IMPACT OF SUSTAINABLE BUSINESS PRACTICES ON STRATEGIC PERFORMANCE FOR COMMERCIAL BUILDING CONTRACTORS

By

Heather Ilene Eilers

Submitted to the Department of Civil,
Environmental, and Architectural Engineering
and the Graduate Faculty of the University of Kansas
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy.

Chairperson Daniel Tran

Brian Lines

Mario Antonio Medina

Robert C. Rowland

Stacey Swearingen White

Thomas E. Glavinich, original chair

Date defended: May 5, 2015

The Dissertation Committee for Heather Ilene Eilers
certifies that this is the approved version of the following dissertation:

IMPACT OF SUSTAINABLE BUSINESS PRACTICES ON
STRATEGIC PERFORMANCE
FOR COMMERCIAL BUILDING CONTRACTORS

_____
Chairperson Daniel Tran

Date approved:

ABSTRACT

IMPACT OF SUSTAINABLE BUSINESS PRACTICES ON
STRATEGIC PERFORMANCE
FOR COMMERCIAL BUILDING CONTRACTORS

Heather Eilers, PhD CE
Department of Civil, Environmental, and Architectural Engineering
May 2015
University of Kansas

The existing commercial building construction industry is not sustainable and sustainability is not a prominent matter in construction. The construction industry has made strides in sustainability efforts over the past couple decades, but there remains a long pathway to improving stewardship of the environment, people, and resources.

This study reviews existing conditions in the construction industry through specialty and general contractor survey questionnaires. Interview investigation of three Midwest commercial building contractors examines the impact of embracing sustainable business practices. A case study offers a project level investigation of the research question to expand and support the study. Embracing sustainable business practices has a positive impact on strategic firm performance for commercial building contractors through employee satisfaction, project opportunities, and market advantage. Sustainable business practices are beneficial for construction businesses.

DEDICATION

This dissertation is dedicated to the memory of Roger and Louise Bruninga, Madison and Lila Self, Dr. Thomas Glavinich, and the honor of Michael Eilers and my family.

ACKNOWLEDGMENTS

Special thanks to Madison and Lila Self for their vision and generous support through the Self Graduate Fellowship which enabled this academic endeavor. I want to express heartfelt appreciation for my original chair Dr. Thomas Glavinich (1952-2014) who was a mentor, teacher, and friend. I also express gratitude to my original co-chair, Dr. Oswald Chong.

Thank you so much to my chair Dr. Daniel Tran for being a driving force at the finish line. I truly appreciate the insight, mentorship, and patience of my chairs and dissertation committee: Dr. Brian Lines, Dr. Mario Medina, Dr. Robin Rowland and Dr. Stacey Swearingen White.

Thank you to ELECTRI, AHRAE, MCAA, SMACNA, and AGC for distributing survey requests. Thank you to JE Dunn, Tarlton, and A.L. Huber who made this study possible by participating in the research through employee interview data collection and the case study. Thank you to each participant for their time and insight. Thank you to all who have generously supported my academic journey and professional career. Lastly, I would like to express gratitude to my family, friends, and my wonderful husband Michael for providing encouragement and support through the academic marathon of the PhD program.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 – Observed Problem

In order to support the global population, substantial changes are necessary to do more with less. Since the built environment is a significant component of society, changes in construction are imperative. The first step to achieve this goal requires increasing material reuse and recycling, using highly renewable materials, and managing waste more efficiently. Since the construction industry typically uses various types and vast quantities of materials, a core area to implement sustainable changes is in the design and construction of buildings and other facilities. Halliday (2008) indicated that critical success factors for construction projects involve improvement in material design and methods of construction.

A substantial component of change in construction involves energy usage. Commercial buildings comprised thirteen percent of the total energy usage in the United States in 2014 which accounted for 18,387 of 98,444 Trillion British thermal units (U.S. Energy Information Administration 2014). Innovation and implementation of higher efficiency mechanical and electrical systems are improving the commercial building sector by reducing energy resources required to operate and maintain facilities (Glavinich 2008). Coupled with the improvement of building enclosures, the construction industry is geared to make a large impact in reducing energy consumption. Renewable energies such as solar, wind, and hydroelectric also help reduce the environmental impact on the planet.

Water usage is another crucial component of sustainability of buildings. Low flow plumbing fixtures, hands free faucets, and high efficiency appliances are just a

few of the ways to reduce water consumption. Grey water systems are designed help recycle water within the building by flushing toilets with reused hand-washing water. Furthermore, decreasing the volume of water use helps to reduce energy and chemicals required for water treatment processes.

Aspects of design are often core concepts to sustainability research. Saparauskas (2003) highlighted negative impacts of buildings on the environment and offers a software program to aide sustainable design decisions. Negative impacts by buildings include extensive energy usage, carbon dioxide emissions, hazardous waste, and micro climate impacts (Saparauskas 2003). Mora (2004) asserted that sustainability comprises of both the durability of a project and its material components.

Although several researchers have investigated aspects of sustainability, there is a paucity of sustainability research relative to contractors. In fact, limited studies were found focusing on construction companies and sustainability efforts outside of material waste reduction, productivity, and Leadership in Energy and Environmental Design (LEED) guidelines. In addition, minimal information was found on sustainability efforts by construction companies. This study builds upon the body of knowledge in construction research by evaluating impacts of sustainability efforts on commercial building contractors using a mixed-methods research methodology.

1.2 – Research Questions and Objectives

The primary objective of this study is to evaluate existing management and methods of construction contractors and determine how sustainability efforts

influence firm performance. To obtain this objective, this study aims to answer the following primary research question:

How will contractor sustainable business practices influence firm performance?

Specifically, to address the practical and theoretical aspects the research explores three sub-questions that build upon one another as illustrated in Figure 1.1. This figure demonstrates the primary research question and the three supporting research questions which are explained further in this chapter. Figure 1.1 also provides an introduction to the areas of measurement related to the three supporting questions.

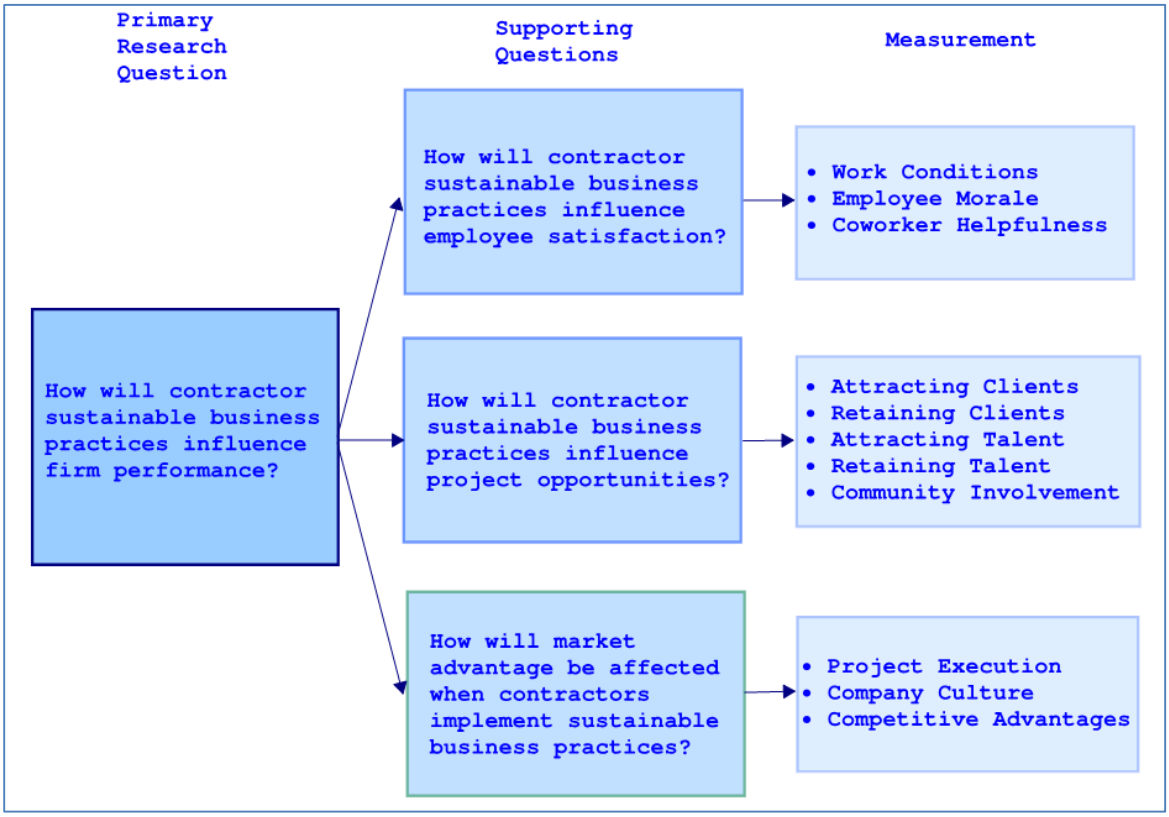

Figure 1.1: Research Questions and Measurement

Supporting Question 1:

How will contractor sustainable business practices influence employee satisfaction?

The objective of the first supporting question is to investigate the influence of implementing sustainable business practices on employee satisfaction (i.e., better work environment and improving employee performance). These components may lead to capacity for more work to be completed by the existing workforce or fewer employees to accomplish the same workload. The measurement of employee satisfaction is based on data collected from interviews with regards to work conditions and employee morale. Improving employee productivity may improve firm performance by reducing labor costs.

Supporting Question 2:

How will contractor sustainable business practices influence project opportunities?

The objective of the second supporting question is to examine the impact of sustainable business practices on project opportunities. It is expected that sustainable strategies will open doors to more projects, especially government-funded projects and projects funded by sustainably conscious clients. Project opportunity is measured by the perception of interviewees relating to attracting clients, retaining clients, and community involvement.

Supporting Question 3:

How will market advantage be affected when contractors implement sustainable business practices?

Most firms look for ways to improve market advantage. Improving market advantage can in turn lead to better performance not only by providing the opportunity for more projects to be awarded but by also executing work more efficiently. This supporting question aims to investigate the impact of implementing sustainable business practices on market condition. It is expected that by differentiating from competitors and showing an added value or less cost alternative, market advantage is improved. Market advantage is measured by analyzing project execution, culture, and other competitive advantages.

1.3 – Overview of Research Methodology

The frame of this study follows the Stanford's Center for Integrated Facility Engineering (CIFE) Horseshoe Research Method and is a multiple methods investigation. The study employs a mixed methods approach, which is a relatively new research concept, to investigate the research questions. Mixing methods started as a validity component in Campbell and Fisk's psychology research in 1959 and by the 1990s mixed methods evolved to combining quantitative and qualitative data as a research methodology (Creswell 2009). This study applies several research instruments, including a comprehensive literature review, surveys, structured interviews, and a case study.

The survey seeks both specialty contractors and general contractors' perspectives. After obtaining this information, in-person interviews were conducted at

three Midwest general contracting firms that embrace sustainable business practices in order to measure firm performance. The questions in the surveys and interviews were sensitive to proprietary information and efficiently designed to minimize company disruptions. Finally, a case study of the JE Dunn headquarters project was performed for study validation.

1.4 – Research Scope

The research setting is the commercial building construction industry. For the initial data collection, electronic surveys are distributed nationwide. The second data collection is individual in-person interviews conducted by the author at the three contractors' headquarters buildings during standard hours of operation. The case study data collection includes in person and phone interviews of key project team members, review of project documentation, and onsite observations.

Since this is an initial study in this area of research, the goal is to gain insight into existing conditions in the building construction industry and determine how sustainable business practices impact company performance at commercial building contractors. The study intends to be applicable for the building construction industry within the continental United States.

1.5 – Research Contribution

Each company and project is unique, the goal of this study is to uncover trends, opportunities, and challenges related to sustainable business practices. Results from this study are anticipated to advance general knowledge regarding sustainability efforts by commercial building contractors and will not necessarily be applicable to other industries or nations.

This study provides both theoretical and practical contribution. The main theoretical contribution is to advance the understanding of how sustainable business practices influence strategic performance for commercial building contractors. In addition to the theoretical contribution, this study may help contractors improve best practices in relation to sustainability. For example, if a firm can improve performance while implementing sustainable business practices, it would be a winning strategy. This would positively impact business performance and improve environmental conditions for society. Smarter building practices should have a snowball effect in improving firm performance even further through market advantage. Furthermore, this study may provide a basis for potential policy change regarding sustainability regulations. If sustainable practices can improve business performance and generate benefits for the community, policy should move in the direction of encouraging more sustainable requirements in construction.

1.6 – Research Limitations

This study has inherent limitations. First, because contractors are widely privately held firms, financial information is not accessible. There is also concern among private companies to protect proprietary information, so information disclosed is limited. Due to the sensitivity of proprietary company information, cost and confidential information is not collected. Because of these limitations, analysis requires some assumptions and extrapolations. Second, due to financial limitations, Midwest building contractors geographically close to the investigator are included in the study. Contractors in other regions and sectors may have different conditions. In

addition, the existing state of the national economy may influence results since the surveys and interviews were conducted during a great recession.

1.7 – Dissertation Format

This study continues with a literature review as a basis of the current body of knowledge related to sustainability. Chapter 2 presents a basic review of sustainability. Chapter 3 discusses studies related to businesses and construction. Chapter 4 provides explanation of the methodology of this study including the data collection processes and analysis. Chapters 5 and 6 provide the survey and interview analysis. Chapter 7 addresses verification and validation with a case study of the JE Dunn headquarters building project. Chapter 8 summarizes the key findings of this study. Finally, Chapter 9 concludes the study and addresses future study opportunities.

CHAPTER 2: OVERVIEW OF SUSTAINABILITY

2.1 – Introduction

This chapter provides an overview of sustainability concepts. A literature review was conducted to determine past research projects and studies regarding sustainability in construction. Prior to starting the literature search, the Cochrane review guidelines for research were reviewed (Higgins 2009). However, due to the small amount of relevant research and the nature of the subject, these guidelines were not applicable.

The literature review conducted was based on University of Kansas library database searches and Google Scholar Internet searches as well as specific sources recommended by the dissertation committee and colleagues. A review of these articles, books, and Internet sites compiled an overview and understanding of sustainability in the construction industry. Many publications provided observations and ideas relating to sustainability. Several sources found provided basic theory and general insight to sustainability; however, minimal information applied to construction business practices. Back checks were conducted by reviewing select references from the articles acquired to verify the information. Table 2.1 outlines the literature review approach and a sample reference for each approach.

Table 2.1: Literature Review Approach and Typical References

Approach	Typical Reference
University of Kansas library database searches	Barry, M. (2003). Corporate social responsibility – unworkable paradox or sustainable paradigm? *Engineering Sustainability,* I56. ES3, 129-130.
Google Scholar Internet Searches	Santos, Juliana Bonomi, and Luiz Artur Ledur Brito (2012). "Toward a subjective measurement model for firm performance." *Brazilian Administration Review,* 9, 95-117.
Dissertation committee recommendations	Prahalad, C.K. and Kenneth Lieberthal (1998). The End of Corporate Imperialism. *Harvard Business Review,* 109-117.
Reference back checks	Wernerfelt, B (1984). "A Resource-based view of the firm." *Strategic Management Journal,* 5(2), 171- 180.

Minimal information regarding sustainability in construction companies was discovered. No research information was discovered regarding sustainable efforts by contractors. This preliminary finding confirmed the assumption that limited lines of research were conducted focusing on sustainability practices related to construction firm performance and supported this study as an incremental contribution to the existing basis of knowledge. The following sections provide the background to investigate the impact of sustainability on contractor firm performance.

2.2 – Definition of Sustainability

Many definitions of sustainability exist. The 1987 Report of the World Commission on Environment and Development Sustainability defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (www.usgbc.com). The U.S. National Environmental Policy Act of 1969 declared a national policy goal to "create and

maintain conditions under which [humans] and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans" (www.usgbc.com).

Sustainability is not a new concept. Leaders in ancient Greece responded to depletion of nearby forests with laws protecting tree consumption, and they utilized solar heating to help with this sustainable effort (National Trust for Historic Preservation 1981). Other societies in history strived to sustain the earth and their people. A Native American proverb emphasized that society borrows the earth from future generations so considerations of imminent impacts was crucial (Orecchini 2007). The knowledge and resources are accessible to improve the sustainability of the planet.

Behaviors were critical to drive global sustainability (Leiserowitz et al. 2006). Becker and Jahn (1999) study provided recommendations for achieving sustainability include: ecological configuration, economic activity, political behavior and governance, and institutional performance (Becker and Jahn 1999). They also suggested voluntary acceptance is important for leveling the competition. Lines of research in psychology regarding sustainability expressed the importance of social awareness and concern, knowledge and motivation to engage, memory or situational prompts, opportunities to follow through, and skills and perceived competence (Becker and Jahn 1999).

A common paradigm explained sustainability in terms of the three pillars with equal weight: the environment, economy, and society (Dawe and Ryan 2003). A South African study added technology as a fourth pillar to the three pillar analogy and

outlined the significance of a technical pillar as well as expressed the importance of process in addition to the end product (Hill and Bowen 1997). The United Kingdom considered sustainable development as five capitals: natural capital including resources and services, human capital, social capital, manufactured capital, and financial capital (Parkin et al. 2003).

