the project characteristics provide lesser opportunities to improve dispute performance. This aspect is divided into two categories, which is illustrated in Figure 2-8.

Within the internal variables, the *Environmental Issues* indicate the importance of environmental regulations related to the project. *Public Interference* defines who will be impacted by the project. *Site Limitations* measure the actual boundaries of the project site. *Remoteness of the Project* is measured by the availability of adequate materials and technical expertise. Lastly, *Availability of Capable Craftsmen and Subcontractors* takes into account the ability of these local trades (Diekmann and Girard 1995).

As for the external variables, *Pioneer Project* measures the precedence of the technology used in this project and the degree of innovation. On the other hand, *Design Complexity* deals simply with the complexity of the design and the *Construction Complexity* deals simply with the complexity of the construction. Lastly, the *Size* is measured in terms of the estimated contractual amount (Diekmann and Girard 1995).

Process

The process issues include exactly how the project is executed. Some of the types of activities that are involved in this phase of the project are planning, financing, scope, obligations, risk allocation, administration procedures, quality of construction documents, and dispute mitigation techniques. The process aspect is divided into two branches, which is illustrated in Figure 2-9. Pre-construction planning identifies the issues that are dealt with before the contract is actually signed. Construction contract actually defines the signed agreement between the owner and the contractor.

The first factor under pre-construction planning is *Input from all the Groups Involved*, which includes the information about planning activities that must be shared with all parties. The next one is *Financial Planning*, which considers financial support and planning in relation to anticipating cost growth, change orders, and contingency. *Permits and Regulations* is a measure of the efficiency while executing the permit process. *Scope Definition* indicates how well the owner defined the scope (Diekmann and Girard 1995).

Within the construction contract, *Realistic Obligations* measure how practical and achievable the requirements are for the project. *Risk Identification and Allocation* decides if the risk was accurately identified and then allocated appropriately. *Adequacy of Technical Plans and Specifications* measures the quality of the documents in regard

to completeness, clarity, errors, and omissions. *Formal Dispute Resolution Process* measures how well the contract creates guidelines for resolution of disputes. Lastly, *Operating Procedures* measure how well these procedures are outlined and described in the contract documents (Diekmann and Girard 1995).

Table 2-1. Maximum Points within each LEED Category

LEED-NC 2.2 Category	Maximum Points
1. Sustainable Sites	14
2. Water Efficiency	5
3. Energy and Atmosphere	17
4. Materials and Resources	13
5. Indoor Environmental Quality	15
6. Innovation and Design Process	5
Total Possible Points	69

Table 2-2. Points Required for LEED-NC 2.2 Certification Level

LEED-NC 2.2 Certification Level	Points Required
Platinum	52-69
Gold	39-51
Silver	33-38
Certified	26-32
No Rating	25 or less

Table 2-3. Maximum Points within each Green Globe Category (Kibert 2008)

Green Globe Category	Maximum Points
Project Management	50
Site	115
Energy	300
Water	100
Resources, Building Materials, and Solid Waste	100
Emissions and Effluents	75
Indoor Environment	200
Total Possible Points	1000

Table 2-4. Percentage Required for Green Globe Certification Level (Kibert 2008)

Percentage Required	Certification Level	Description
85-100%	4 Green Globes	Reserved for select building designs which serve as national or world leaders in energy and environmental performance. The project introduces design practices that can be adopted and
70-84%	3 Green Globes	Demonstrates leadership in energy and environmental design practices and a commitment to continuous improvement and industry leadership
55-69%	2 Green Globes	Demonstrates excellent progress in achieving eco-friendly results through current best practices in energy and environmental design.
35-54%	1 Green Globe	Demonstrates movement beyond awareness and commitment to sound energy and environmental design practices by demonstrating good progress in reducing environmental impacts

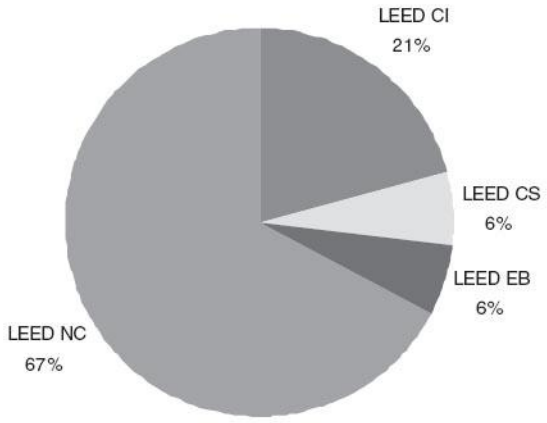

Figure 2-1. Share of LEED rating systems in all registrations (as of March 2009) (Fuerst 2009)

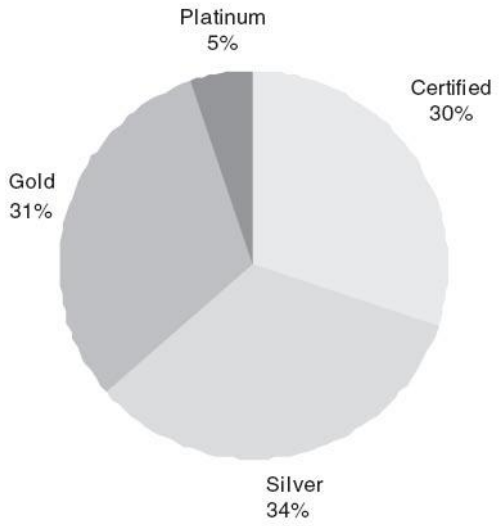

Figure 2-2. Achieved levels of LEED certification (as of March 2009) (Fuerst 2009)

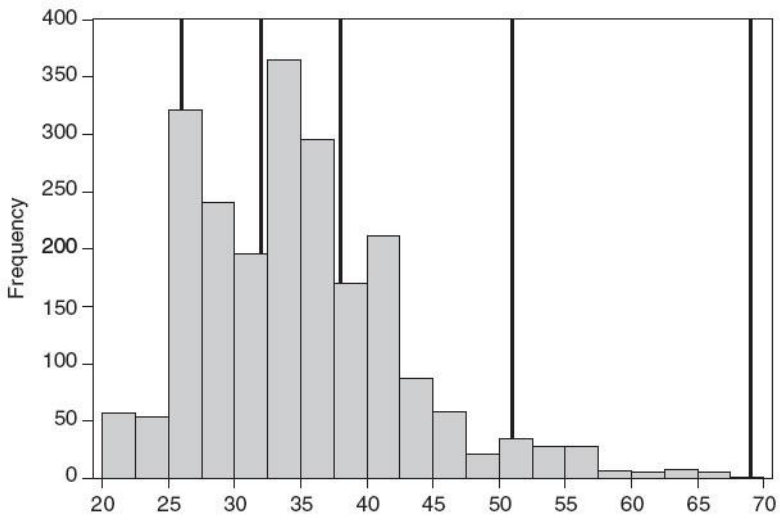

Figure 2-3. Distribution of credits achieved and certification levels (as of March 2009) (Fuerst 2009)

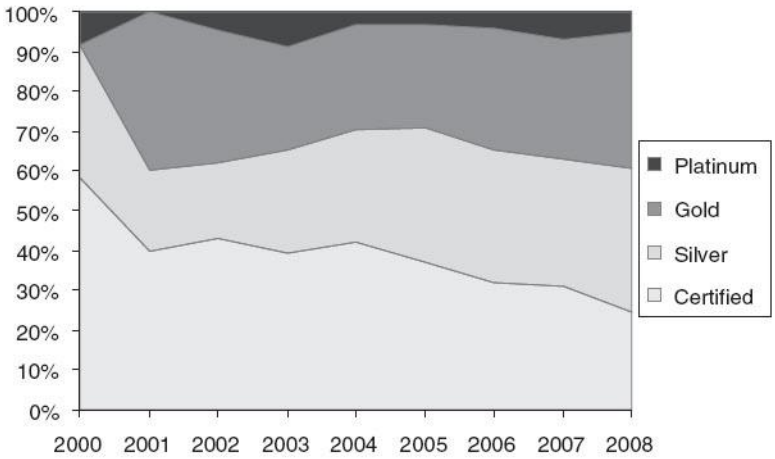

Figure 2-4. Distribution of certification levels 2000-2008 (Fuerst 2009)

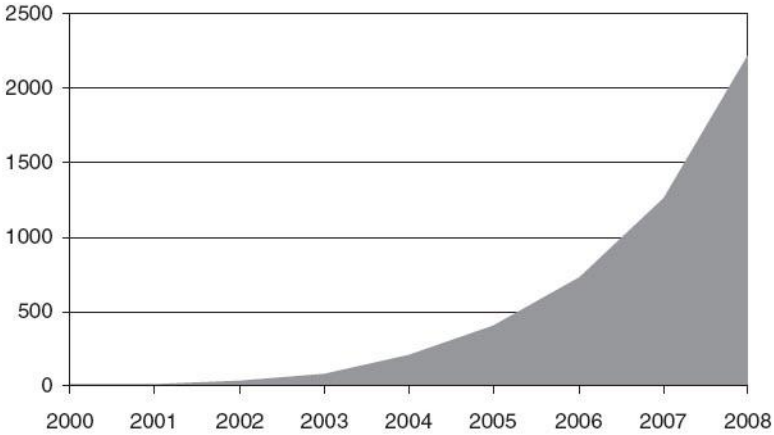

Figure 2-5. Number of certified LEED buildings (2008) (Fuerst 2008)

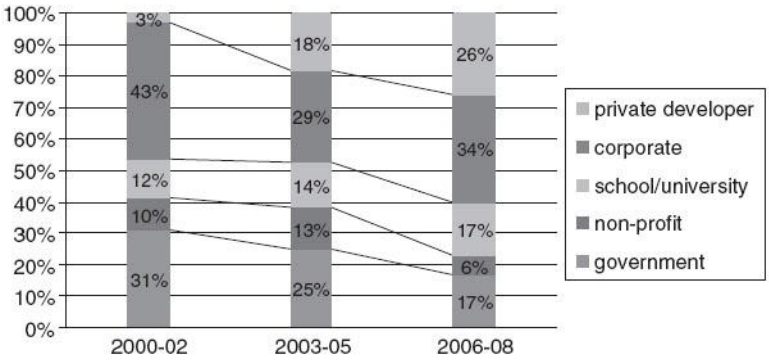

Figure 2-6. The changing composition of organizations and companies seeking LEED certification (Fuerst 2009)

People		
Contractor	**Business Relationship**	**Owner**
Capable Management	Team Building	Capable Management
Responsibility Structures	History Together	Responsibility Structures
Experience w/type Project	Power Balance	Experience w/type Project
Success of Past Projects	Expectations of Further Work	Success of Past Projects
Experience/Competence		Experience/Competence
Motivation		Motivation
Interpersonal Skills		Interpersonal Skills

Figure 2-7. People aspect of construction project characteristics from Diekmann and Girard (1995)

Project	
External	**Internal**
Environmental Issues	Pioneer Project
Public Interference	Design Complexity
Site Limitation	Construction Complexity
Remoteness	Size
Availability of Capable Craftsmen and Subcontractors	

Figure 2-8. Project branch of hierarchy from Diekmann and Girard (1995)

Process	
Pre-Construction Planning	**Construction Contract**
Realistic Obligations	Input from All Groups Involved
Risk Identification/Allocation	Financial Planning
Adequacy of Technical Plans/Specifications	Permits and Regulations
Formal Dispute Resolution Process	Scope Definition
Operating Procedures	

Figure 2-9. Process branch of hierarchy from Diekmann and Girard (1995)

CHAPTER 3
SURVEY DESIGN AND METHODOLOGY

Sample Selection

The objective of this study was directed towards contractors and subcontractors; therefore the sample population was contractors and subcontractors. To obtain information from various perspectives, the sample selection consisted of small to large companies and the targeted individuals ranged from upper management and project managers to superintendents and craftsmen. Both the companies and the individuals possessed varying degrees of green building experience. Therefore, the data was collected from both novices and experts within the green building arena.

Survey Design

As stated in Chapter 2, a study conducted by Diekmann and Girard (1995) sought to identify several project characteristics that were thought to have an effect on the potential for disputes to arise. The overall structure of the project characteristics (People, Project, Process) and the general design and development of the survey for this green building research was adopted from the Diekmann and Girard research. The overall structure of the green building factors is shown in Figure3-1.

Other than demographics, the survey contained three main sections: People, Project and Process. Within these sections, a total fourteen green building factors were defined; each of which was assigned a question that was designed to gather information about the importance of each factor's occurrence in regard to issues. Within the realm of this study, an "issue" was any unplanned loss of time and/or money that the contractor suffered, specifically due to a green building practice. The instructions to the survey read as follows:

> The following 14 questions ask whether a specific green building factor hindered the contractor in completing a project ON TIME and ON SCHEDULE. Please answer the questions from the perspective of individual projects, as opposed to your overall career experience in general.
>
> For example, assume you have worked on 10 separate green building projects. If, "Factor X" played a "very important" role in 2 projects, but in the other 8 projects it had "no effect", then please answer accordingly.