In order to address sustainability, these elements (environment, social, economy, and technology) are intertwining pieces to the big puzzle. Ideally these components function harmoniously. In the real world, sometimes there are tradeoffs. It is important for designers, contractors, and academic professionals to be knowledgeable of options to make informed decisions with their projects. The tragedy of the commons, or the misuse of common property such as the atmosphere, oceans, and natural resources, is a large factor in the current environmental struggle (Cooperrider and Dutton 1999). Reconsidering common property as indispensable and as a shared responsibility is necessary for sustainable development (Becker and Jahn 1999). Expansion of sustainability efforts across all industries globally is necessary to improve the global commons and protect the planet for future generations (Becker and Jahn 1999). The construction industry must play a key role in sustainability efforts by approaching construction methods differently (Shelbourn et al. 2006). Designers, constructors, and academic professionals should demand sustainability to be an essential part of construction projects.

2.3 – Regulations and Guidelines

Regulations and guidelines recently evolved to drive sustainability aspects in building construction. Possibly the most significant advancements were with the

American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings. The 2012 International Building Code (IBC) and LEED Version 4 both incorporated the ASHRAE 90.1 – 2010 Standard, and regulations are likely to become more stringent in future releases. Buildings under this 2010 standard were expected to use significantly less energy than those under the 2004 and 2007 standards (32% and 25% less respectively). Changes had the greatest impact on the building envelope, Heating, Ventilation, and Air Conditioning (HVAC) systems and electrical systems (ASHRAE 2010). The building envelope guidelines required a continuous air barrier, with increased insulating values, passive solar requirements, and specific skylight requirements (ASHRAE 2010).

HVAC system changes included higher cooling efficiency requirements, economizer requirements, reheating restrictions, piping insulation requirements, motorized dampers, ductwork sealing requirements, and leak testing. Along with these modifications, more specific requirements for mechanical systems such as variable frequency drives, energy recovery, and pump pressure optimization were regulated (ASHRAE 2010). Electrical system requirements included occupancy sensors, lighting controls testing, power reductions for lighting, and automatic off on 50% receptacles in offices and schools, partial interior lighting, and partial exterior lighting (ASHRAE 2010).

Additional sustainability guidelines available included the international Kyoto Accord, Building Research Establishment Environmental Assessment Method (BREEAM), Green Globes, and Leadership in Energy and Environmental Design

(LEED). While regulations and guidelines can help improve the present condition of the construction industry, researchers indicated the main solution to improve the construction project involves a psychological shift (Koger and Scott 2007).

2.4 – Overview of LEED

Sustainability measurement of green building projects was necessary to determine the state of progress and provide feedback for additional improvement (Reed et al. 2005). One existing tool to measure construction sustainability is the LEED system. LEED was established in 2000 by the U.S. Green Building Council (USGBC) which is a non-profit organization to help owners and designers create sustainable and environmentally responsible buildings. The USGBC defined LEED as below:

> The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED provides building owners and operators with the tools they need to have an immediate and measurable impact on their buildings' performance. (www.usgbc.com)

LEED outlined a green building based on three main values: environmental, economic, and health and community benefits. The following page outlines main values and areas of focus are listed in detail.

1. Environmental benefits:
    a. Enhance and protect ecosystems and biodiversity
    b. Improve air and water quality
    c. Reduce solid waste
    d. Conserve natural resources
2. Economic benefits:
    a. Reduce operating costs
    b. Enhance asset value and profits
    c. Improve employee productivity and satisfaction
    d. Optimize life-cycle economic performance
3. Health and community benefits:
    a. Improve air, thermal, and acoustic environments
    b. Enhance occupant comfort and health
    c. Minimize strain on local infrastructure
    d. Contribute to overall quality of life

To assess these potential benefits, LEED included a rating system based on eight sustainable parameters. Table 2.2 summarizes the LEED checklist for new construction credits. The LEED categories shown in Table 2.2 are sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. Additional credits unique to the project were obtained under innovation in design processes and regional priority credits. The LEED guidelines were a recommended framework to assess sustainability in design and construction

(Lee and Guerin 2009). Pearlmutter (2007) suggested that modern society often disregards the relationship between regional climate and indoor environments. For example, traditionally passive solar heating and passive ventilation cooling were essential in building design. Modern conveniences such as forced air conditioning allowed these elements to be ignored (Pearlmutter 2007). LEED standards are trying to reestablish this direct link between climate and the built environment.

TABLE 2.2: LEED Construction Credits Project Checklist

LEED 2009 for New Construction and Major Renovation

Project Checklist

Project Name

Date

Y	N	?			
Sustainable Sites				Possible Points:	26
Y			Prereq 1	Construction Activity Pollution Prevention	
			Credit 1	Site Selection	1
			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation—Public Transportation Access	6
			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
			Credit 5.1	Site Development—Protect or Restore Habitat	1
			Credit 5.2	Site Development—Maximize Open Space	1
			Credit 6.1	Stormwater Design—Quantity Control	1
			Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
			Credit 8	Light Pollution Reduction	1
Water Efficiency				Possible Points:	10
Y			Prereq 1	Water Use Reduction—20% Reduction	
			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
			Credit 3	Water Use Reduction	2 to 4
Energy and Atmosphere				Possible Points:	35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
			Credit 1	Optimize Energy Performance	1 to 19
			Credit 2	On-Site Renewable Energy	1 to 7
			Credit 3	Enhanced Commissioning	2
			Credit 4	Enhanced Refrigerant Management	2
			Credit 5	Measurement and Verification	3
			Credit 6	Green Power	2
Materials and Resources				Possible Points:	14
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
			Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1 to 2

Y	N	?			
Materials and Resources, Continued					
			Credit 4	Recycled Content	1 to 2
			Credit 5	Regional Materials	1 to 2
			Credit 6	Rapidly Renewable Materials	1
			Credit 7	Certified Wood	1
Indoor Environmental Quality				Possible Points:	15
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
			Credit 1	Outdoor Air Delivery Monitoring	1
			Credit 2	Increased Ventilation	1
			Credit 3.1	Construction IAQ Management Plan—During Construction	1
			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
			Credit 5	Indoor Chemical and Pollutant Source Control	1
			Credit 6.1	Controllability of Systems—Lighting	1
			Credit 6.2	Controllability of Systems—Thermal Comfort	1
			Credit 7.1	Thermal Comfort—Design	1
			Credit 7.2	Thermal Comfort—Verification	1
			Credit 8.1	Daylight and Views—Daylight	1
			Credit 8.2	Daylight and Views—Views	1
Innovation and Design Process				Possible Points:	6
			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
			Credit 2	LEED Accredited Professional	1
Regional Priority Credits				Possible Points:	4
			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1
Total				Possible Points:	110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

The main goal of LEED is to remain a prominent design and construction tool to measure sustainability efforts on projects. LEED is a good start, yet it fails to address most parameters of the construction process. Therefore, LEED is not an

ultimate determining factor of best sustainability practices in construction. A more holistic approach should be applied when making construction project decisions in regards to sustainability.

2.5 – Summary

Chapter 2 provides a basis of sustainability knowledge that supports this study. The definition of sustainability varied, but the four main pillars of sustainability were environment, society, economy and technology. General regulations and LEED guidelines were reviewed to further understand the impact of sustainability on building construction. The review indicated that although LEED was necessary to consider in the design and construction process, it was not the determining factor of best sustainability practices in construction. Rather a holistic view of sustainability was required to understand and implement contractor sustainable business practices. Aspects of sustainability in relation to business are addressed in the following chapter.

CHAPTER 3: REVIEW OF SUSTAINABILTY IN BUSINESS

3.1 – Introduction

Building upon the findings from Chapter 2, this chapter presents sustainability in relation to business. The following sections summarize literature pertaining to manufacturing, life cycle analysis, business management sustainability studies, and sustainability studies and construction.

3.2 – Life Cycle Analysis (LCA) and Manufacturing

Some similarities exist between manufacturing and the construction industry. As mentioned previously, there was limited research focusing on sustainability in construction companies and contractor sustainability efforts. Several studies have investigated sustainability efforts and LCA.

LCA, which looks holistically at the life of the project and not just initial construction costs, is one method to address sustainability of a building (Bogenstatter 2000). The 3M Company used LCA to improve manufacturing processes and as a way of thinking in their business practices (Price and Coy 2001). Ericsson, a telecommunications manufacturer, used life cycle and environmental analyses as a tool in the design of products and as an enterprise impact. Ericsson used LCA less and less over time because of extensive time commitment and high cost. More efficient LCA tools would allow wider implementation. In fact, the researchers indicated the use of LCA was not for design but as a key phrase for marketing efforts (Cerin and Laestadius 2003).

Table 3.1 summarizes the results from the Tanzil and Beloff (2006) study of a chemical manufacturing industry. This study considered sustainability aspects that

were important to companies and encourages companies to consider all aspects of sustainability.

TABLE 3.1: Important Sustainability Aspects in a Company (Tanzil and Beloff, 2006, 44)

Environmental Stewardship	Resources	• Material intensity • Energy intensity • Water usage • Land use
	Pollutants and Waste	• Wasted resources • Releases to air, water, and land • Material recycling • Impacts on human health • Impacts on ecosystem and biodiversity
Economic Development	Internal	• Eco-efficiency • Internal costs to the company • Revenue opportunities • Access to capital and insurance • Shareholder value
	External	• Costs of externalities • Benefits to local community • Benefits to society
Social Progress	Workplace	• Workplace conditions • Employee health, safety, and well-being • Security • Human capital development (education and training) • Aligning company values with employee values
	Community	• Social impacts of operations • Stakeholder engagements • Quality of life in community • Human rights
General/Institutional	Sustainability Management	• Commitment to triple bottom line • Product stewardship and supply-chain leadership programs • Accountability and transparency • Product and service development • Employees' impact on environment

Source: BRIDGES to Sustainability.

As outlined in Table 3.1, the four major sustainability aspects and their components were considered. Environmental stewardship included use of resources and bi-products of processes including pollutants and waste. Economic development contained internal components such as profits and external components such as community benefits. Social progress consisted of the workplace and community. The final sustainability aspect was general sustainability management a holistic

consideration to sustainability (Tanzil and Beloff 2006). Each of these considerations was important and reflected a sustainability approach from the business standpoint.

Shireman and Kiuchi (2002) recommended running a business like a rainforest. They indicated that companies create value webs with interconnections, not value chains with one-way connections. In the closed-loop system, waste was reused or a cost was associated for disposal. A case study of Coors Brewing Company demonstrated their efforts to reduce waste by first including a biological water treatment plant in Golden, Colorado in 1952. They repurposed byproducts as fertilizer, animal feed, and compost. They also initiated aluminum recycling in their region, encouraged innovation, and valued human capital (Shireman and Kiuchi 2002).

Braithwaite (2007) conducted a case study for manufacturer Kingspan Insulation that had an independent sustainability assessment in 2004 and subsequent reassessments annually to improve sustainable performance. The sustainability assessments benefited the company by providing market advantage through community relations and operational savings (Braithwaite 2007). Base-lining sustainability efforts were a key to tracking improvement.

It is important to note that manufacturing and construction, while they have similarities, have noteworthy differences. Construction projects are often unique, and therefore, have fewer repetitions and efficiencies compared to what manufacturing companies encounter. People, materials, and locations typically change with each new construction project. Understanding the life cycle of a product is critical.

Assembly made products encounter repetition and project-based product have varying components and conditions (Molcho and Shpitalni 2006).

3.3 – Business Management Sustainability Studies

This section briefly discusses three main areas of business management in relation to sustainability: corporate responsibility, sustainability management, and firm performance. Motivations for sustainable efforts were often mixed and included promoting social interests on varying levels when a company pursued more sustainable business practices (Bansal and Roth 2000). Other obstacles were company willingness to implement non-mandated efforts and sharing knowledge with other firms.

A qualitative study by Bansal and Roth (2000) of fifty-three companies in the United Kingdom and Japan discovered corporate ecological responsiveness was mediated by three major motivators (competitiveness, legitimization, and ecological responsibility) and influenced by three major contextual factors (field cohesion, issue salience, and individual concern). This study demonstrated the significance of the human dimension in sustainability (Bansal and Roth 2000).

3.3.1 – Corporate Responsibility

Corporate responsibility often included environmental, human rights, sustainable development, and civic duties (Krizov and Allenby 2004). Barry (2004) indicated corporations often do not meet expectations despite being more socially responsible than ever before. Corporate social responsibilities are ethical behavior as defined by society which impacts public impression of the company (McAdam and Leonard 2003).

Key factors that drove corporate environmental responsibility included "international agreements; national government policies; market forces; community groups and NGOS" (Dummett 2006). An Australian study revealed business support of prescriptive-based environmental regulations. This study also indicated that enforcement of minimal standards including public disclosure and penalties for non-compliance were fundamental to economic fairness (Dummett 2006).

In addition, companies (e.g., AT&T) often utilized a social value-added tool which provided a snapshot of a business CSR. However, this tool was prone to the halo effect where responses may be biased based on influences or perceptions (Krizov and Allenby 2004). In summary, Drummett (2006) concluded that companies need to change their culture so corporate responsibility is integrated into management and planning.

3.3.2 – Sustainability Management

Some sustainability efforts stemmed from federal government driving green products and services. In the United States, programs such as the Resource Conservation and Recovery Act in 1976, Environmental Protection Agency's Energy Star, Department of Energy Federal Energy Management Program, Environmental preferable purchasing program, and Bio based Products program contributed to sustainability efforts. Greening the Government through Leadership in Environmental Management Executive Order 13148 in 2000 also aimed to make the country more sustainable (Bergeson 2002). Pimental et al. (2004) recommended removing energy industry subsidies to motivate consumer energy conservation.

Illustrated in Figure 3.1, Managing Sustainable Companies (MaSC) was a measurement tool to quantify sustainable business practices in an organization (Woodall et al. 2004). This tool gauged best management practices as a score of "5" and worst practices as a score of "1", and adding the key areas result in an overall assessment score. It considered six main areas: strategy, responsibility, planning, communication, implementation, and auditing. This was a tracking device to measure improvement within a company's sustainable management practices. Greater sustainability progress was likely when companies have internal social drivers more so than economic and external environmental drivers alone (Woodall et al. 2004).

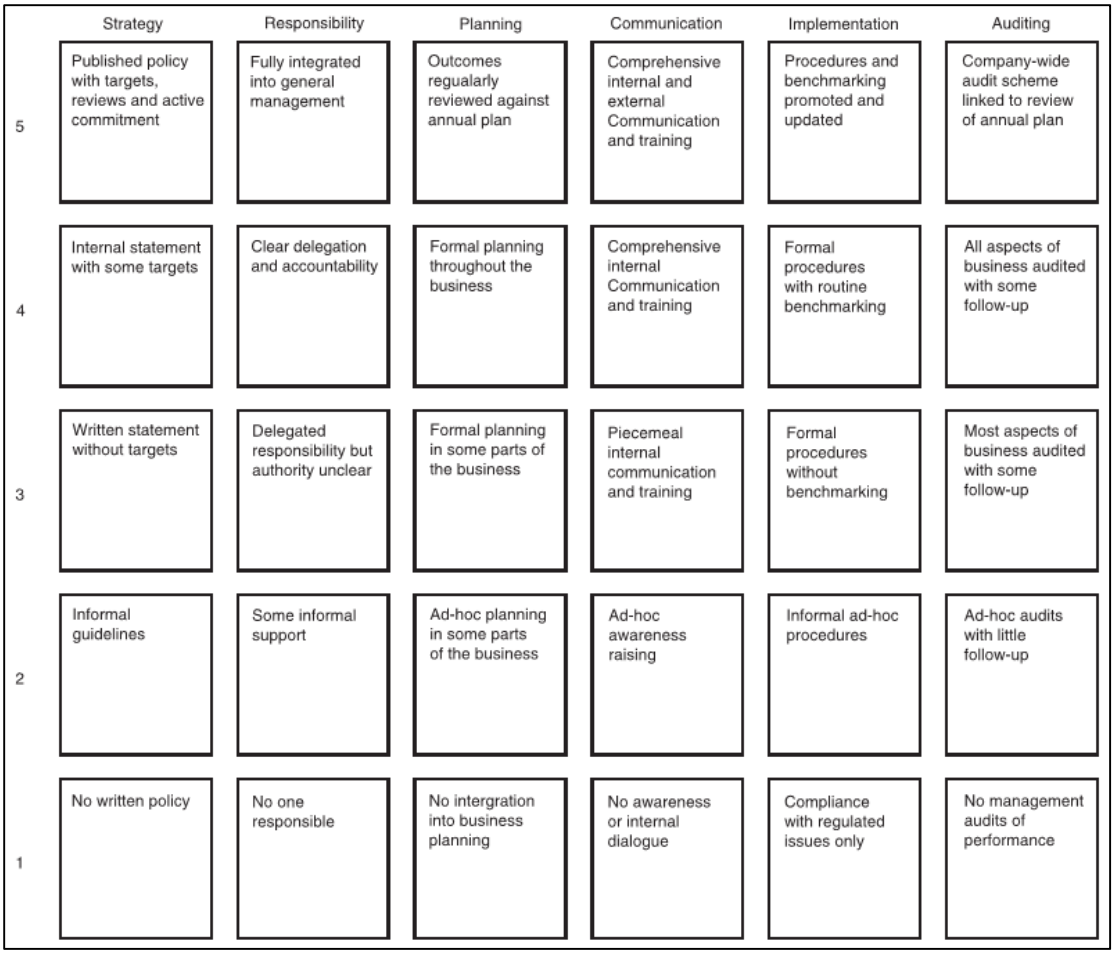

FIGURE 3.1: Managing Sustainable Companies Matrix (Woodall et al, 2004, 17)

Another assessment, Corporate Sustainability Commitment Index (CSCI) considered the three primary areas of sustainability in a corporation: top level strategic planning, sustainability and investor relations, and the frequency of sustainability benchmarking. Additionally, sustainability Component of Project Planning Index (SCPPI) considered three sustainability pillars: status of preparation and documentation, completeness of investor relation studies, and completeness of sustainability benchmarking (Beheiry et al. 2006).