In other words, each individual respondent was asked to account for every single green building project he/she had ever been involved with. Therefore, the maximum amount of information was gathered from each respondent. Some respondents represented a single project while other respondents represented several projects.

A five point Likert Scale was used to rate each factor's importance. To avoid forcing false information out of the respondent, a sixth option of "not sure" was added as a choice. The six choices were: not sure, no effect, fairly important, important, very important, and critically significant.

People

Considering the number of individuals that are involved in a construction project and the fact that they must work together to manage and control the constantly changing conditions of the project, people can be considered the foundation of the entire endeavor. The people aspect of the survey considers the role of the contractor's employees throughout the green building process.

Upper Management was defined as the group of individuals at the highest level of management within the organization. This includes any personnel at a home office or corporate level. The upper management does not focus on the daily activities of the project. Instead they are responsible for major financial and managerial decisions. Upper management can also be referred to as executive, corporate, or senior

management. *How significant was the upper management's role in regard to green building issues for the contractor?*

Project Manager was defined as the person who provides the general administrative direction for the project. This person is typically responsible for the overall performance of the project, which includes cost, schedule, quality, and project status. Among other things, this person oversees the operations of the superintendent and is responsible for maintaining the relationship between the contractor and the other parties involved in the project: owner, architect, engineer, subcontractors, and suppliers. *How significant was the project manager's role in regard to green building issues for the contractor?*

Superintendent was defined as the person responsible for all the field aspects of the project, which includes budget, schedule, quality, and performance. Among other things, this person plans and implements the construction means and methods, site utilization, job site office operation, and project closeout. The superintendent is also responsible for coordinating and supervising all trade and field personnel. *How significant was the superintendent's role in regard to green building issues for the contractor?*

Craftsman was defined as an employee of either the general contractor or subcontractor that is involved in the physical construction of the project. Some examples of this position include: plumber, electrician, carpenter, brick layer, painter, equipment operator, et cetera. *How significant was the craftsman's role in regard to green building issues for the contractor?*

Project

Another main aspect of this study is the project itself. This considers the variables that are related to the surrounding area where the project is located and the fundamental characteristics that are built into the project.

Green Building Materials was defined as any specified material that is used to satisfy a green requirement. An example of this would be Forest Stewardship Council (FSC) wood, low volatile organic compound (VOC) materials, solar panels, material containing recycled content, or low emissivity (low E) glass. *How much did the green building materials contribute to issues for the contractor?*

Before the next three factors are discussed, the difference between innovation and complexity must be clearly defined. Innovation refers to the introduction of new strategies and the precedence of that type of strategy. Complexity refers to the intricacies of the interconnected parts of a strategy. For example, the façade of the Notre Dame Cathedral is very complex; however, the design itself is several hundred years old, therefore it is not innovative. Likewise, a new type of drywall, which is able to be produced with 80% less energy than traditional drywall, is simply made of recycled material. Therefore, this is an innovative yet simple product.

Innovativeness of the Green Building Strategies is defined as new and cutting edge practices. This criterion does not consider the complexity of the project; it considers the precedence of this type of strategy. *How much did the innovativeness of the green building strategies contribute to issues for the contractor?*

Design Complexity of the green building strategies was defined as the intricacies of the interconnected parts of the design while the *construction complexity* of the green building strategies is defined as the intricacies of the construction process. The design

and construction are two different factors, both of which deal with complexity. *How much did the design complexity of the green building strategies contribute to issues for the contractor? How much did the construction complexity of the green building strategies contribute to issues for the contractor?*

Process

This is the last main aspect of the study and it contains two sub-sections. *Pre-Construction* considered the process that occurs before the contract between the owner and the contractor is signed while *Construction Contract* considered the process after the agreement is signed and how different factors are defined within it.

Pre-construction planning

Scheduling considered any issues that occur during the scheduling process or any issues that arise during the construction process that result from decisions that were made during the scheduling process. *How much did the scheduling of the green building strategies contribute to issues for the contractor?*

Estimating considered any issues that occur during the estimating process or any differences between the estimate and actual costs incurred due to a green building factor. *How much did the estimating of the green building strategies contribute to issues for the contractor?*

Construction contract

Scope Definition considered any ambiguity in the responsibilities of the parties involved in the green building process. For example, if a building is expected to earn a green building certification, and the contractor is solely responsible for energy commissioning, then these responsibilities should be clearly stated and described. Furthermore, in some cases a third party is responsible for energy commissioning. This

third party has no contractual relationship with the contractor; however, if they must coordinate and perform tasks together, the scope should define the relationship. *How much did the scope definition of the green building strategies contribute to issues for the contractor?*

Expectations considered the green building requirements of the contract to determine if these requirements are actually possible. An example can be illustrated by using the Waste Management credit from LEED-NC. The contract states that the existing structure must be demolished and 75% of the demolished material must be diverted from the landfill. If 75% of the material is not actually recyclable or otherwise divertible from the landfill, then this requirement is not realistic. *How much did the practicality of the green building obligations contribute to issues for the contractor?*

Technical Plans and Specifications were defined as the drawings and documents that describe what needs to be built. This factor deals with any errors or omissions in regard to these drawings and documents. *How much did the accuracy of the technical plans and specifications of the green building strategies contribute to issues for the contractor?*

Operating Procedures considered the requirements of the submittal and communication procedures that directly affect the green building certification. An example would be any issues that arise due to sample and cut-sheet submittals or the use of online up-loadable databases such as Project Management Information Systems (PMIS) or LEED Online. *How much did the operating procedures of the green building strategies contribute to issues for the contractor?*

Initial Data Analysis

In order to perform the initial analysis of the data, the mean of each factor was calculated by converting the five point Likert Scale into numerical values in which:

"no effect" = 1
"fairly important" = 2
"important" = 3
"very important" = 4
"critically important" = 5

The "not sure" choice was eliminated from analysis because it carried no statistical significance.