Sustainable business practices influenced company culture, impact decisions, and reduce costs for IBM manufacturing (Olson 2008). A European study found the cost of implementing environmental management systems did not harm financial performance (Watson et al. 2004). Innovation and reputation helped firms differentiate from their competitors and created value for the firm (Rodriguez et al. 2002). When sustainable business practices were a principal business strategy, it influenced business processes and was apparent to stakeholders (Leiper et al. 2003).

3.3.3 – Firm Performance

Organizational, environmental and individual factors had a significant impact on company resources. This resulted in the change in the organizational climate, individual behaviors, and organizational performance (Hansen and Wernerfelt 1989). Therefore, the quality of the firm's resources was determined by strategic factors including employee satisfaction, project opportunities, and market advantage.

Firm performance was often calculated with capital market data including shareholder value (Strecker 2009). In the case of privately held firms, firm performance was more difficult to obtain and measure from outside the firm. Measure of profitability included characteristics of the industry, industry comparisons, and company resources (Hansen and Wernerfelt 1989). A recent model (Santos and Brito 2012) displayed firm performance that included financial performance and strategic performance as illustrated in Figure 3.2. Strategic performance included domains related to customer satisfaction, employee satisfaction, social performance, and environmental performance. The financial performance included profitability, growth, and market values.

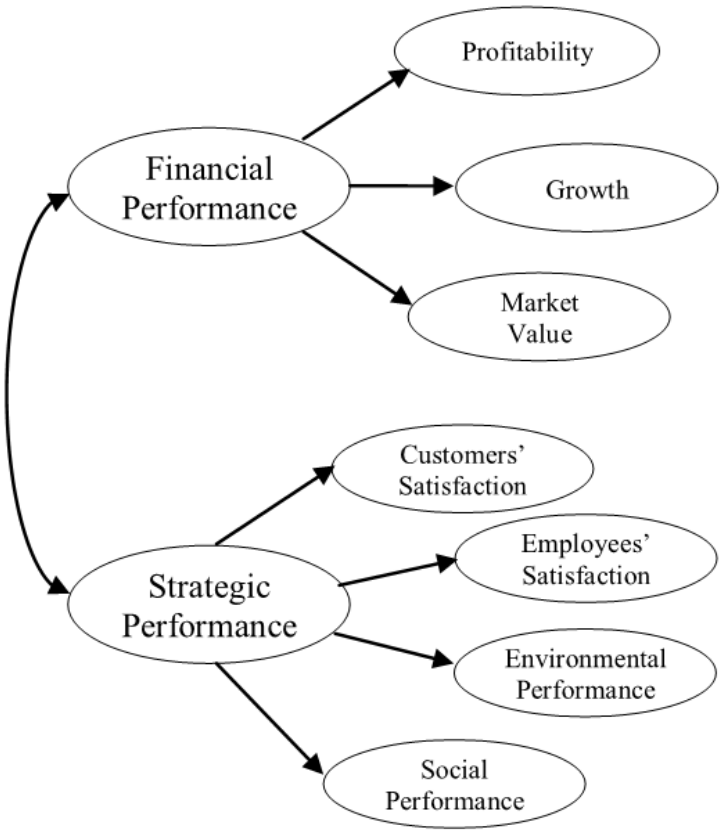

Figure 3.2: Model of Firm Performance (Santos and Brito, 2012, 102)

Researchers showed the market often involves willingness to pay a premium for ethically produced goods over unethically produced goods. This observation could extend to construction services and commercial buildings as a market advantage from sustainable efforts.

3.4 – Sustainability Studies in Construction

A literature review revealed limited sustainability studies to date focus on construction excluding those studies that investigated construction waste management. Myers (2005) emphasized a contractor's view of sustainability as "the complex and fragmented nature of the [construction] sector will restrict it from making a rapid transition – if any at all." (Myers 2005, 784) This view expressed the

slow-to-change field of construction had not made substantial progress in sustainability efforts.

Sustainable construction starts early in the planning phase before project design and extends beyond construction to operations and maintenance phases and the demolition of the project following its useful life (Hill and Bowen 1997). This section discusses sustainable construction with regard to three main areas in the construction process: materials, means and methods, and management.

3.4.1 - Materials

Apparent differences existed between industrialized and developing countries in terms of sustainability, particularly with policies and regulations regarding material use (Ofori 1992).The construction industry consumed more materials by weight than any other industry in the United States (Horvath 2004). Materials currently recycled in most regions included: asphalt, steel, aluminum, and wood (Horvath 2004). Concrete, block, brick, plastics, paper, cardboard, roofing, and drywall were also recycled in several areas. Numerous studies showed that waste management in construction dramatically improved material usage in the construction industry over the past two decades (Bossink and Brouwers 1996; Dainty and Brooke 2004; Formoso et al. 2002; Lawson et al. 2001; Peng et al. 1997; Poon et al. 2004; Teo and Loosmore 2001). It is of paramount importance that the construction industry seriously considers what is done with spent materials. Peng et al. (1997) examined the benefits of onsite waste recycling operations, but noted that this endeavor is a costly process. Recycling can be an excellent means to reduce construction waste. However,

transportation to recycling facilities, ease of reuse, and recycling processes should be considered as well.

Construction can be more complicated than manufacturing processes since it involves various site conditions, materials, systems, and methods. Monitoring compliance in the construction industry is more difficult and costly. Since owners often require projects to be constructed faster and cheaper, long-term sustainability goals are often overlooked (Bon and Hutchinson 2000).

Choosing optimal materials in the design and procurement phase is crucial to minimize waste later in the life of the building. A study in Brazil indicated that improving initial efforts in the design and procurement phases was economical in reducing construction waste (Formoso et al. 2002). The study also suggested improving control efforts in the construction process to help reduce construction waste (Formoso et al. 2002). Both material costs and potential reuse should be considered as a life-cycle element during design and procurement.

3.4.2 – Means and Methods

A literature review indicated that limited studies focus on construction means and methods in relation to sustainability. Available studies typically addressed management approaches rather than construction means and methods in the field. Given the minimal existing literature, it is challenging to address the present sustainability status of construction means and methods.

Bilec et al. (2006) used a hybrid life-cycle assessment to evaluate the construction process of a precast parking structure. This particular study determined that transportation, equipment, and support functions in the construction process had

the largest negative effects on the environment. Improving these areas on this type of project would provide the most sustainable benefit (Bilec et al. 2006).

In the United Kingdom, the Chartered Institution of Building Services Engineering (CIBSE) provided sustainable guidelines for design through operation of buildings focused on energy use, CO2 emissions, water use, and adapting buildings for climate change (Cheshire 2007). This guideline offered a more holistic tool than LEED, which focused primarily on design. However, the CIBSE sustainable guidelines did not address construction means and methods per se.

3.4.3 – Management

Several studies investigated sustainability in construction management strategies. For example, Hill and Bowen (1997) developed the Environmental Management System (EMS) tool to help managers address sustainability on construction projects. Figure 3.3 shows the four primary requirements of EMS for construction, which included (1) setting performance standards, (2) setting the project ground rules and responsibilities, (3) setting protocols for measurement and management, and (4) conducting internal and external reviews for verifications of results (Hill and Bowen 1997). All members of a construction project team were responsible for achieving sustainability (Riley et al. 2003).

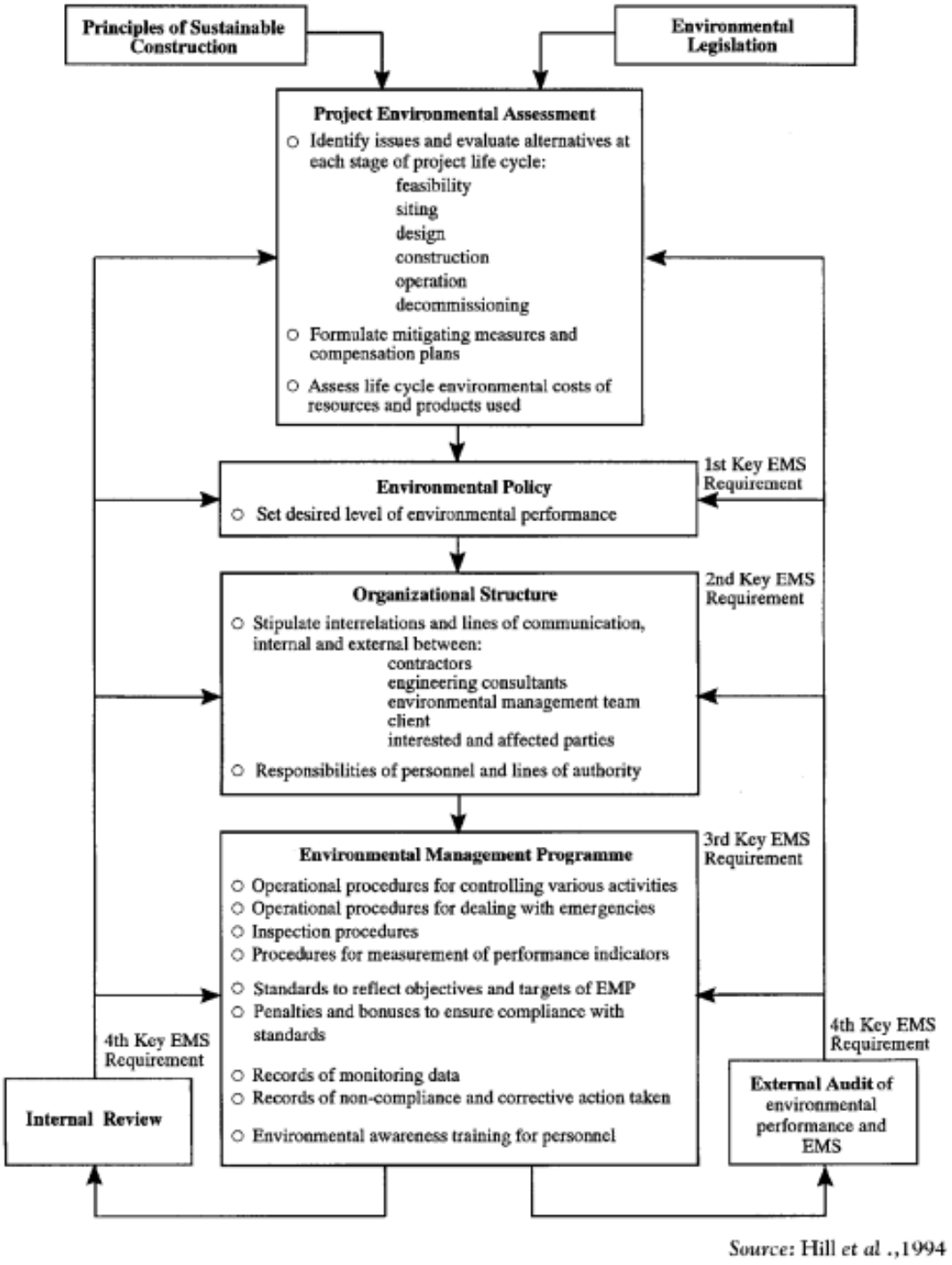

Figure 3.3: Principals of sustainable construction (Hill and Bowen 1997, 238)

A study in the Netherlands divided construction innovation into four categories: technological capability, environmental pressure, knowledge exchange, and boundary spanning (Bossink 2004). Innovation is essential for moving construction sustainability forward. Bossink explained sustainability improvement is one of the several drivers to construction innovation. Bossink (2004) also showed that the resistance from private firms to share innovations outside their network is mostly in an effort to maintain competitive advantage, but it hinders forward progress of the industry as a whole. Van Bueren and Priemus (2002) suggested barriers to sustainable construction in the Netherlands were largely institutional and policy barriers.

A paradigm shift towards a holistic view and integrated approach toward construction projects is necessary to advance sustainability efforts in the construction industry (Riley et al. 2003). Since few contractors are embracing environmental policy, it is a market differentiator (Riley et al. 2003).

3.5 – Summary

Research advanced knowledge related aspects of sustainability in business. LCA and manufacturing research illustrated benefits a holistic approach to sustainability while challenges included time commitments and high costs. Business management sustainability studies suggested ideas and tools for addressing corporate social responsibility and sustainability management. Construction management studies provided valuable insight primarily focused on waste management and management tools.

Through a comprehensive literature review, the author found that there were limited studies on sustainability in construction companies and sustainable efforts by

contractors. Therefore it was difficult to determine the state of the industry. The current study aims to make a contribution to the body of knowledge on sustainability efforts and contractor performance by providing a preliminary review of the status of sustainability in the construction industry, investigating sustainability efforts by three contractors, and analyzing the impact of sustainability efforts on business performance.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 – Introduction

This study follows the research framework developed by the Stanford's Center for Integrated Facility Engineering (CIFE) as shown in Figure 4.1. In general, the CIFE framework includes eight major steps:

1. Observed Problem
2. Intuition and Theoretical Point of Departure
3. Research Questions
4. Research Methods
5. Research Tasks
6. Validation Results
7. Claimed Contributions
8. Predicted Impact

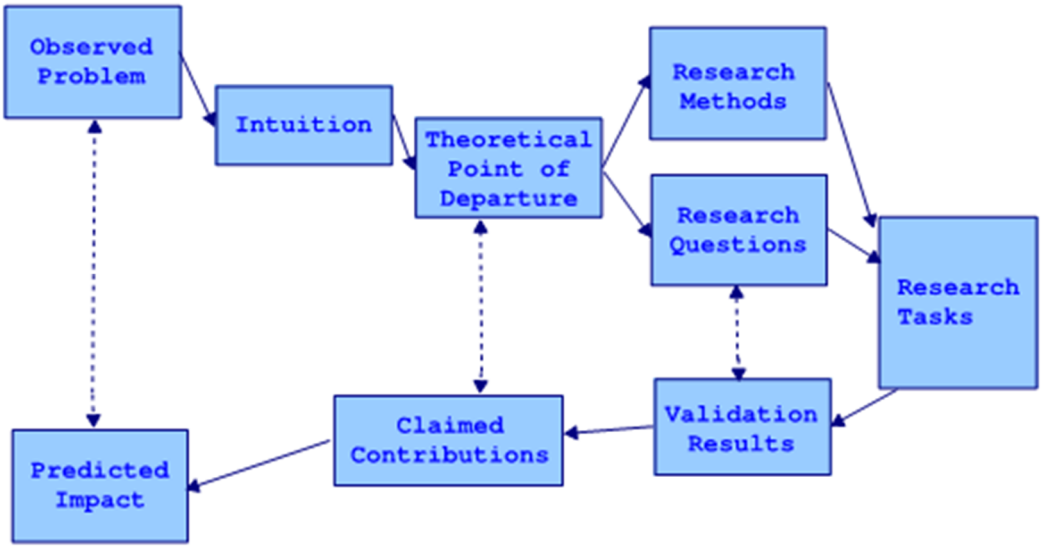

Figure 4.1: Stanford's CIFE Horseshoe Research Framework

(adapted from Kunz 2012, 11)

The continuous arrows of this diagram indicate the overall sequence of the framework. The dashed arrows indicate additional links that must be considered between the components of the study. Figure 4.2 illustrates the research approach for this study.

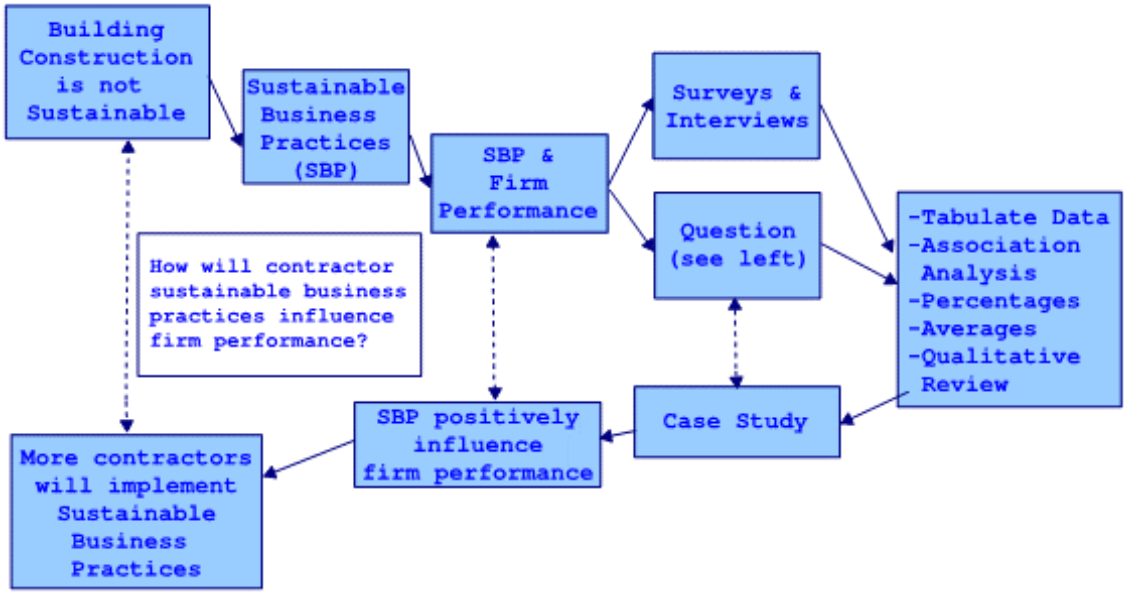

Figure 4.2: Research Framework

The next several paragraphs elaborate on the framework of this study.

- **Observed Problem**

  The observed problem is that building construction, as it exists today, is not sustainable. Sustainability is not a prominent matter in the existing construction industry. Some companies are taking steps towards sustainable business practices, but there is not enough sustainability focus and improvement in the construction industry to date. Many contractors believe being more sustainable will cost more and erode profits. The scope of this

study examines existing conditions in the construction industry pertaining to sustainability efforts, and then investigates three general building contractors embracing some sustainable business practices.

- **Intuition**

  Intuition from over a decade of operations experience in the building construction industry suggests contractors that embrace sustainable business practices may improve their firm performance. Embracing sustainable business practices may contribute to the construction companies' strategic performance such as improving employee satisfaction, project opportunities, and market advantage.

- **Theoretical Point of Departure**

  The theoretical point of departure derives from a comprehensive literature review of sustainability and business performance. The relationship between sustainable business practices and firm performance is an evolutionary topic since some existing studies focus on sustainability or firm performance, but these studies have not attempted to investigate the impact of sustainable business practices on building contractors and firm performance. The relationship between sustainable business practices and firm performance is important for the construction industry because contractors are primarily in business for profits. If sustainable business practices enhance firm performance, understanding this relationship would be a critical success factor for both contractors and society.

- **Research Methods**

  This research employs a three-part, mixed method approach. The three-part data collection includes (1) surveys to examine existing sustainability conditions in the industry, (2) in-person structured interviews at three general contractors that have embraced sustainable business practices, and (3) a case study of the JE Dunn headquarters project. This mixed method approach is predominantly quantitative with a smaller qualitative component of data collected concurrently.

- **Research Questions**

  The primary research question considers how contractor sustainable business practices will influence firm performance. Three supporting components substantiate the primary question of this study by examining sustainable business practices in relation to employee satisfaction, project opportunities, and market advantage each as aspects of firm performance. The research questions were discussed in detail in Chapter 1.

- **Research Tasks**

  Research tasks includes creating the survey and interview questions, pilot tests to verify approach, distributing and collecting surveys, and conducting individual structured interviews. The data analysis includes tabulating the survey and interview data in Microsoft Excel, coding the data, and searching for trends. Examination of descriptive data and chi-square analyses are utilized. Finally, examining qualitative data provides a comprehensive approach to the study.

- **Validation of Results**

  Validation of results is addressed by conducting a case study of the JE Dunn headquarters building project. The investigator has over a decade of commercial building construction experience which provides an in-depth understanding of the field and allows proper reflection necessary for qualitative components. Peer debriefing to review and interpret the research results also provides validity to this study (Creswell 2009).

- **Contributions**

  This study contributes to theory by expanding the body of knowledge on sustainability in construction. In particular, this study provides guidance to capture the relationship between construction sustainability and strategic firm performance. In addition, the study contributes to industry by providing insight into how sustainable business practices impacts contractor performance. It will help construction contractors understand the long term benefits of implementing sustainable business practices.

- **Predicted Impact**

  The potential impact of this study may lead to future research regarding sustainability in construction. Hopefully the construction industry will embrace sustainable business practices extensively. It is expected that if contractors pursue more sustainable practices, they will obtain more benefits to their business and society as a whole.

4.2 – Research Method

Inherent with construction, applied research is often more practical and suitable than pure research methods when investigating industry questions. This research approach utilizes surveys and interviews as primary means of data collection.

Given this study involves human subjects, it is critical to carefully consider ethics and the protection of participants. Human Subjects Training was completed by the investigator, and the study was reviewed and approved by the University of Kansas Human Subjects Committee for the Lawrence Campus (HSCL study #18677). All surveys and interviews were conducted in accordance within the guidelines and requirements of the university.

4.3 – Survey Data Collection Process

The purpose of this study is to gauge existing sustainability conditions in the commercial construction industry in the United States. Therefore, data collection consists of surveys questionnaires with construction building contractors in the United States. Surveys are conducted to help quantify overall trends and opinions through a sample of that group (Creswell 2009; Zeisel 2006).

Researchers show that questions should be asked in the same manner and without prompting answers (Zeisel 2006). Additionally when designing survey questions, questions should avoid complexity and multiple meanings, and should carefully consider the participants (Zeisel 2006). Table 4.1 presents purposes and challenges for asking questions in survey questionnaires.

Table 4.1: Designing Survey Questionnaires (Zeisel 2006)

Purpose	Pitfalls to Avoid
To ensure that respondents understand questions	Over complexity: • Double-barreled questions • Words and phrases outside respondents' experience • Questions assuming knowledge respondents might not have
To ensure that different respondents understand questions in the same way	Imprecision: • Complicated words with multiple meanings • Simple words with implicit double meanings • Questions about general times and places rather than specific ones
To ensure that questions do not unwittingly influence the direction of respondents answers	Loading: • One-sided alternatives • Emotionally charged words • Embarrassing answers

The intent of the surveys is to collect preliminary data to address the status of sustainability in contracting. This survey contained closed and open-ended questions to obtain quantitative and qualitative data simultaneously. Most questions were closed with fixed answers to allow for quantitative data analysis. Some open-ended questions in the survey added a qualitative component in an attempt to gather more balanced data. Researchers show that using open-ended questions can gain greater insight into the survey respondent and helps to understand complex environments (Creswell 2009).

This study used a web-based survey (Survey Monkey) to collect data. Paper surveys were also available upon request; however, none were requested. Assistance from ASHRAE, Mechanical Contractors Association of America (MCAA), and

ELECTRI International – The Foundation for Electrical Construction (ELECTRI) was critical to this research by providing contacts and aiding the survey distribution.

To address validity, the questions included several aspects of LEED construction and sustainability practices designed to gauge existing sustainability efforts in the industry. Prior to distribution, the dissertation committee and select industry professionals reviewed the questions for refinement and content.

It is noted that human factors could potentially change perceptions, so there are inherent risks with a survey study. Adding the interview component to this study helps support the reliability and consistency of results. Identical questions were administered to each survey participant in order to maintain objectivity. The survey requests did not single out particular employee positions or demographics. In addition, survey responses were volunteer and anonymous. Since few responses were received, there was a concern for response bias which was addressed by adding the interviews. The survey questionnaires were distributed to both specialty and general contractors.

This study conducted two rounds of surveys; the first round of surveys focused on specialty contractors. Specialty contractors in the parameter of this study were companies primarily in the business of providing and installing mechanical, plumbing, fire suppression, or electrical systems in commercial buildings in the continental United States. These contractors may have been involved in other specialty construction or a combination of these specialties. The specialty contractor survey is included in Appendix 1 for reference. The key questions in the survey questionnaire were designed as follows:

- Nine questions were designed to obtain a level of company demographics. These were designed to examine similarities and differences across different sectors, and what type of company was represented by the respondent. Additionally, these questions intended to be used as dependent variables if enough responses were obtained.
- One question asked the respondents their company percentage of competitively bid projects which could impact financial decisions.
- Two questions quantified participation in LEED projects by collecting quantity and percentage. These questions could also potentially be used as dependent variables in the analysis of the survey data.
- Three multiple answer, multiple choice questions addressed corporate messaging regarding sustainability.
- Three multiple answer, multiple choice questions observed whether the company had already implemented thirteen individual sustainable efforts addressing thirteen unique sustainable business practices. One multiple answer, multiple choice question addresses anticipated changes including three sustainable business practices.
- Seven Likert scale questions addressed current levels of sustainable business practices and company culture related to sustainability.
- Six Likert scale questions uncover preplanning events by the company which in turn could make projects more sustainable, and rate existing planning and organization efforts by the company that could make them more sustainable.

- Seven Likert scale questions gauged aspects of LEED and one Likert scale question addressed anticipated regulations.
- Six open-ended questions were designed to gain additional insight into sustainable business practices.

To further understand the state of sustainable business practices in the construction industry, the survey wording was modified slightly and distributed to general contractors in the United States. The general contractors may perform construction work such as concrete installation or carpentry in addition to construction management. The question content was the same in both surveys, but the reference to specialty contractor was changed to general contractor for this distribution.

4.4 – Interview Data Collection Process

The interview process intended to determine the impact of embracing sustainable business practices on contractor firm performance. The author conducted in-depth structured interviews at three general contractors in the Midwest to explore the research question further. A study of three contractors with ninety-nine interviews and observations were utilized for data collection. Records, documents, and company research were also used to support the study. Upper management at each company approved the interviews and supported employees to help with this study.

It is noted that profitability, financials, and return on investment were not available. In addition, the firm's financial position relative to competitors was not

accessible for this study. Therefore, the firm performance is quantified through strategic performance.

4.4.1 – Contractor Selection

JE Dunn, Tarlton, and A.L. Huber were selected to investigate because each implemented sustainable business practices. They were established contractors that build commercial buildings in the Midwest and provided general contractor and construction management services to their clients. All three contractors identified sustainability as a key value and company initiative. They also regularly focused on sustainability aspects in their businesses such as processes and procedures that embrace sustainability. Additionally, these three contractors were also chosen for proximity because of financial restrictions.

JE Dunn, which was founded in 1924, is a national general contractor headquartered in Kansas City, Missouri. JE Dunn was ranked 16 of 50 of leading green builders by Engineering News Record in 2014. They built and reside in their LEED Gold building that opened in 2009. At the time of the study, 330 employees were housed in their headquarters building. Featured components included daylighting, a grey water system, occupancy sensors, and high efficiency systems. The pillars of excellence at JE Dunn include safety, sustainability, value, quality, wisdom, collaboration, and integrity (JE Dunn 2014). JE Dunn added sustainability to their pillars of excellence in 2009 which drive everyday decisions of employees.

Tarlton is a regional general contractor located in St. Louis, Missouri committed to sustainable construction. Their mission statement states that “Tarlton builds our reputation as a Master Builder on the qualities of Energy, Enthusiasm,

Integrity, Responsiveness and Safety."(Tarlton 2014) This company is one of the top 400 contractors by Engineering News Record and has been in business since 1946. Tarlton emphasizes sustainable construction in their business. They built and reside in a LEED Silver headquarters building since 2004. Some unique features of their building included daylight at every office space, occupancy sensors, and high efficiency systems.

A.L. Huber is a general contractor headquartered in Overland Park, Kansas with 13 employees housed in their headquarters building. A.L. Huber has been a Kansas City area general contractor since 1903. They renovated their headquarters, added several sustainable elements in 2009 and 2010, and were committed to sustainable practices. They chose to forgo LEED existing building because the required mechanical upgrades would have considerably exceeded their budget. It made more sense to wait to upgrade their mechanical system closer to the end of the equipment's useful life and then upgrade to more efficient system components. Many could argue this choice was more sustainable than replacing units before the end of their useful life. Upgrades included punched windows, solotube skylighting, occupancy sensor lighting in select areas, new finishes, green wall, xeroscape landscaping with native, drought tolerant plantings, solar panels that serve as window shades, and a wind turbine. The company has a strong commitment to provide sustainable solutions.

4.4.2 – Interview Process

The purpose of interviews was to obtain both quantitative and qualitative data to gauge employee sustainability perceptions of the company, and evaluate

information in relation to the sustainability efforts by the company. Given the nature of sustainability in construction, looking at quantitative data or qualitative data alone does not give a holistic analysis. By taking different angles of the same questions, the desire was to determine the state of sustainability efforts in construction and its relation to firm performance. Sustainable efforts may offer competitive advantages or provide added value.

The data collection was bounded within a three-month time frame. All interviews were conducted between November 4, 2011 and January 6, 2012 at Tarlton, A.L. Huber, and JE Dunn. To protect identities, no names were collected when conducting the interviews. Sharing demographic information was also restricted.

The interview notes were recorded by hand during the interviews. After the interviews, the raw data was inputted into Microsoft Excel software application, scrubbed for consistency, and coded. Microsoft Excel was utilized for quantitative and qualitative analysis. Descriptive information (e.g., averages, percentages, and ranges) were examined. The last area of analysis reviewed the data qualitatively to search for trends and other considerations.

The coded data in Microsoft Excel was converted to a CSV file and imported into statistics software. The Statistical Analysis System (SAS) software application was used for chi-square analysis to test for associations between dependent and independent variables. Frequency procedures using the Cochran-Manzel-Haenszel (CMH) method of chi-square analysis were used for its usefulness in revealing associations. The CMH method allowed an association comparison of two groups and

allowed adjustment for control variables. This method is also helpful when combining data sets such as the interviews from the three contractors in this component of the study.

4.5 –Case Study Process

Case studies are typically used to examine modern topics in a real-life context (Yin 2014). The objective of this case study was to validate survey and interview findings related to how contractor sustainable business practices impact their firm performance.

As shown in Table 4.2, case study strengths include explaining links, multiple data sources, and ability to generalize help with validation. The case study was kept simple and limitations were clearly outlined (Groat and Wang 2002). The case study approach for this study utilized archival records, interviews, and observations to expand upon the survey and interview data collected (Creswell 2007).

Table 4.2: Case Study Strengths and Weaknesses (Groat and Wang 2002, 360)

Strengths	Weaknesses
Focus on the embeddedness of the case in its context	Potential for over-complication
Capacity to explain causal links	"Causality" likely to be multi-faceted and complex
Richness of multiple data sources	Challenge of integrating many data sources in coherent way
Ability to generalize to theory	Replication required in other cases
Compelling and convincing when done well	Difficult to do well; fewer established rules and procedures than other research designs

This single, embedded case study was conducted in the first quarter of 2015. Similar to the entire study, multiple sources of information were used for

triangulation in the case study component (Yin 2014). Data collection included reviewing documentation records of the JE Dunn headquarters building project. In-depth interviews of key personnel for this project were conducted and reviewed for additional insight into the project. Rival theories were investigated, and a participant review of the case study helped increase construct validity (Yin 2014).

4.6 – Summary

This mixed method study utilized a survey questionnaire to provide insight into current sustainability conditions in the construction industry. Ninety-nine individual interviews at three general contractors investigated the impact of sustainable business practices on strategic firm performance. Finally, a case study of the JE Dunn headquarters project helped provide additional insight for the research and provided validation for the study.

CHAPTER 5: SURVEY ANALYSIS AND RESULTS

5.1 – Introduction

Surveys were conducted to determine the existing sustainability conditions in the building construction industry. This survey a select snapshot the industry and areas for improvement relating to sustainability efforts. Two separate surveys were sent to construction contractors. The first survey was distributed to specialty contractors and the second survey was distributed to general contractors.

5.2 – Survey Responses

ASHRAE, MCAA, and ELECTRI were critical to this research by providing contacts and aiding the survey distribution. Email requests were sent to individuals on a bidder's list. Then the survey was modified slightly and distributed to general contractors through AGC – Environmental E-Forum and email requests to individuals on bidder's lists. Email reminders were sent for both surveys to maximize participation.

This study utilized the web-based survey (survey monkey) to collect data. This service tracked IP addresses to avoid multiple responses and allowed participants to save and continue at a separate time.

The responses from the specialty contractor and general contractor surveys were combined to conduct statistical analysis. Forty-five valid survey responses were received (28 from specialty contractors and 17 from general contractors). This was a 20% response rate considering the two hundred and twenty direct requests. The response rate may have depended on several factors including not receiving the request, not reading the request, recipients' time available, or interest level of

recipients. The demographic parameters such as size of company and location were not included in the results of this study because these responses varied and no trends were discovered.

The results were cleaned in Excel for consistency and import compatibility into statistics software application. Each question was assigned a unique number in sequential order to avoid duplicates. In the SAS software application, the data was analyzed with chi-square associations as best fit for the data obtained. The data was also reviewed quantitatively looking at averages, percentages, and ranges.

Table 5.1 outlines key survey questions and the areas of emphasis, which included demographics, corporate messaging, current conditions of the company, current sustainable efforts, and future expectations. Many of these questions were multiple-part questions. Appendix 1 provides the survey questionnaire, and section 4.3 discusses additional detail regarding the question format.

TABLE 5.1 Key Survey Questions

Emphasis	Key Survey Questions
Demographics	What is your primary area of business?
	Which range best describes your company's annual revenue?
	Is your company union, non-union or both?
Company Messaging	Select the following parameters that are included in your company's mission statement.
	Select the following parameters that are included in your company's strategic plan.
	Select the following parameters that are included in your company's operational or business plan.
Current Conditions	Your company has worked on how many LEED projects?
	Approximately what percentage of your projects in 2009 are LEED certified?
	Approximately what percentage of your projects are competitively bid?
	How does your company plan projects?
	Select the items your company incorporates into project planning.
	Rate the following items as they pertain to your company.
Current Sustainable Business Practices	Select the following actions that have been implemented at your office.
	Select the practices your company regularly incorporates.
	How does your company consider environmental impacts in business decisions?
	How does your company invest in improving productivity?
	Rate the following LEED items as they pertain to your company.
Future Expectations	Select the items your company is considering changing.
	What is your primary concern for the future of your company?