Once the mean was calculated, the green building factor with the largest mean value within its respective category of *People*, *Project*, and *Process*: *Pre-construction* and *Process*: *Contract* was selected for further analysis. The four green building factors that meet the selection criteria were then entered into a contingency table to depict the frequency and percentage of each occurrence. The data was organized as "Dependent Variable by Independent Variable" or more specifically, "Importance Rating by Green Building Factor". This created five rows down the side for the dependent variable and four columns across the top for the independent variable. That is, the four green building factors were entered across the top to create four columns and the five point Likert Scale was entered down the side to create five rows. It also included a "Total" column that depicts the sum of the columns and a "Total" row that depicts the sum of the rows.

Final Data Analysis

Lastly, the data from the contingency table was used to create a chi-square matrix work sheet, which was used to perform the chi-square test. This significance test was performed to determine if the collected data from the sample population was genuine

and therefore could be applied to the full population. If the test proves that there are no differences, then the null hypothesis can be accepted. However, if there are in fact differences, this is the indication of a sampling error; therefore, the collected data cannot be applied to the full population and the null hypothesis must be rejected.

Chi-squared formula:

$$X^2 = \sum [(f_o - f_e)^2 / f_e]$$

where

X^2 = chi-squared calculated
f_o = obtained frequencies
f_e = expected frequencies

The number calculated from the chi-square formula is referred to as X^2 calculated. The number from the chi-square statistical tables is referred to as X^2 table, which is determined from two pieces of information: the level of confidence and the degrees of freedom. The level of confidence used in this analysis was 95% because this is a commonly used value for statistical analysis. The degrees of freedom was calculated from a formula.

Degrees of freedom formula:

$$df = (r - 1)(c - 1)$$

where

df = degrees of freedom
r = number of categories of the dependant variable
c = number of categories of the independent variable

If X^2 calculated is less than X^2 table, the null hypothesis is rejected, however, if X^2 calculated is greater than X^2 table, the null hypothesis is accepted and the results can be applied to the full population.

People	**Project**	**Process**	
		Pre Construction	Contract
Upper Mgmt	Materials	Scheduling	Scope Definition
Project Manager	Innovation	Estimating	Expectations
Superintendent	Design Complexity		Plans and Specs
Craftsman	Construct Complexity		Operating Procedures

Figure 3-1. Structure of the green building project characteristics

CHAPTER 4
ANALYSIS AND RESULTS

As stated in the methodology section, the five point Likert Scale was converted from vocabulary terms into numerical values. Table 4-1 illustrates the frequency of occurrences for each of the fourteen green building factors. Note the numerical value assigned to each point of the Likert Scale. These values were used to calculate the mean of each green building factor occurrence, which is illustrated in Table 4-2. Based on the highest mean value within its respective category, four green building factors were selected for further analysis. The four factors that meet the selection criteria were *Project Manager, Materials, Estimating,* and *Operating Procedures*.

The four green building factors were entered into the contingency table depicted in Table 4-3. This table was used to create the data in the chi-squared matrix worksheet depicted in Table 4-4. The chi squared test yielded an X^2 calculated value of 110.554. With a degrees of freedom of 12 and a level of confidence of 95%, the X^2 table value was found to be 21.026. The X^2 calculated value was greater than the X^2 table, therefore, there were no differences and the null hypothesis was accepted.

This is a summery of the data described in the previous paragraph:

- X^2 calculated = 110.554
- Level of confidence = 95%
- Degrees of freedom = 12
- X^2 table = 21.026
- 110.554 > 21.026

Therefore the null hypothesis was accepted.

Further analysis was conducted in order to determine the statistical significance of each of the four green building factors on an individual basis. The chi-squared test was performed four additional times, once for each of the four factors. The confidence level

remained 95%, however the degrees of freedom was 5 since the input data differed. The X^2 calculated for *Project Manager, Materials, Estimating, Operating Procedures* were 39.696, 31.270, 22.024, and 17.561 respectively.

This is a summery of the data described in the previous paragraph:

- Level of confidence = 95%
- Degrees of freedom = 5
- X^2 table = 11.070
- Project Manager X^2 calculated = 39.696
- Materials X^2 calculated = 31.270
- Estimating X^2 calculated = 22.024
- Operating Procedures X^2 calculated = 17.561

Therefore, the null hypothesis was accepted for each green building factor on an individual basis.

Table 4-1. Frequency of occurrence of green building factors

Rating	Green Building Factor	1 no effect	2 fairly important	3 important	4 very important	5 critically significant
Q1	Upper Management	23	45	60	51	25
Q2	Project Manager	6	21	42	71	61
Q3	Superintendent	22	50	46	54	23
Q4	Craftsman	55	57	43	32	14
Q5	Materials	30	34	71	35	20
Q6	Innovation	43	44	55	48	11
Q7	Design Complexity	43	42	43	58	13
Q8	Construct Complexity	48	72	32	23	13
Q9	Scheduling	40	70	22	38	28
Q10	Estimating	4	56	47	53	40
Q11	Scope Definition	42	32	55	47	11
Q12	Expectations	26	44	67	22	25
Q13	Plans and Specs	22	51	60	29	25
Q14	Operating Procedures	26	32	52	61	15

Table 4-2. Mean and standard deviation values of green building factors

Rating	Green Building Factor	Mean	Std Dev	Chi-Sqrd
Q1	Upper Management	3.05	1.19	
Q2	Project Manager	3.80	1.08	x
Q3	Superintendent	3.03	1.21	
Q4	Craftsman	2.40	1.22	
Q5	Materials	2.90	1.19	x
Q6	Innovation	2.71	1.20	
Q7	Design Complexity	2.79	1.27	
Q8	Construct Complexity	2.37	1.19	
Q9	Scheduling	2.72	1.36	
Q10	Estimating	3.35	1.15	x
Q11	Scope Definition	2.75	1.23	
Q12	Expectations	2.87	1.21	
Q13	Plans and Specs	2.91	1.20	
Q14	Operating Procedures	3.04	1.18	x

Table 4-3. Contingency table: Importance rating by green building factor

	Project Manager		Materials		Estimating		Ops		Total	
	f	%	f	%	f	%	f	%	f	%
1	6	3%	30	16%	4	2%	26	14%	66	8%
2	21	10%	34	18%	56	28%	32	17%	143	18%
3	42	21%	72	38%	47	24%	52	28%	213	27%
4	71	35%	35	18%	53	27%	61	33%	220	28%
5	61	30%	20	10%	40	20%	15	8%	136	17%
Total	201	100%	191	100%	200	100%	186	100%	778	100%

Table 4-4. Chi-squared matrix worksheet: Importance rating by green building factor