5.3 – Survey Results

Figure 5.1 shows different types of contractors who responded to the survey. The majority of respondents were mechanical (36%) and general contractors (21%).

Respondents in the other category (24%) included contractors in business primarily for low voltage, structural steel, roofing, concrete, asphalt, or department of defense work. Companies consisted of both union and non-union trades.

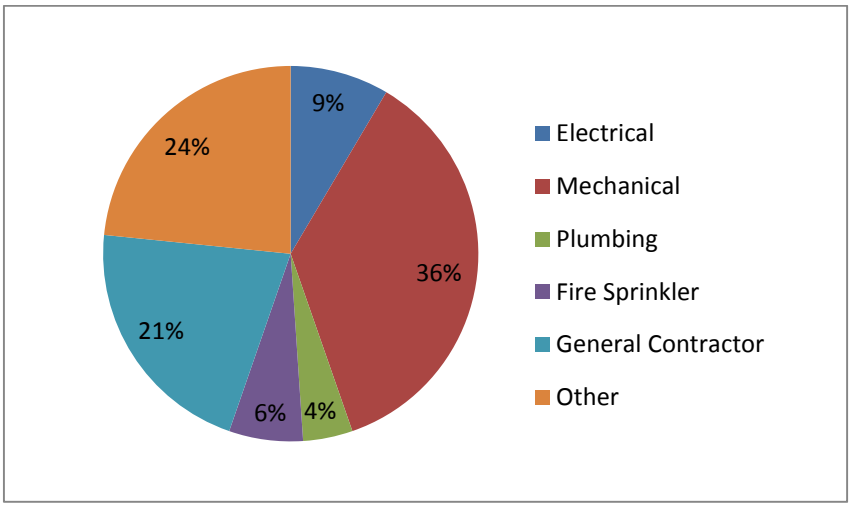

Figure 5.1: Types of Contractors

None of the companies represented were micro companies under $2 million in annual revenue. As illustrated in Figure 5.2, annual revenue for the companies ranged from two million to over 30 million dollars. Specifically, seven respondents stated that the annual revenue of their company was $2-5 million, five reported $5-10 million, nine reported $10-20 million, five reported $20-30 million, and fifteen reported over $30 million dollars of annual revenue. This demonstrated an appropriate sampling distribution of revenue size for commercial building contractors.

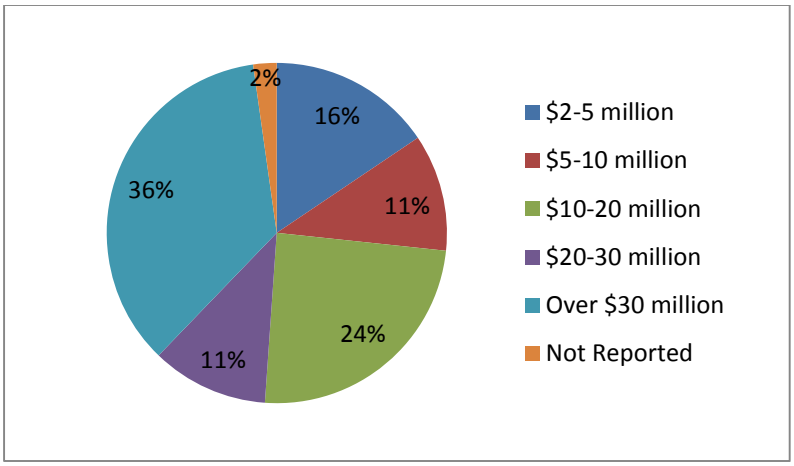

Figure 5.2: Annual Revenue

The number of LEED projects reported ranged from zero to 100 projects with an average of almost thirteen projects. Figure 5.3 shows 89% of respondents' companies are involved with LEED projects. Only 11% did not report having LEED projects within the past year.

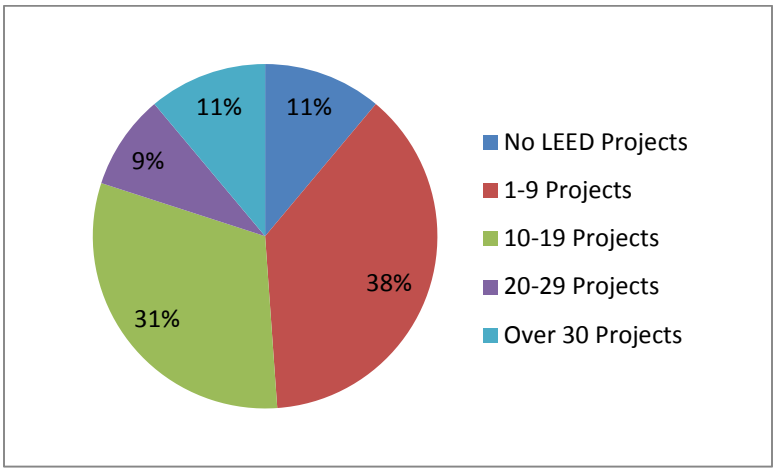

Figure 5.3: Quantity of LEED Projects in the Previous Year

To further understand the exposure of the companies to LEED projects, the percentage of LEED certified projects within the past year was evaluated. The percentage of LEED projects for each company ranged from zero to 50% with an

average of 6% as shown in Figure 5.4. Sixty-percent of responses were within 1-29%, and 18% reported over 40% LEED projects.

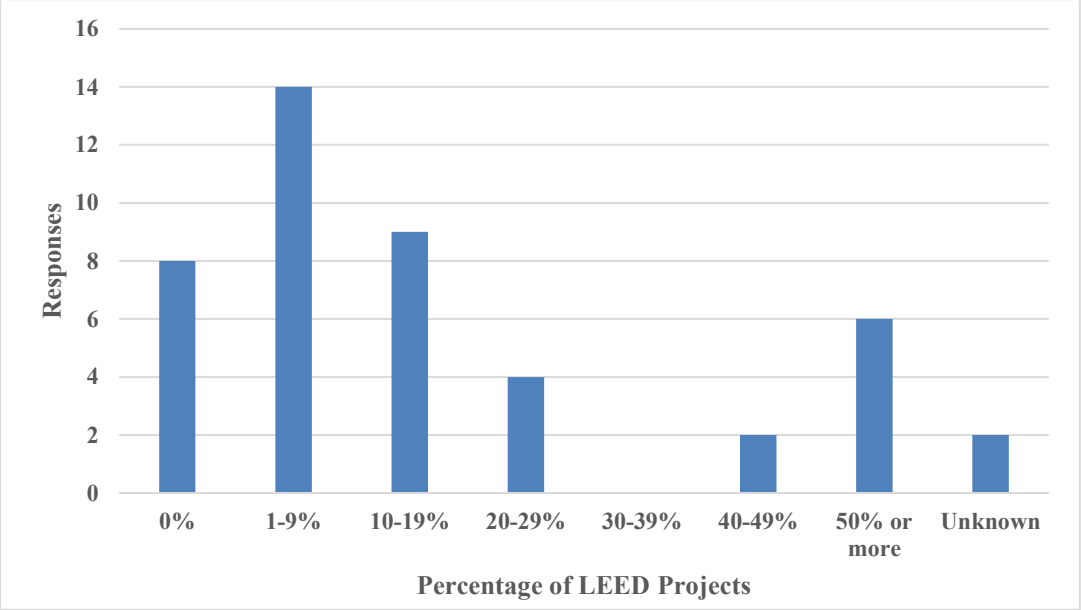

Figure 5.4: Percentage of LEED Projects in the Previous Year

There was a slight discrepancy between those reporting zero LEED projects (11%) and zero percent of LEED projects (16%). Regardless of which was accurate, the majority of companies had exposure to LEED projects. The other key point was the percentage and quantity of LEED projects for most companies was relatively low indicating room for growth. Thus, understanding how construction and sustainability interrelate should help most companies.

Eighty percent of respondents stated that their company tracked proposal and bid success rates. Percentage of projects competitively bid ranged from 0 to 100 percent with an average of 55 percent. Not all work procured was from competitively bid projects as shown in Figure 5.5. This indicated a significant amount of projects

procured were not based on cost alone. Best overall value often requires differentiators from competitors or market advantages.

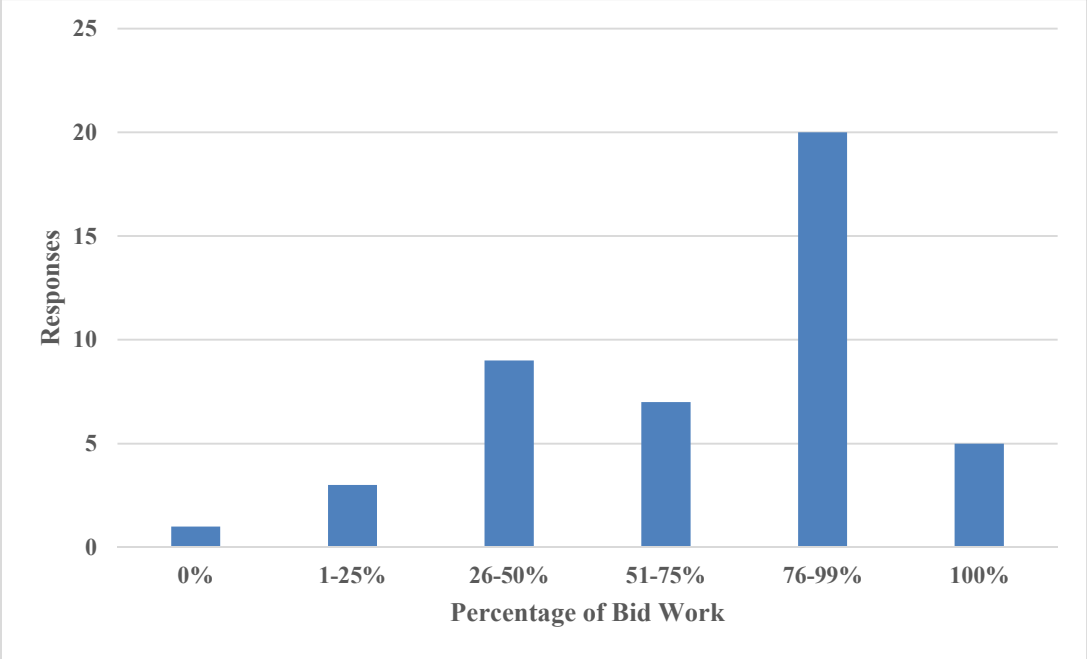

Figure 5.5: Percentage of Competitively Bid Work

Fourteen participants did not respond regarding how their company considered environmental impacts in business decisions. This suggested that many respondents did not know this information for their company, or they were unsure how to respond. Other responses included following the law and regulations, avoiding risks, cost considerations, not considering environmental impacts, pre-planning, prefabrication, and reducing waste. The responses varied with this question, and no trends were discovered. These findings suggested environmental sustainability was not a key value for most construction companies.

The top concerns for the future included new projects, the economy, and profits. This indicated a concern related to backlog and acquiring future work.

Concerns also related to keeping a competitive edge. Each of these three top concerns appear interrelated and linked to procuring continuous profitable work for the company. If a significant amount of work was negotiated as indicated, the companies would need competitive advantages other than purely a price point. The responses suggested that any advantage for improving backlog and opportunities for projects would be well received. Most contractors would also appreciate advantages that could minimize risk. These responses substantiated that sustainability was a secondary concern among contractors unless it was viewed as helping to achieve these goals.

When asked how the company invested in improving productivity, fourteen surveys left the response blank. Seven responded technology, seven responded equipment, six responded training, five responded pre-planning, four responded tracking progress, and one responded pre-fabrication. This indicated a majority of the companies surveyed were investing in improving productivity even if they were focused on different aspects of improving productivity. The responses suggested productivity was a focus of many contractors as it impacts financial success. This indicated the majority of contractors would consider changes that improved productivity.

5.4 – Comparison of Sustainable Practices among Different Company Types

It was important to consider differences between the types of construction companies represented in this questionnaire. The survey data analyses searched for an association between sustainable business practices while controlling for type of company to determine if there are any trends for the eight different types of

construction companies represented. A generalized Cochran-Mantel-Haenszel test for conditional dependence aimed at detecting association was ran. In order for a p-value to be deemed significant, it must be less than 0.05.

5.4.1 – Office Sustainability Efforts

Table 5.2 summarizes thirteen sustainable business practices in the survey related to the office environment. Refer to Appendix 2 for select statistical output which supports the table in this section. No associations between the type of company and office sustainable business practices were observed.

Table 5.2 Office Sustainable Efforts Controlling for Type of Company

Variable	Office Sustainable Efforts	P-Value
19a	HVAC adjusted during unoccupied times	0.2812
19b	Automated mechanical controls	0.3502
19c	Energy efficient HVAC	0.2510
19d	Energy efficient appliances	0.6889
19e	Building insulation improvements	0.6346
20a	Energy efficient lighting	0.7943
20b	Automated lighting controls	0.7590
20c	Daylight controls	0.8865
20d	Efficient water fixtures	0.7893
21a	Recycling	0.0731
21b	Purchasing recycled materials	0.2930
21c	Composting	N/A
21d	Carpooling	0.7518

The values in Table 5.2 were determined by conducting chi-square analyses to test for associations. For example, variable 19a had a p-value of 0.2812. This p-value was greater than 0.05 which demonstrated no statistically significant variation between the type of companies and the sustainable business practice of adjusting HVAC settings during non-occupied hours.

Participants were asked about anticipated changes at their offices. Table 5.3 shows there was no statistically significant difference between type of company and the sustainable changes anticipated. Refer to Appendix 3 for select statistical output which supports these test results.

Table 5.3 Anticipated Changes Controlling for Type of Company

Variable	Anticipated Changes	P- Value
22a	Office building energy efficiency changes	0.2376
22b	Reducing water consumption	0.1768
22c	Adding recycling and/or composting	0.9251

Office sustainability efforts did not vary between different types of construction companies. Each type of company represented in the surveys was at a similar stage regarding office sustainable business practices.

5.4.2 – Operations Sustainability Efforts

Table 5.4 summarizes the chi-square association tests conducted for dependent variable area of business with independent variables for operational sustainability efforts at the company (variables 24-44). The null hypothesis assumed the type of business will not have an effect company's sustainability efforts. Refer to Appendix 4 for select statistical output which supports these test results. Only one of the p-values in this set were within the association parameters, so the null hypothesis could not be rejected for most of the operations sustainable efforts.

Table 5.4 Operations Sustainable Efforts Controlling for Type of Company

Variable	Operations Sustainable Efforts	P-Value
24	Plans ahead to minimize deliveries	0.9094
25	Maintains an inventory of frequently used materials	0.9572
26	Seeks out "green" projects	0.8893
27	Sustainability is considered in business decisions	0.5574
28	Recycles in the office	0.4289
29	Tracks proposal/bid success rates	0.5111
30	Searching for opportunities in sustainable markets	0.9907
31	Employees propose alternative methods for executing project tasks	0.9434
32	Management is actively involved in evaluating installation methods	0.1832
33	Company recycles or reuses demolition and scrap material	0.6239
34	Company has a quality plan	0.1478
35	Company has incentives for employee innovations	0.2070
36	Company has an indoor air quality plan for projects	0.2558
37	Qualified to participate in LEED projects	0.0486
38	Willing to participate in LEED projects	0.3172
39	Provided voluntary alternates for LEED credits	0.5515
40	Encourages employees to seek LEED accreditation	0.4110
41	Provides training pertaining to LEED and/or sustainability	0.4877
42	Considers LEED a passing trend	0.2450
43	Considers LEED as the best way to measure sustainability	0.8554
44	Anticipates more stringent sustainability regulations	0.8491

The association for the test between area of business and company qualification to participate in LEED projects (variable 37) had a p-value of 0.0486, which was statistically significant. This finding suggested potential differentiation between the various types of companies and qualification to participate in LEED projects. In the surveys, more general contractors indicated qualification for LEED projects than the other company types. This was expected since general contractors were typically required to complete LEED applications and documentation. This also

indicated targeting sustainability education for specialty contractors could have greater impact. Future study regarding qualification for LEED projects may be beneficial.

5.4.3 – Company Leadership and Vision

Several parameters were reviewed regarding corporate messaging. Corporate messaging included what sustainability components the company emphasized in their mission statements, strategic plan, and operations plan. As Table 5.5 demonstrates, corporate messaging did not vary by type of company. Refer to Appendix 5 for select statistical output which supports these test results.

For example, when investigating if the company's mission statement included sustainability (variable 16a) was associated with the type of company, the p-value was 0.6840. No notable variation for the type of construction companies was detected for corporate messaging regarding sustainability, environmental responsibility, and social responsibility.

Table 5.5 Corporate Messaging Controlling for Type of Company

Variable	Corporate Vision	P-Value
16a	Mission statement includes sustainability	0.6840
16b	Mission statement includes environmental responsibility	0.3960
16c	Mission statement includes social responsibility	0.3012
17a	Strategic plan includes sustainability	0.5260
17b	Strategic plan includes environmental responsibility	0.0718
17c	Strategic plan includes social responsibility	0.3986
18a	Operations plan includes sustainability	0.3618
18b	Operations plan includes environmental responsibility	0.2687
18c	Operations plan includes social responsibility	0.1916

Table 5.6 summarizes the associations between the sustainable messages. Refer to Appendix 6 for select statistical output which supports these test results. The relationships between the different corporate messages revealed consistency regarding sustainability and social responsibility messages. Association tests indicated some inconsistency among environmental responsibility messages. Since only positive correlations were found, the variables appear to be moving in tandem and not opposite each other. The associations with company messages and strategies relative to sustainability and social responsibility was a notable finding to show consistency among messaging.