	Project Manager		Materials		Estimating		Ops		Total
	f	f_e	f	f_e	f	f_e	f	f_e	
1	6	(17.1)	30	(16.2)	4	(17.0)	26	(15.8)	66
2	21	(36.9)	34	(35.1)	56	(36.8)	32	(34.2)	143
3	42	(55.0)	72	(52.3)	47	(54.8)	52	(50.9)	213
4	71	(56.8)	35	(54.0)	53	(56.6)	61	(52.6)	220
5	61	(35.1)	20	(33.4)	40	(35.0)	15	(32.5)	136
Total	201		191		200		186		778

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

Aim and Hypothesis

The aim of this study was to determine the relative importance of a set of criterion that create issues and have a negative effect on the contractor's cost and schedule, specifically because green building practices were involved. Furthermore, the null hypothesis stated that a common set of green building factors that have a negative impact on the contractor's cost and schedule exist. After completing a comprehensive literature review, conducting a survey on green building factors, and analyzing the data from the survey, the null hypothesis was accepted; therefore, the common set of green building factors does indeed exist: *Project Manager, Materials, Estimating,* and *Operating Procedures*.

Research Objectives

The research objectives were completed in two different phases of the research process. The first three objectives had to be satisfied before the survey design could be considered complete. The last two objectives could only be satisfied after the survey data was analyzed.

Pre Design Objectives:

- How can the contractor's entire construction endeavor be categorized in a manner that will help identify the root cause of a green building related issue?
- What types of green building related issues does the contractor encounter?
- Who or what causes the contractor to experience a green building related issue?

Firstly, the Diekmann and Girard (1995) study served as a foundation for the first three objectives and the overall structure of the survey. Their project characteristics were either modified as much as possible in order to satisfy the conditions of this study or

they were simply eliminated. The characteristics that were eliminated were developed from a combination of other sources encountered during the review of literature and from the personal experience of the researcher.

The contractor's entire construction endeavor was categorized in a manner that would determine the root cause of green building related issues. During this process, different types of green building related issues were identified and described, which includes the potential causes of these issues. The overall structure of the characteristics is depicted in Figure 5-1 while the detailed descriptions of the terms can be found in Chapter 3 and Appendix A of this document.

Post Analysis Objectives:

- Which factors involved in the construction process deserve the most attention in order to streamline the green building process for the contractor?
- What knowledge or experience is advantageous to a contractor that is entering into a green building contract?

After performing the statistical analysis described in Chapter 4, it was determined that the four green building project characteristics that deserve the most attention are *Project Manager, Materials, Estimating,* and *Operating Procedures*. All of the information found in this research would be advantageous to a contractor entering into a green building contract. However, the information that would be most valuable is the structure and characteristics of a green building project combined with the data found in Figure 5-2. With these two items combined, it would help the contractor think of the project in an organized and simplified manner and plan and perform accordingly once the data is applied.

Recommendations for Future Study

Under the circumstances of unlimited time and unlimited resources, this study could have explored many other possibilities. Below are some recommendations for future study on green building practices and the contractor.

Sample Characteristics

An increased sample size would obviously yield more accurate results when compared to the true population. However, various demographic characteristics would yield much more specific and thus valuable information. When considering the demographics of projects, further research could study public, private, commercial, and/or residential projects either individually or the differences and similarities among them. The same could be done with project size in terms of price or area. Another area that deserves more attention is the green building experience of individuals and/or companies. Identifying issues encountered by expert green builders and comparing them to novice mistakes on an individual and/or company wide basis would be extremely valuable information to the construction industry.

Survey Design

The survey for this study was inspired mainly from a literature review combined with a relatively small amount of real world experience with green building. A researcher with more construction experience, specifically pertaining to green building, could possibly design a much different approach to characterizing a green building project.

People	Project	Process	
		Pre Construction	Contract
Upper Mgmt	Materials	Scheduling	Scope Definition
Project Manager	Innovation	Estimating	Expectations
Superintendent	Design Complexity		Plans and Specs
Craftsman	Construct Complexity		Operating Procedures

Figure 5-1. Structure of the green building project characteristics

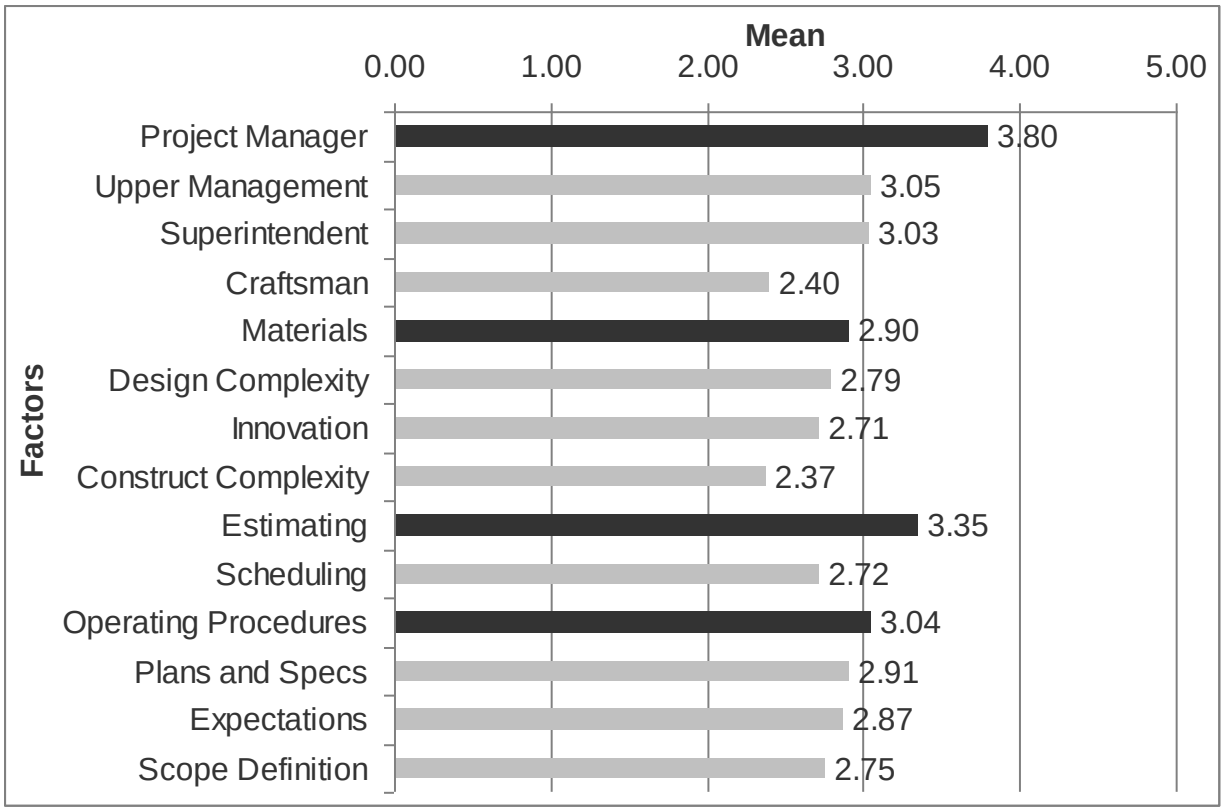

Figure 5-2. Mean value of green building factor from highest to lowest in each category

APPENDIX A
SURVEY

The Impacts of Green Building on the Contractor

Demographics

This survey is part of a thesis study that is required to earn the degree of Master of Science in Building Construction from the M.E. Rinker, Sr., School of Building Construction at the University of Florida.

The objective of this survey is to determine the relative importance of a set of 14 criterion that create ISSUES and have a negative effect on the contractor's COST and SCHEDULE, specifically because green building practices were involved.

1. What is you current job title?

- ◯ Upper-Management
- ◯ Estimator
- ◯ Scheduler
- ◯ Project Manager
- ◯ Superintendent
- ◯ Craftsman

Other (please specify)

2. How many years have you been working in the construction industry?

- ◯ Less than 5 years
- ◯ 5-10 years
- ◯ Over 10 years

3. Years of experience working on green buildings? (LEED projects or projects that incorporate green strategies)

	1	2	3	4	5	6	7	8	9	+10
You	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Your employer	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

4. How many green building projects have you worked on? (LEED projects or projects that incorporate green strategies)

	1	2	3	4	5	6	7	8	9	+10
You	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

The Impacts of Green Building on the Contractor

People Aspect

The following 14 questions ask whether a specific green building project factor hindered the contractor in completing a project ON TIME and UNDER BUDGET. Please answer the questions from the perspective of individual projects, as opposed to your overall career experience in general.

For example, assume you have worked on 10 separate green building projects. If, "Factor X" played a "very important" role in 2 projects, but in the other 8 projects it had "no effect", then please answer accordingly.

5. Upper Management: group of individuals at the highest level of management within the organization; also referred to as executive, corporate or senior management.

How significant was the upper management's role in regard to green building issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

6. Project Manager: person who provides the overall administrative direction for the project.

How significant was the project manager's role in regard to green building issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

7. Superintendent: person responsible for all field aspects of the project.

How significant was the superintendent's role in regard to green building issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

The Impacts of Green Building on the Contractor

8. Craftsman: person involved in the physical construction of the project.

How significant was the craftsman's role in regard to green building issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

The Impacts of Green Building on the Contractor

Project Aspect

9. Green building materials: any specified material that is used to satisfy a green requirement; For example: FSC wood, Low VOC, recycled content, solar panels, Low E glass.

How much did the green building materials contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

10. Innovation: introduction of new green building strategies and the precedence of this type of strategy. Not complex, rather cutting-edge.

How much did the innovativeness of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

11. Design complexity: intricacies of the interconnected parts of the design of the green building strategies.

How much did the design complexity of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

12. Construction Complexity: intricacies of the interconnected parts of the construction of the green building strategies.

How much did the construction complexity of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

The Impacts of Green Building on the Contractor

Process: Pre-Construction Planning

Thank you for participating, only 6 questions left.

13. Scheduling: any decisions that were made during the scheduling process regarding the green building strategies; For example, time.

How much did the scheduling of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

14. Estimating: any decisions that were made during the estimating process regarding the green building strategies; For example: costs.

How much did the estimating of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

The Impacts of Green Building on the Contractor

Process: Construction Contract

15. Scope Definition of Responsibilities: description of the green building responsibilities of the parties involved; For example: gaps or overlaps in responsibilities.

How much did the scope definition of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

16. Expectations: requirements of the contract; For example: practicality/feasibility of obligations.

How much did the expectations of the green building obligations contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

17. Technical plans and specifications: drawings and documents that describe what needs to be built; For Example: errors, omissions, changes.

How much did the technical plans and specifications of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

18. Operating procedures: requirements of the submittal and communication procedures; For example: Samples, Cut-Sheets, Project Management Information Systems (PMIS), LEED Online.

How much did the operating procedures of the green building strategies contribute to issues for the contractor?

	not sure	no effect	fairly important	important	very important	critically significant
-						

APPENDIX B
SURVEY RESULTS

What is you current job title?		
Answer Options	**Response %**	**Response Count**
Upper-	75.0%	27
Estimator	0.0%	0
Scheduler	2.8%	1
Project Manager	22.2%	8
Superintendent	0.0%	0
Craftsman	0.0%	0
Other (please specify)		2
answered question		**36**
skipped question		**2**

How many years have you been		
Answer Options	**Response Percent**	**Response Count**
Less than 5 years	5.3%	2
5-10 years	7.9%	3
Over 10 years	86.8%	33
answered question		**38**
skipped question		**0**

Years of experience working on green buildings? (LEED projects or projects that incorporate green strategies)											
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**+10**	**Response Count**
You	2	6	6	4	10	1	1	2	1	5	38
Your employer	0	2	1	3	6	5	0	3	1	13	34
										answered question	**38**
										skipped question	**0**

How many green building projects have you worked on? (LEED projects or projects that incorporate green											
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**+10**	**Response Count**
You	7	4	2	4	5	3	1	0	0	12	38
										answered question	**38**
										skipped question	**0**

Upper Management

not sure

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	20
-	2	2	0	1	0	0	0	0	0	1	6	

no effect

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	23
-	5	2	0	1	2	0	0	0	0	0	10	

fairly important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	45
-	4	2	2	1	2	0	1	0	0	1	13	

important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	60
-	1	1	1	3	1	0	1	0	0	3	11	

very important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	51
-	3	0	3	1	0	0	1	0	2	1	11	

critically significant

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	25
-	3	0	0	0	0	2	0	0	0	1	6	

	Question Totals	224
answered question	38	
skipped question	0	

Project Manager

not sure

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	22
-	2	0	0	0	0	0	0	0	0	2	4	

no effect

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	6
-	3	0	1	0	0	0	0	0	0	0	4	

fairly important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	21
-	4	1	0	0	3	0	0	0	0	0	8	

important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	42
-	3	1	1	1	0	0	0	0	0	3	9	

very important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	71
-	4	2	0	2	0	2	2	0	1	2	15	

critically significant

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	61
-	3	1	1	1	3	1	0	1	0	2	13	