Table 5.6 Consistency in Corporate Messaging

Dependent Variable	Independent Variable	P-Value
Mission Statement includes Sustainability	Strategic Plan includes Sustainability	0.0076
Mission Statement includes Sustainability	Operations Plan includes Sustainability	0.0001
Strategic Plan includes Sustainability	Operations Plan includes Sustainability	0.0002
Mission Statement includes Environmental Responsibility	Strategic Plan includes Environmental Responsibility	0.1109
Mission Statement includes Environmental Responsibility	Operations Plan includes Environmental Responsibility	0.0001
Strategic Plan includes Environmental Responsibility	Operations Plan includes Environmental Responsibility	0.1332
Mission Statement includes Social Responsibility	Strategic Plan includes Social Responsibility	0.0044
Mission Statement includes Social Responsibility	Operations Plan includes Social Responsibility	0.0001
Strategic Plan includes Social Responsibility	Operations Plan includes Social Responsibility	0.0005

As shown in Table, 5.6, seven associations had p-values less than 0.05. These p-values indicated consistency between corporate messages. Overall, messaging for

sustainability and social responsibility was relatively consistent for the contractors. The two p-values greater than 0.05 indicated less consistency with environmental responsibility messages. This was likely due to the 16% response rate for the strategic plan included environmental responsibility, which was a lower response rate than the other corporate messages. Overall, messaging did not vary by type of contractor and most messaging was consistent.

5.5 – Sustainability in the Construction Industry

Additional review of the aggregate survey data was necessary to understand present conditions of the construction industry with regard to sustainability. Several quantitative considerations were taken into account for the survey data in this section. The following considerations did not rely on type of company.

5.5.1 – Existing Conditions

As shown in the survey results section, the companies averaged thirteen LEED projects. This represented about six percent of their work in the past year. While these numbers may seem small, only eleven percent of respondents reported that they did not work on a LEED project. LEED projects made up a significant portion of the building construction marketplace because regulations required government building construction projects to be LEED certified. Other projects required LEED for reasons such as energy savings, better environments for occupants, client values, and marketing benefits. Contractors may benefit from understanding sustainability and LEED requirements to effectively compete and seize some of this market share.

Table 5.7 illustrates LEED considerations according to the surveys. Positive responses affirmed the statements or answered in alignment with the statement.

Table 5.7 LEED Considerations

LEED Considerations	Positive Response
Qualified to participate in LEED projects	78%
Willing to participate in LEED projects	78%
Provided voluntary alternates for LEED credits	78%
Encourages employees to seek LEED accreditation	80%
Provides training pertaining to LEED and/or sustainability	80%
Considers LEED a passing trend	78%
Considers LEED as the best way to measure sustainability	78%

As observed in Table 5.7, eighty percent of respondents' companies encouraged employees to seek LEED accreditation and provided training pertaining to LEED and/or sustainability. Seventy eight percent considered LEED as the best tool to measure sustainability. Surprisingly seventy-eight percent considered LEED a passing trend. These findings suggest mixed notions about the value LEED certification provides for projects. Overall, it appeared that companies considered LEED important to their business.

Table 5.8 illustrates response rates for existing office conditions related to sustainable business practices. Some areas of sustainability were going fairly well at respondents' offices. Eighty-four percent recycle at their office. Sixty-seven percent state HVAC adjustments were made at their office during unoccupied times. Fifty-one percent said they have automated mechanical controls at their office, and almost half (47%) had energy efficient lighting at their office. Significantly lower percentages reported energy efficient HVAC, energy efficient appliances, building

insulation improvements, automated lighting controls, daylighting, and efficient water fixtures, which suggest areas for improvement at contractor offices.

Table 5.8 Office Existing Conditions

Sustainable Business Practice	Response Rate
HVAC adjustments during unoccupied times	67%
Automated mechanical controls	51%
Energy efficient HVAC	29%
Energy efficient appliances	22%
Building insulation improvements	16%
Energy efficient lighting	47%
Automated lighting controls	29%
Daylight controls	11%
Efficient water fixtures	24%
Purchasing recycled materials	42%
Composting	2%
Carpooling	22%
Recycles in the office	84%

Table 5.9 illustrates planning efforts at the companies observed. Eighty percent of respondents' companies tracked proposal/bid success rates. Companies were aware that a backlog of projects was critical to maintaining operations, staffing, and cash flow. In order to improve project success rates, eighty-four percent sought sustainable projects and eighty percent were searching for opportunities in sustainable markets. Eighty-seven percent expressed that sustainability was considered in business decisions. These were all worthy indicators that sustainability was at the forefront of business decisions when impacting firm performance.

Table 5.9 Planning Efforts

Sustainable Business Practice	Response Rate
Pre-construction planning meetings	82%
Project handoff meetings	78%
Progress planning meetings	78%
Post-construction review meetings	67%
Plans ahead to minimize deliveries	80%
Maintains an inventory of frequently used materials	82%
Seeks out "green" projects	84%
Sustainability is considered in business decisions	87%
Tracks proposal/bid success rates	80%
Searching for opportunities in sustainable markets	80%
Your employees propose alternative methods for executing project tasks	76%
Your management is actively involved in evaluating installation methods	78%
Your company recycles or reuses demolition and scrap material	78%
Your company has a quality plan	80%
Your company has incentives for employee innovations	78%
Your company has an indoor air quality plan for projects	80%

It was important to analyze specific planning procedures related to sustainability efforts. Eighty percent of respondents' companies planned ahead to minimize number of deliveries, and eighty-two percent maintained an inventory of frequently used materials. These material efficiency considerations were encouraging since minimizing deliveries and stocking common materials can be more efficient and environmentally conscious. Seventy-eight percent of responses stated their company recycles or reuses demolition and scrap material. Eighty percent had an indoor air quality plan for projects. Seventy-eight percent were qualified and willing to participate on LEED projects, and these same respondents also indicated their company provided voluntary alternates on LEED projects to try to add value to their

projects. These were positive results indicating active involvement in sustainability efforts. However, only 42% purchased recycled materials, 22% carpooled regularly, and 2% composted.

As shown in Table 5.10, the majority of companies did not include sustainability, environmental responsibility, and social responsibility in their corporate messaging. Less than 50% of responses (ranging from 16% to 47%) indicated that their company mission statement, company strategic plan and company operational or business plans included sustainability, environmental responsibility, and social responsibility. Positive responses ranged from 31% to 42% for mission statements, 16% to 33% for strategic planning, and 44% to 53% for operational business plans. The exception was that fifty-three percent reported that their operational or business plan included sustainability.

Table 5.10 Corporate Messaging

Corporate Messaging	Response Rate
Mission Statement includes Sustainability	38%
Mission Statement includes Environmental Responsibility	31%
Mission Statement includes Social Responsibility	42%
Strategic Plan includes Sustainability	33%
Strategic Plan includes Environmental Responsibility	16%
Strategic Plan includes Social Responsibility	18%
Operations Plan includes Sustainability	53%
Operations Plan includes Environmental Responsibility	44%
Operations Plan includes Social Responsibility	47%

Findings indicated sustainability, environmental responsibility, and social responsibility were not primary factors in the current company messaging. Since sustainability was not a key component for the majority of corporate messages, these

results indicated that most construction companies do not consider sustainability a core value.

The current conditions suggested that many contractors considered sustainability at a basic level; however, sustainability did not drive all aspects of business. The current construction industry conditions showed small initial steps towards sustainable business practices, but indicated considerable opportunity for improvement.

5.5.2 – Future Expectations

The survey addressed future expectations as well as existing conditions of sustainability efforts in the construction industry. Table 5.11 summarizes some important future considerations by the contractors surveyed.

Table 5.11 Future Considerations

Anticipated Sustainable Changes	Response Rate
Office building energy efficiency changes	24%
Reducing water consumption	7%
Adding recycling and/or composting	4%
Seeks green projects	84%
Searches for opportunities in sustainable markets	80%
Employees propose alternative procedures	76%
Management actively evaluates installation methods	78%
Incentivizes employee innovations	78%
Sustainability is considered in business decisions	87%
Anticipates more stringent sustainability regulations	80%

Only a small percentage of companies considered the following changes: office building energy efficiency changes (24%), reducing water consumptions (7%), and adding recycling or composting (4%). This low interest level of anticipated improvements suggested only a partial commitment to sustainability. Sustainable

business practices could be improved with education, awareness, and analyzing returns on sustainable investments.

At the same time, eighty percent of responses indicated their company was actively searching for opportunities in sustainable markets. Seventy-six percent reported that their employees proposed alternative methods for executing project tasks. Seventy-eight percent stipulated management was actively involved in evaluating installation methods. Seventy-eight percent said that their company had incentives for employee innovations. These factors suggested growing interest in sustainability when it was related to business performance.

Moreover, eighty percent anticipated more stringent sustainability regulations in the future. The survey showed productivity, project opportunities, and market advantage was important to many of the survey respondents. Additionally, concerns for the future included obtaining new projects (backlog), the economy, making a profit, and tough competition. These results indicated that many companies envision sustainability changes forthcoming, so market advantage a company could obtain in areas of sustainability should be considered.

Survey data revealed mixed messages of action and interest in relation to sustainability. If sustainability efforts improve productivity, project opportunities, or market advantage, more contractors may be eager to embrace new sustainability efforts and focus.

5.6 – Summary

The different types of contractors did not have notable differences in office sustainable business practices, operations sustainability efforts, or corporate messaging. The survey results found most respondents were involved with LEED projects, qualified and willing to be involved with LEED projects, provided voluntary alternates to support LEED efforts, and encouraged LEED training and accreditation for their employees.

Initial sustainability efforts such as recycling and indoor air quality plans existed. Unfortunately, exposure to LEED projects did not appear to influence sustainable business practices. Contractors were not integrating many sustainable business practices or intending to make sustainable improvements. Corporate sustainability messaging was relatively consistent, but demonstrated little emphasis on sustainability, environmental responsibility, and social responsibility.

The surveys provided evidence that sustainability has not been fully embraced in the construction field. It appeared that sustainability was not a key value for most construction companies, and sustainable efforts were limited to project requirements and performance enhancement actions. As expected, the surveys indicated that the construction industry has substantial room for improvement in sustainability. In depth interviews, as reported in the following chapter, were an approved method to further explore existing practice in the research context.

CHAPTER 6: INTERVIEW ANALYSIS AND RESULTS

6.1 – Introduction

This chapter presents the findings from the structured interviews with three general contractors: JE Dunn Construction, Tarlton Corporation, and A.L. Huber General Contractor. These three contractors adopted and internalized sustainability as a corporate value and actively incorporated sustainable business practices. Each contractor had a LEED certified headquarters or sustainably renovated headquarters. All three had sustainability as a key value and company initiative. Each contractor continuously strived to improve sustainability efforts.

The three contractors were of different sizes to provide variance. JE Dunn is a large national contractor with revenue of about $2 billion annually. Tarlton is a mid-size regional contractor with revenue of about $100 million annually. A.L. Huber is a relatively smaller regional contractor with annual revenue of about $5 million annually. While each company provided construction management services, they also self-performed portions of construction projects. By self-performing work, each of these contractors employed tradespeople who put construction work in place, owned equipment, and procured materials to build parts of construction projects such as cast-in-place concrete, carpentry, and/or masonry. These contractors were also chosen for proximity because of financial restrictions.

The author conducted 99 employee interviews in person from November 2011 through January 2012. All interviewees were current employees and were located at the headquarters office during the interviews. There was a wide range of individuals, who took part in the interview process, including numerous departments, positions,

backgrounds, and company tenure. Inclusion of a wide range of interviewees was important to obtain a comprehensive view of the companies. Each interview was approximately 15 minutes and all interviews followed the same script which asked questions in sequential order.

6.2 – Interview Questions

As noted in the Chapter 4, structured interviews with the same set of questions were conducted. To drive consistency, the author administered all interviews, and notes were taken by hand. To protect anonymity of interviewees, demographics such as gender, age, and race were not used in this study.

Questions were restricted to protect proprietary company information such as profit information and confidential clients. The interview questions were reviewed by the dissertation committee, and vetted with select people in the construction industry for content, clarity, and word refinement. Each company had a representative review and approve the interview questions prior to starting interviews.

The interview questions pursued various information about the company current conditions regarding sustainability. Questions gauged employee perceptions of the company's sustainability efforts. Some questions reviewed current work conditions and specific building spaces. Other questions addressed differences between the previous office building and the current building that was built or renovated with a sustainability focus.

In addition to determining current conditions, questions searched for direct or indirect impacts from sustainability efforts. Questions were designed to determine if sustainability efforts impacted the company, employees, and/or clients. Questions

determined changes in employee behaviors, employee satisfaction, and company culture. Questions also looked at market advantages impacted by sustainability efforts. Interviewees were allowed to discuss, comment and expand upon questions. They were also given free reign at the end of the interview to offer additional thoughts. Table 6.1 summarizes the key interview questions by area of emphasis.

TABLE 6.1 Key Interview Questions

Emphasis	Key Interview Questions
Work Conditions	What do you like/dislike about your work station?
	What do you like/dislike about the common areas?
	What do you like/dislike about the meeting rooms?
	What is your opinion on the visual privacy level?
	What is your opinion on the acoustical privacy level?
	Do often do you utilize recycling and composting? Is it easy to participate?
	What are your thoughts on the daylighting?
	How is the indoor air quality?
Employee Morale	How does the work environment impact collaborative/group work?
	How does the work environment impact your learning and skill development?
	How does the work environment impact social/interactive activities?
	Do you work more or less hours? Why?
	Do you enjoy coming to work more than the previous facility?
	Are co-workers more or less helpful?
Project Opportunities	How do you rate sustainability as a corporate value?
	How has social responsibility varied?
	How has community involvement varied?
	Have the sustainability changes attracted new clients?
Market Advantage	What level of commitment to sustainability is demonstrated on non-LEED projects?
	Have the sustainability changes attracted new talent?
	Have the sustainability changes helped retain talent?
	How has the employee culture changed?
	What has changed in planning and executing jobs?

This chapter discusses these interview questions, responses, and analysis in detail. An overview of responses is summarized in section 6.3. The first two emphases are work conditions and employee morale that make up employee satisfaction, which is addressed in section 6.4. Project opportunities are analyzed in section 6.5, and market advantage is analyzed in section 6.6. Current conditions and growth opportunities are discussed in section 6.7.

6.3 – Interview Responses

The author conducted 99 employee interviews at three general contractors (JE Dunn Construction, Tarlton Corporation, and A.L. Huber General Contactor). Table 6.2 summarizes the interviews associated with each contractor.

Table 6.2: Summary of Interviews Conducted

Company	Number of Interviews	Employees Based at Location	Percentage
JE Dunn	62	330	19%
Tarlton	28	35	80%
A.L. Huber	9	13	69%
Aggregate	99	378	26%

Table 6.3 illustrates the types of responses from the interviews. Positive-leading questions were worded to try to obtain advantageous aspects. Negative-leading questions were worded to try to obtain disadvantageous characteristics. Positive responses focused on benefits and advantages. Negative responses focused on drawbacks or areas for improvement.

Table 6.3: Type of Interview Responses

Type of Question	Positive Reponses	Neutral Responses	Negative Responses
Positive-leading Questions	74%	22%	4%
Neutral Questions	66%	27%	8%
Negative-leading Questions	38%	19%	42%
Aggregate	61%	25%	14%

As observed in Table 6.3, eighty-six percent of responses were positive or neutral with only fourteen percent negative responses. It must be noted, a couple outlier skeptical interviewees thought the company's sustainability efforts were for marketing purposes. These individuals did not see apparent benefits from these efforts.

Eight-five interviewees were consistently optimistic about their new sustainable environment and the efforts their company was making to embrace sustainability. Responses included sustainability was a "part of everything we do," "we're always thinking about sustainability," and sustainable efforts "represent the company well." Interviewees spoke positively about their company's current condition. Employees expressed strong positive responses regarding their company, work conditions and their sustainable progress. Comments included this was a "great company", this was a "great place to work", and this was a "better working environment."

6.4 – Employee Satisfaction Analysis

Attrition, absenteeism, and performance are influenced by employee morale (WeiBo et al. 2010). Employee satisfaction is important in all business including construction. If employees see sustainability efforts as a positive attribute, sustainable business practices may increase employee satisfaction. This section discusses employee satisfaction related to work conditions and employee morale.

6.4.1 – Work Conditions

The interviewees were asked their opinions of their individual workspace, the building's common areas, and meeting rooms. Table 6.4 summarizes some important attributes of the work conditions.

Table 6.4 Work Conditions

Work Conditions	Satisfied	Not Satisfied	Unsure
Individual Workspaces	81%	2%	17%
Common Areas	85%	1%	14%
Meeting Rooms	94%	0%	6%
Individual Work	73%	6%	21%
Collaboration	85%	5%	10%
Learning/Skill Development	64%	2%	34%
Social/Interactive	90%	4%	6%
Daylighting	83%	11%	6%
Indoor Air Quality	83%	8%	9%

As summarized in Table 6.4, employees were satisfied with their individual work spaces, common areas, and meeting rooms. Interviewees comments included they "wouldn't change anything" regarding their work conditions, and they reported "more pride in where I work." Employees were "more positive about the workspace, more positive about the company."