	Question Totals	223
answered question	38	
skipped question	0	

Superintendent

not sure

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	26
-	2	0	0	1	0	0	0	0	0	2	5	

no effect

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	22
-	2	2	2	0	0	0	0	0	0	1	7	

fairly important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	50
-	4	1	1	0	3	1	0	0	0	2	12	

important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	46
-	3	1	0	0	1	0	1	0	1	2	9	

very important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	54
-	2	2	1	1	2	2	0	0	1	1	12	

critically significant

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	23
-	3	2	1	2	1	0	0	0	0	0	9	

	Question Totals	221
answered question	38	
skipped question	0	

Craftsman

not sure												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	26
-	2	0	0	1	0	0	0	0	0	2	5	

no effect												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	55
-	1	0	2	2	2	0	0	0	0	3	10	

fairly important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	57
-	2	2	1	1	3	2	1	0	0	1	13	

important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	43
-	3	1	1	1	1	1	0	0	0	2	10	

very important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	23
-	3	2	0	0	0	1	0	0	0	1	7	

critically significant												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	14
-	4	1	1	0	1	0	0	0	0	0	7	

	Question Totals	218
answered question	38	
skipped question	0	

Green building materials

not sure												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	20
-	3	1	0	0	1	0	0	0	0	1	6	

no effect												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	30
-	2	1	1	2	1	0	0	0	0	1	8	

fairly important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	34
-	4	1	0	0	1	1	1	0	0	1	9	

important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	72
-	2	1	2	1	0	2	1	0	1	3	13	

very important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	35
-	3	0	1	0	1	0	2	0	0	1	8	

critically significant												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	20
-	1	1	2	0	1	1	0	0	0	0	6	

	Question Totals	211
answered question	38	
skipped question	0	

Innovation

not sure												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	17
-	2	0	0	0	1	0	0	0	0	1	4	

no effect												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	43
-	4	1	1	2	2	1	0	0	0	1	12	

fairly important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	44
-	3	3	1	1	0	2	1	0	1	0	12	

important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	55
-	3	2	1	1	0	1	1	1	0	2	12	

very important												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	48
-	2	3	4	0	1	1	1	0	0	1	13	

critically significant												
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	11
-	1	2	2	0	0	0	0	0	0	0	5	

	Question Totals	218
answered question	38	
skipped question	0	

Design complexity

not sure											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 18
-	3	0	0	0	1	0	0	0	0	1	5

no effect											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 43
-	1	3	1	2	3	0	0	0	0	1	11

fairly important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 42
-	4	2	2	1	1	2	1	0	0	0	13

important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 43
-	2	1	2	0	1	2	0	2	0	0	10

very important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 58
-	3	3	2	0	0	1	1	0	0	3	13

critically significant											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 13
-	2	1	3	0	0	0	0	0	0	0	6

	Question Totals	217
answered question	38	
skipped question	0	

Construction Complexity

not sure											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 27
-	2	0	0	0	1	0	0	0	0	2	5

no effect											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 48
-	2	1	1	1	4	0	1	0	0	1	11

fairly important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 72
-	4	3	1	0	1	0	2	0	0	4	15

important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 32
-	4	0	2	0	0	2	0	0	0	1	9

very important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 23
-	4	1	0	1	0	1	1	0	0	0	8

critically significant											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 14
-	2	0	2	0	0	1	0	0	0	0	5

	Question Totals	216
answered question	38	
skipped question	0	

Scheduling

not sure											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 17
-	2	0	0	0	1	0	0	0	0	1	4

no effect											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 40
-	3	1	1	1	2	0	0	1	0	1	10

fairly important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 70
-	3	3	2	0	3	0	0	0	0	4	15

important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 22
-	3	3	1	0	2	0	0	0	0	0	9

very important											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 38
-	3	0	0	2	0	1	3	0	0	0	9

critically significant											
Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count 28
-	3	0	1	0	0	2	0	0	0	1	7

	Question Totals	215
answered question	38	
skipped question	0	

Estimating

not sure

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	17
-	2	0	0	0	1	0	0	0	0	1	4	

no effect

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	4
-	1	0	1	0	0	0	0	0	0	0	2	

fairly important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	56
-	0	2	1	1	1	1	2	0	0	2	10	

important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	47
-	1	2	1	1	3	0	0	0	0	2	10	

very important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	53
-	4	3	3	1	0	0	0	0	0	3	14	

critically significant

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	40
-	4	0	0	0	2	2	2	0	0	0	10	

	Question Totals	217
answered question	38	
skipped question	0	

Scope Definition of Responsibilities

not sure

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	27
-	2	0	0	0	1	0	0	0	0	2	5	

no effect

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	42
-	1	3	1	3	0	0	0	0	0	2	10	

fairly important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	32
-	3	1	1	1	2	0	0	0	0	1	9	

important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	55
-	3	2	2	0	1	0	1	0	0	3	12	

very important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	47
-	3	2	2	1	0	1	2	0	0	1	12	

critically significant

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	11
-	1	0	0	1	0	1	0	0	0	0	3	

	Question Totals	214
answered question	38	
skipped question	0	

Expectations

not sure

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	27
-	2	0	0	0	1	0	0	0	0	2	5	

no effect

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	26
-	2	3	0	2	0	0	0	0	0	1	8	

fairly important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	44
-	5	2	2	1	1	0	0	0	0	2	13	

important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	67
-	4	2	2	2	1	0	0	0	0	4	15	

very important

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	22
-	2	1	1	0	1	0	0	0	0	1	6	

critically significant

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	25
-	2	0	0	1	0	2	1	0	0	0	6	

	Question Totals	211
answered question	38	
skipped question	0	

Technical plans and specifications

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	
not sure												
-	2	0	0	0	1	0	0	0	0	2	5	27
no effect												
-	1	4	1	0	0	0	0	0	0	1	7	22
fairly important												
-	2	4	0	1	0	0	1	0	0	3	11	51
important												
-	1	2	2	1	3	0	0	0	0	3	12	60
very important												
-	6	0	1	0	0	1	2	0	0	0	10	29
critically significant												
-	3	0	2	0	2	1	0	0	0	0	8	25
											Question Totals	214
										answered question	38	
										skipped question	0	