Seventy-three percent (n=72) indicated sustainable efforts helped individual work conditions. Eighty-five percent (n=84) stated that sustainability efforts helped with collaboration. Sixty-four percent (n=63) specified it helped with learning and skill development. Ninety percent (n=89) reported that it helped create a more social and interactive environment.

Eighty-three percent (n=82) indicated they like or love the day lighting that was incorporated into the new or renovated building. Comments regarding the natural light included the interviewee "loves the natural light," and was "more energized because of the light." Interviewees also noted they were "happier because of the environment" and more "energetic." These comments appear to contribute to employee happiness.

Eighty-three percent of interviewees perceived the indoor air quality was good or improved at their office as shown in Figure 6.1. Sixty-three percent (n=62) stated the indoor air quality was fine in their new building. An additional twenty percent (n=20) stated that the indoor air quality was improved or they experienced fewer sick days. Only eight percent of interviewees indicated indoor air quality was not improved, and nine percent were unsure.

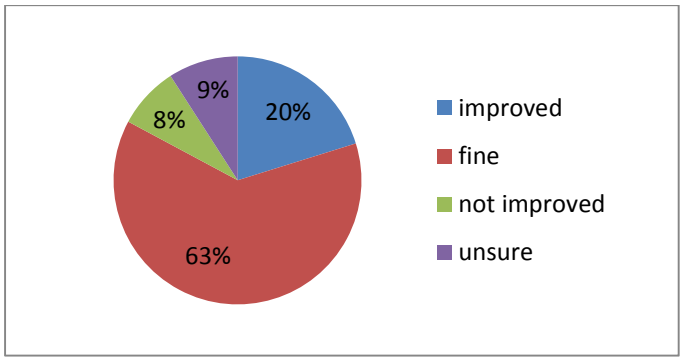

Figure 6.1: Satisfactory Indoor Air Quality

Interviewees reported less sickness, allergies, and headaches. Interviewees indicated that they had a "healthy environment" and they were "happier because of the environment." Of all of the respondents, seventy-five percent (n=74) thought indoor air quality affected occupants' health. Indoor air quality was not evaluated before the sustainability changes, so a direct comparison could not be assessed.

Figure 6.2 shows favorite aspects of individual workspaces included natural lighting and openness of the space. Responses varied because of variability in individual workspaces. Some respondents had more ideal work areas and were gushing with praises. A few did not have natural lighting or were in less desirable locations, so this contributed to the variance in the responses. Seventy-six percent (n=75) were satisfied with their workspace, and twenty-four percent (n=24) were neutral and did not have specific comments.

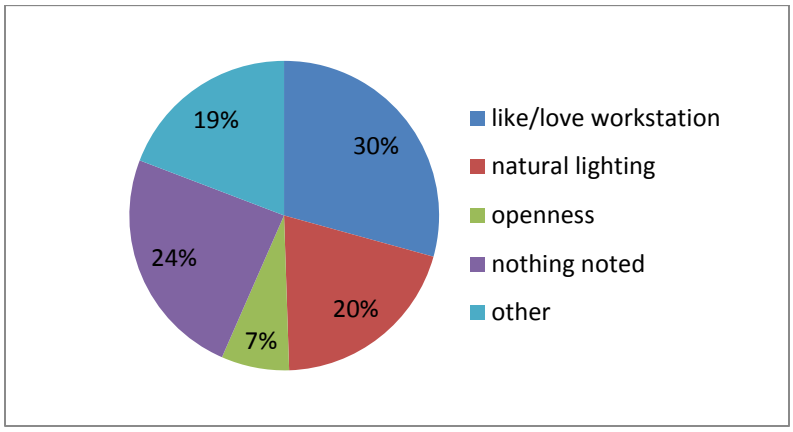

Figure 6.2: Comments about Workspaces

Interviewees were asked to provide feedback on their favorite aspects of the common areas (i.e., lobby, break rooms, restrooms). As shown in Figure 6.3, thirty percent (n=29) liked or loved the common areas in their entirety. Seventeen percent (n=17) liked the openness of the environment, nine percent (n=9) liked the natural

lighting, and fifteen percent (n=15) noted other positive aspects of the common areas. Twenty-nine percent (n=29) did not have particular comments. Satisfaction with the common areas contributed to enjoyable work conditions.

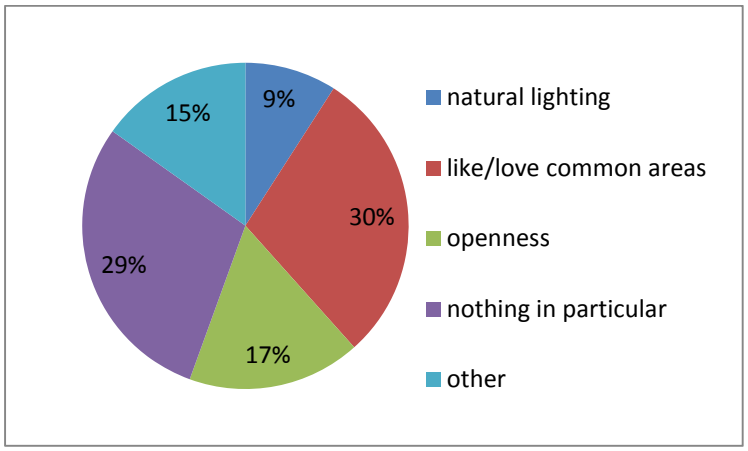

Figure 6.3: Comments about Common Areas

Figure 6.4 illustrates sixty-nine percent (n=68) respond they liked or loved the meeting rooms in their entirety. Seventeen percent (n=17) were impressed with the technology available at meeting rooms and ten percent (n=10) were impressed with the overall design. Satisfaction with the meeting rooms contributed to enhanced work conditions.

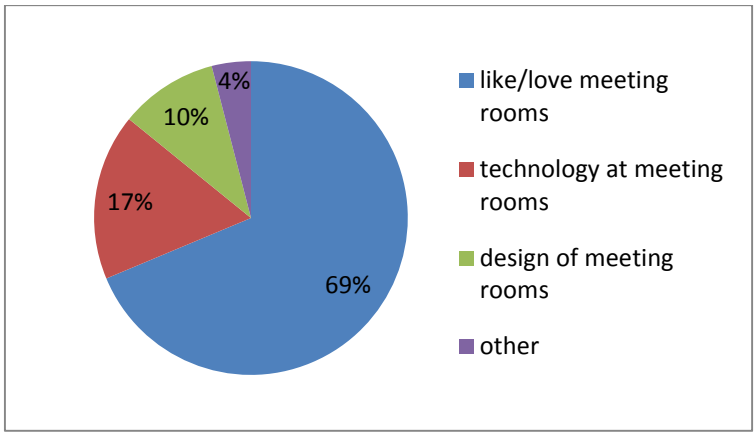

Figure 6.4: Comments about Meeting Rooms

Each interviewee was asked to pick one aspect to change about their workspace (reference Figure 6.5). Twenty-eight percent (n=27) did not want any changes. Desired changes included increasing the size of the workspace, acoustics, better temperature control, lighting, layout, and offering a closed office option. Many interviewees gave extra consideration to this question, and the responses were varied as shown in Figure 6.5.

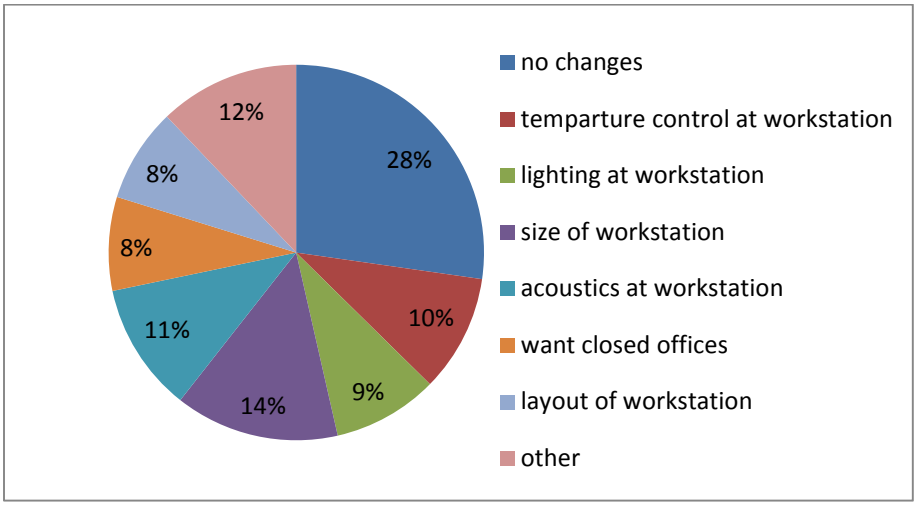

Figure 6.5: Changes Desired for Individual Workspaces

Each person was asked to choose one aspect to change about the common areas. The most common request for change was to the overall design of the common spaces and acoustics as shown in Figure 6.6. Seventy-one percent were pleased with the common areas and did not desire changes. This contributed to the employee satisfaction level regarding work conditions.

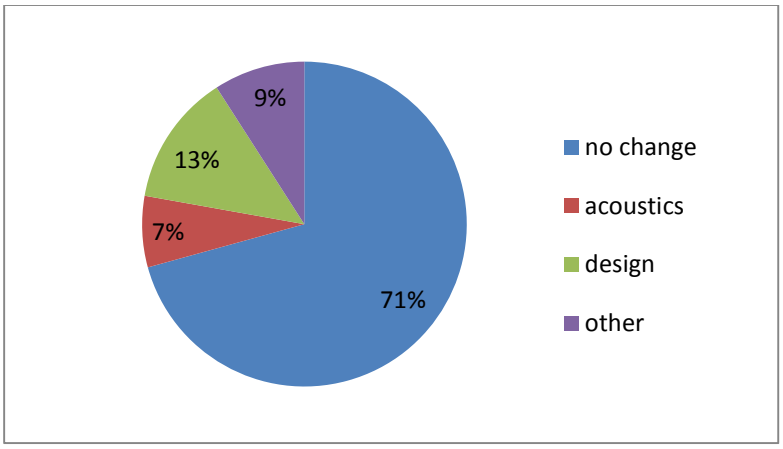

Figure 6.6: Changes Desired for Common Areas

Each person was asked to choose one feature to change about the meeting rooms and the responses are illustrated in Figure 6.7. The majority did not want changes to the meeting rooms. Suggested changes varied and included increasing meeting room size, improving technology, overall design, temperature control, acoustics, and having more rooms available. Figure 6.7 illustrates 59% did not desire changes to the meeting rooms; thus indicating general satisfaction with meeting room work conditions.

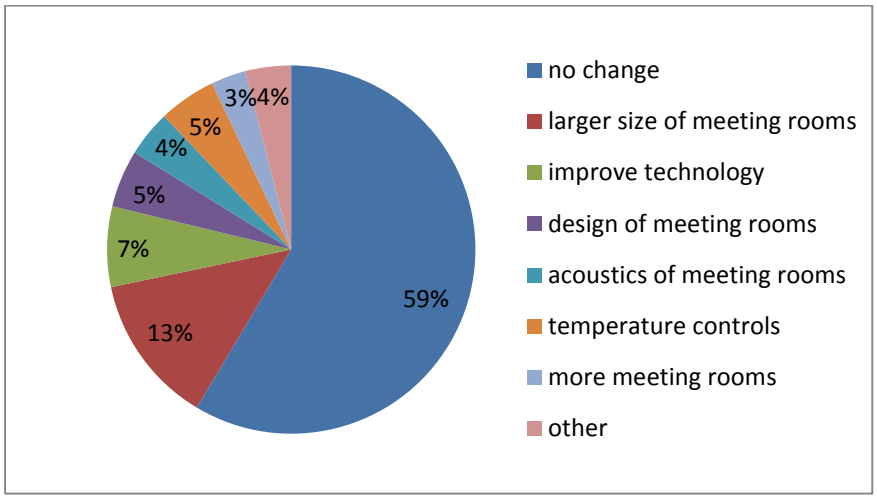

Figure 6.7: Changes Desired for Meeting Rooms

No significant building improvements were noted for the individual workspaces, common areas, or meeting rooms. As illustrated in the previous three tables, varied suggestions for improvement were small quantities of the responses. Improvements should be considered, but additional study is suggested to provide focus on which areas to change to provide the best impact. A deeper look into the individual work environment in the following section provides additional insight into work conditions.

6.4.2 – Visual and Acoustical Considerations

The sustainable design of each of the contractors' headquarters included an open office concept for the majority of employees. Overall, seventy-two percent indicated the new environment helped with individual efforts. Refer to Figures 6.7 and 6.8 which demonstrate visual privacy levels from open office environments were not a significant concern. The majority of employees were satisfied with the open office condition when it related to visual privacy levels.

Figure 6.8 shows seventy-six percent (n=76) were satisfied with the visual privacy levels. Twenty four percent (n=24) did not like the visual privacy levels, wanted a door (closed office), or mentioned other improvements desired. Figure 6.9 shows eighty percent (n=79) and eighty-three percent (n=82) were okay and liked the visual privacy level, respectively. The majority were satisfied with the visual privacy levels which contributed to desirable work conditions.

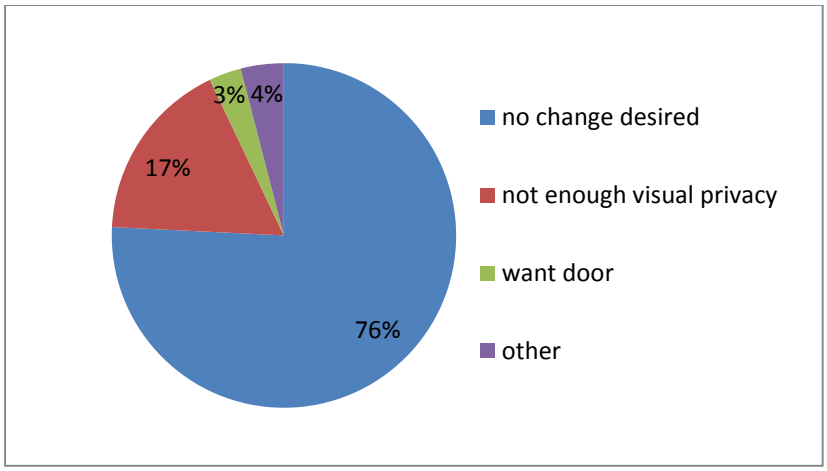

Figure 6.8: Visual Privacy Levels

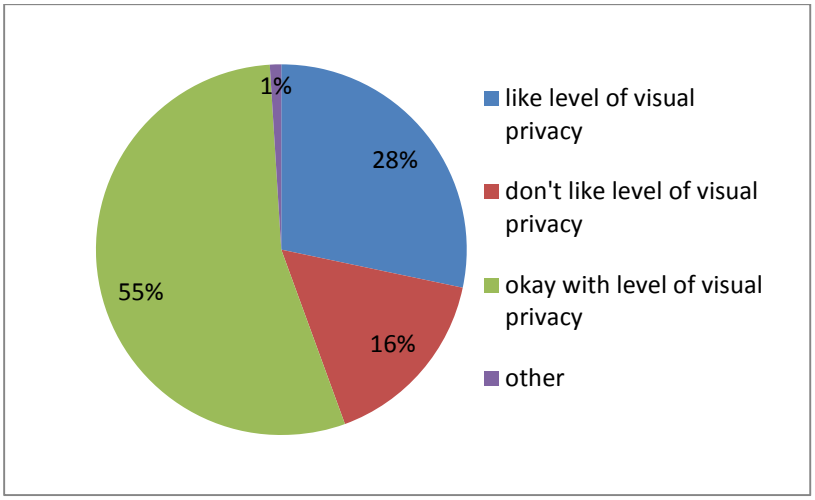

Figure 6.9: Visual Privacy Levels with Open Office Environments

Some occupants were concerned with acoustical privacy levels that hindered individual work. Refer to Figures 6.10 and 6.11 which demonstrate that acoustical privacy levels were a challenge in open office environments.