Operating procedures

Answer Options	1 project	2 projects	3 projects	4 projects	5 projects	6 projects	7 projects	8 projects	9 projects	+10 projects	Response Count	
not sure												
-	2	0	0	0	1	0	0	0	0	2	5	27
no effect												
-	2	2	0	1	0	1	0	0	0	1	7	26
fairly important												
-	4	3	1	1	1	0	0	0	0	1	11	32
important												
-	1	0	2	2	0	2	1	1	0	1	10	52
very important												
-	5	1	3	0	1	0	0	0	0	4	14	61
critically significant												
-	3	0	0	0	0	2	0	0	0	0	5	15
											Question Totals	213
										answered question	38	
										skipped question	0	

LIST OF REFERENCES

Adler, A., Armstrong, J., Azerbegi, R., Guy, G., Fuller, S., Kalin, M., Karolides, A., Lelek, M., Lippiatt, B., Macalusa, J., Spencer, E., Waier, P., and Walker, A. (2006). *Green building: Project planning and cost estimating; A practical guide to: Materials, systems & standards; green products- specifying & assessing cost verse value; resource efficiencies, health, comfort & productivity; commissioning*, 2nd Ed., R.S. Means, Kingston, MA.

Assessment System for Building Environmental Efficiency (CASBEE). (2009). "An overview of CASBEE," Japan GreenBuild Council and Japan Sustainable Building Consortium, <http://www.ibec.or.jp/CASBEE/english/index.htm> (March 2010).

Building and Construction Authority (BCA). (2006). "About Green Mark Scheme." Building and Construction Authority, <http://www.bca.gov.sg/greenmark/green_mark_buildings.html> (March 2010).

Building Research Establishment Environmental Assessment Method (BREEAM). (2009). "BREEAM around the world." BRE Global Ltd., <http://www.breeam.org/page.jsp?id=135> (March 2010).

Cassidy, R. (2003). *White paper on sustainability: A report on the green building movement*, Reed Business Information, Building Design & Construction, Oakbrook, IL.

Diekmann, J., and Girard, M., (1995). "Are Contract Disputes Predictable?" *Journal Construction Engineering and Management*, ASCE, 121(4), 335-363.

District of Columbia. (2006). *Green building act of 2006*, Council of the District of Columbia, West Group Publisher, Washington, D.C., <http://rrc.dc.gov/green/lib/green/pdfs/GreenBuilding_act06.pdf> (April 2010)

Exec. Order No. 12852, 58 Fed. Reg. 124 (July 2, 1993)

Exec. Order No. 13101, 63 Fed. Reg. 179 (Sept. 16, 1998)

Exec. Order No. 13123, 64 Fed. Reg. 109 (June 8, 1999)

Exec. Order No. 13148, 65 Fed. Reg. 81 (April 26, 2000)

Exec. Order No. 13423, 72 Fed. Reg. 17 (Jan. 26, 2007)

Fuerst, F. (2009). "Building momentum: An analysis of investment trends in LEED and Energy Star-certified properties," *Journal of Retail & Leisure Property*, Palgrave Macmillian, 8(4), 285-297.

Gainesville, Florida. (2002). *Code of ordinances: Chapter 6 / Article 1.5 / Section 6-5 through 6-15; Gainesville green building program*, City of Gainesville, Gainesville, FL, <http://fyn.ifas.ufl.edu/materials/gainesville%20-%20greenbuildingprogram.pdf> (April, 2010)

GAS Public Buildings Service (2008). *Assessing green building performance: A post occupancy evaluation of 12 GSA buildings*, GSA Public Buildings Service, <http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/GSA_AssessGreen_white_paper_R2-p-q5Q_0Z5RDZ-i34K-pR.pdf> (October 2009).

Green Building Council of Australia. (2010). "Green star rating tools." Green Building Council of Australia, <http://www.gbca.org.au/green-star/rating-tools/> (May 2010).

Heschong Mahone Group. (1999). *Daylighting in schools: An investigation into the relationship between daylighting and human performance*, Heschong Mahone Group, Pacific Gas and Electric Company, <http://www.coe.uga.edu/sdpl/research/daylightingstudy.pdf> (October 2009).

Kats, G. (2003). *The costs and financial benefits of green buildings: A report to California's sustainable building task force*, Massachusetts Technology Collaborative, Westborough, MA.

Kibert, C. (2008). *Sustainable Construction: Green building design and delivery*, 2nd Ed., John Wiley & Sons, Inc, Hoboken, NJ.

New York, New York. (2005). *Local Law No. 86: To amend the New York city charter, in relation to green building standards for certain capital projects*, City of New York, New York, NY. <http://www.nyc.gov/html/dob/downloads/pdf/ll_86of2005.pdf> (April 2010)

Newsham, G., Mancini, S. and Birt, B. (2009). Do LEED-certified buildings save energy? Yes, but…. *Energy and Buildings*, Elsevier B.V., 14(8) 897-905.

United States Green Building Council (USGBC). (2010). "Welcome to USGBC." U.S. Green Building Council, <http://www.usgbc.org> (November 2009).

Watkin, D. (2005). *A history of western architecture*, 4th Ed., Watson-Guptill Publications, New York, NY.

Yudelson, J. (2008). *Green building through integrated design*, GreenSource Books, McGraw Hill, New York, NY.

BIOGRAPHICAL SKETCH

Michael Ryan McVinney graduated from Seabreeze High School in 2003 and immediately enrolled in classes at Daytona Beach Community College (DBCC). After his first semester, Michael was asked to be a member of the Mu Rho Chapter of the Phi Theta Kappa (PTK) Honor Society as he continued his education in advanced educational courses. In the summer of 2005 he began his first semester at the University of Florida's College of Design, Construction, and Planning School of Architecture. Michael eventually became obsessed with the notion of controlling people's thoughts, emotions, and functionality through properly designed occupiable space. This became his obsession until the summer of 2007 when he reached a moment of clarity in Tequila Valley during a study abroad program in Mexico. Directly after, he applied to the University of Florida's College of Design, Construction, and Planning's M. E. Rinker, Sr., School of Building Construction to embark on a much more practical and fulfilling career and way of life. Promptly after being accepted, the Rinker School extended him an invention to join the Epsilon Chapter of Sigma Lambda Chi (SLX), an international construction honor society. He made his impression on SLX and Rinker alike when he accepted the role of project designer and manager of the 2009 Homecoming Float. Upon graduation, Michael moved back to Ormond Beach.