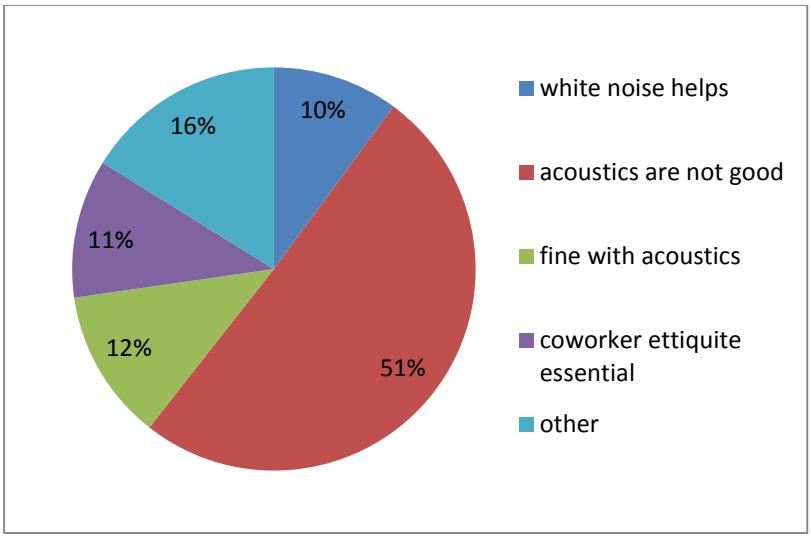

Figure 6.10: Acoustical Privacy Levels

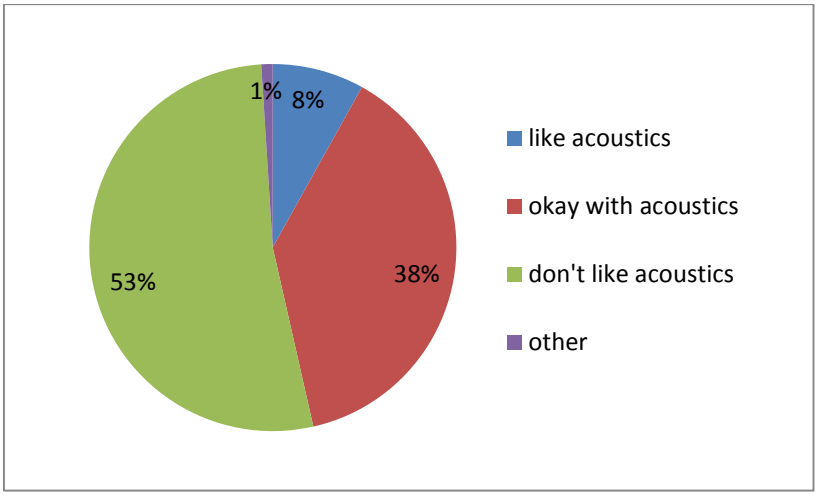

Figure 6.11: Acoustical Privacy Levels with Open Office Environments

Figure 6.10 shows acoustical privacy levels were more concerning than visual privacy levels. Only twelve percent (n=12) were fine with the acoustics. When asked if they liked the acoustics, the results varied as shown in Figure 6.11. Fifty-three percent (n=52) interviewees indicated they did not like the acoustics. Acoustical conditions were noted as an area for improvement in the work environment.

As illustrated with responses regarding acoustics, for some, individual work was hindered by open office environments. According to interviewees, approximately 75% of their work was individual, whereas the other 25% of their work was categorized as group work. The larger the company, the slightly more individual work was reported. A.L. Huber reported 62%, Tarlton 72%, and JE Dunn 78% individual work.

While open office environments help with collaboration and are often part of sustainable office design, open offices could be detrimental to individual work productivity primarily due to acoustical concerns. This could be addressed by providing small work rooms or closed offices for when employees need isolated space to work effectively. Educating employees on open office etiquette, distributing white noise, and offering breakout rooms for conference calls or confidential conversations could also be advantageous for open office environments as suggested by interviewees.

Individual work conditions were improved and beneficial overall as it relates to work spaces, lighting, openness, indoor air quality, and visual privacy levels. Work conditions pertaining to employee morale is observed in the following section.

6.4.3 – Employee Morale

Employee morale is a critical component to employee satisfaction and ties in closely with several aspects of a company including work conditions. Observed improvements included employees enjoy coming to work more and increased coworker helpfulness as illustrated in the following two figures.

The interviewees were positive about their company's sustainability efforts and the current condition of their company. For example, seventy-nine percent (n=78) enjoyed coming to work more now than in the previous conditions (refer to Figure 6.12). Interviewees stated "morale is better," there are "better attitudes," and "it is easier to interact." It was also noted that it was "easier to go to work." This indicated a remarkable improvement and higher morale among employees.

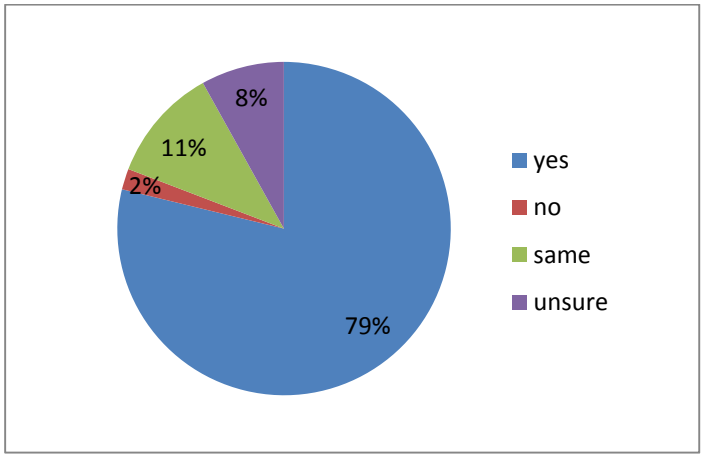

Figure 6.12: Employees Enjoy Coming to Work

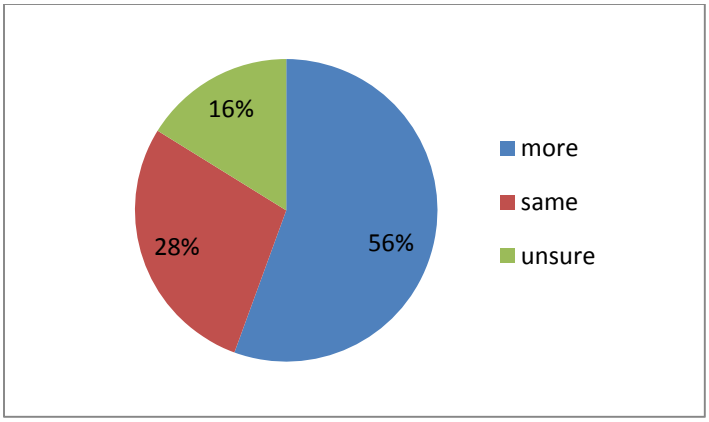

Figure 6.13: Increase in Coworker Helpfulness

Illustrated in Figure 6.13, fifty–six percent (n=56) of respondents indicated that coworkers were more helpful since inhabiting the new LEED or sustainably

renovated building. Interviewees reported the work environment was like a "close knit family," there was an "open door policy," and they experienced "more crossover with other departments." Additionally, interviewees noted it was "easier to communicate," and "problems (were) solved quicker." Remarkably, no one indicated less helpfulness among employees. This finding demonstrated a more collaborative work environment.

6.4.4 – Comparisons for Employee Morale

Chi-square association tests were conducted to provide additional insight into why employee morale improved. Table 6.5 summarizes the p-values regarding these employee morale tests. P-values under 0.05 were considered statistically significant. Select statistical output is included in Appendix 7 for additional information.

Table 6.5: Employee Morale Association Tests Summary

Dependent Variable	Independent Variable	P-Value
Enjoy coming to work more	Coworker helpfulness	0.0283
Enjoy coming to work more	Daylighting	0.9535
Enjoy coming to work more	Indoor Air Quality	0.0243
Individual Effort	Collaborative	0.2652
Individual Effort	Learning/Skill Development	0.1817
Individual Effort	Social/Interactive	0.0273
Collaborative	Learning/Skill Development	0.0013
Collaborative	Social/Interactive	0.0002
Learning/Skill Development	Social/Interactive	0.0063
Work More or Less Hours	Retains Talent & Clients	0.5609
Work More or Less Hours	Sustainability is a Corporate Value	0.2832
Work More or Less Hours	Social Responsibility & Community	0.0820
Work More or Less Hours	Company Culture	0.9792

With a p-value of 0.0283, significant positive correlation was observed between enjoying coming to work more and an increase in coworker helpfulness.

With a p-value of 0.0243, significant positive correlation was observed with enjoying coming to work more and indoor air quality. These findings suggest that coworker helpfulness and improved indoor air quality significantly contributed to increased employee satisfaction.

Four key association observations were observed among the interview data relating to working conditions and employee morale. The first observation was a statistically significant (p=0.0273) positive correlation with individual work and social environment. While this could be seen as a positive condition for collaboration and team building, it could be an undesirable condition if the social environment impeded executing individual work.

The second observation was a statistically significant association between a collaborative and learning environment (p=0.0013). Being both a collaborative and learning environment was good for working conditions and continuous improvement.

With the third observation, there was a statistically significant correlation between collaborative and social environment (p=0.0002). This makes sense because a more social environment would likely be a more collaborative environment.

The fourth observation was the general association between a learning environment and a social environment p-value was 0.0063. Collaborative, learning, and social environments intuitively correlate and this was confirmed with the interview responses. These results indicated the more sustainable environment was collaborative, social, and supported learning.

The work conditions tied into employee morale to comprise employee satisfaction. With exception of acoustical concerns, all aspects of work conditions and

employee morale showed positive signs at the companies after embracing sustainable business practices. Embracing sustainable business practices showed an increase in employee satisfaction which could lead to improving strategic firm performance.

6.5 – Project Opportunities Analysis

In addition to employee satisfaction, project opportunities were a key component to strategic firm performance. Project opportunities can be hard to determine with limited access to private company information. This section looked at corporate values, social responsibility, community involvement, and attracting clients as drivers of project opportunities.

Figure 6.14 shows the interviewees confirmed sustainability was a corporate value with eighty-seven percent (n=86) reporting sustainability was a moderate to very high-level corporate value. Fifty-six percent (n=55) indicated sustainability was a high or very high-level of a corporate value. The remainder of respondents responded moderate to high, with only three respondents unsure. No negative responses were received. Interviewees stated the culture was “more open,” “more integrated,” and there was an “increased awareness and commitment” to sustainability. An interviewee stated sustainability is a “higher (corporate value) than financials would support,” and it was “not profit driven.” This indicated a high confidence level of sustainability in their company values. Having a solid commitment to sustainability could open doors to project opportunities.

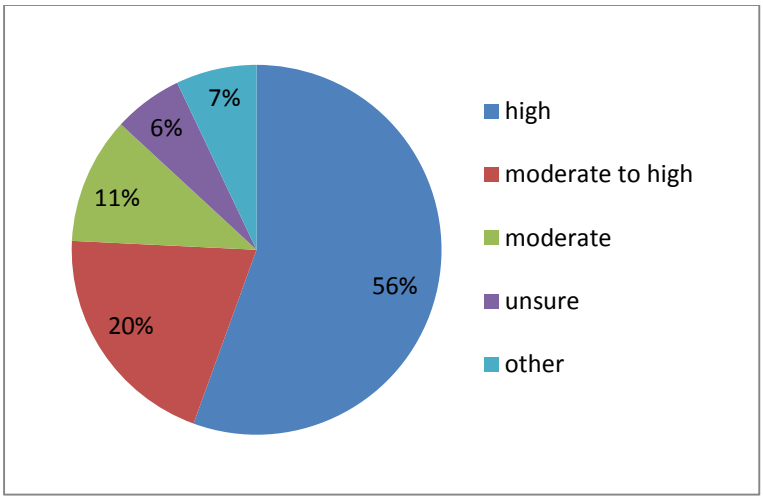

Figure 6.14: Sustainability is a Corporate Value

Responses were consistent; forty-five percent (n=44) of respondents observed an increase in social responsibility and community involvement as illustrated in Figure 6.15. The balance of interviewees did not report a change, and no interviewees indicated there was a decrease in social responsibility and community involvement. Interviewees reported being "more available to the community." Interviewees reported it was "easier to get involved," and noticed "more visitors" at their office. Comments also included they "can't believe the amount of events" and tour groups were "wowed." Being involved in the community, besides the inherent intrinsic value, makes a company more visible in their region and aware of project opportunities.

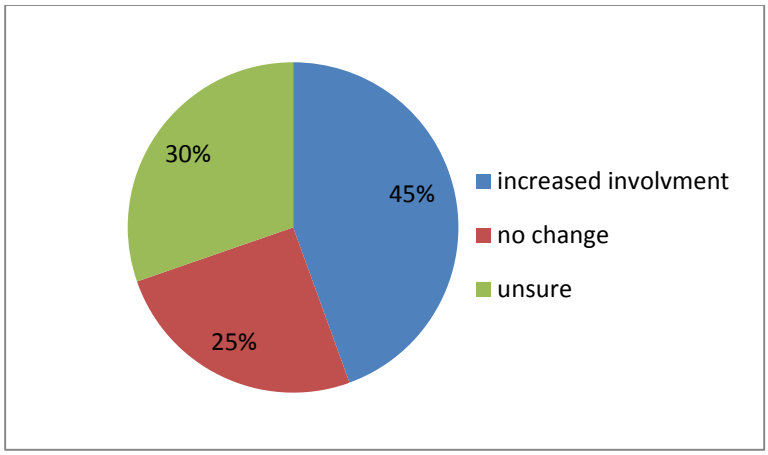

Figure 6.15: Changes in Social Responsibility and Community Involvement

A little over half of interviewees (n=56) indicated the company had a commitment to sustainability on projects that were not LEED focused. Interviewees stated "LEED is common sense," "LEED works," and sustainability was a "mentality that carries over" to other work. Interviewees noted they had an "obligation to make owner aware" of sustainability and noted "more scrutiny on projects." The results illustrated in Figure 6.16 show a higher percentage than expected since costs often drive project decisions. This could be a market advantage.

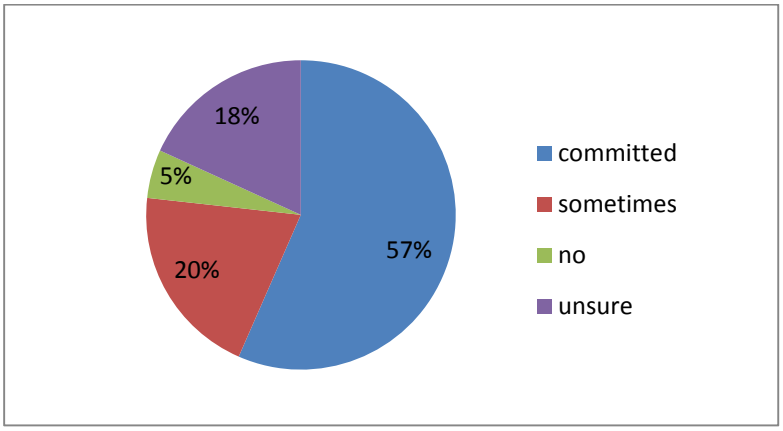

Figure 6.16: Commitment to Sustainability on non-LEED Projects

Interview responses were the same for attracting clients and talent; however, one response indicated efforts attract clients, but not talent. This one response was included with the maybe category in Figure 6.17. This showed eighty-six percent (n=85) believed the sustainability efforts attracted clients and talent.

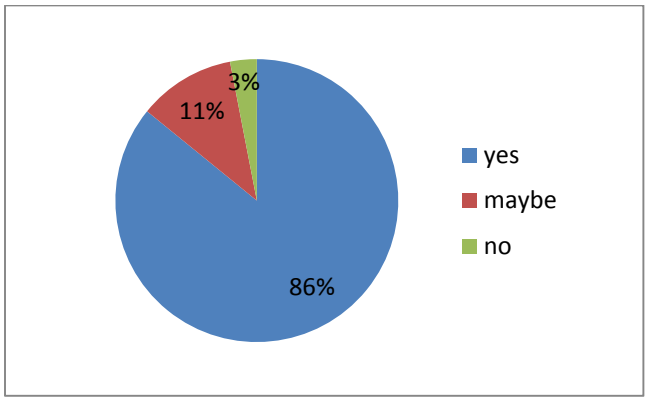

Figure 6.17: Sustainability Efforts Attract Clients and Talent

Responses for retaining clients and talent were identical. Figure 6.18 shows the majority considered sustainability efforts positively influenced retaining clients and retaining talent.

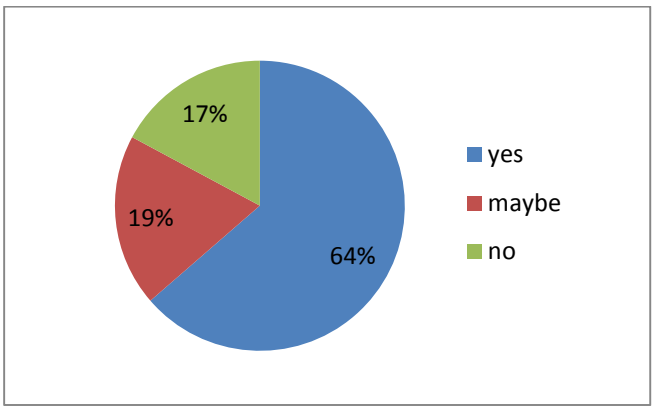

Figure 6.18: Sustainability Efforts Retain Clients and Talent

Eighty-seven percent (n=86) believed the sustainability efforts attracted new clients; new clients attracts more project opportunities. Positive and neutral effects

were observed for corporate values, social responsibility, and community involvement. These indicators of increasing project opportunities could lead to improved firm performance because of a greater opportunity for increased revenue and more opportunity to select the best projects for the firm.

6.6 – Market Advantage Analysis

Market advantage was the third component to strategic firm performance that was considered in this study. Similar to project opportunities, market advantage was also hard to distinguish with limited access to private company information. This study looked at attracting and retaining talent and talent, company culture, and project planning and execution as factors influencing market advantage.

Ninety-four percent (n=93) indicated recycling and composting was easy in their new environment. Making it easy for employees to recycle and/or compost was a simple yet significant company impact on environmental responsibility. Additionally, the sustainable office building provided a "showcase example" and a "great reference for clients." This could be a market advantage by attracting and retaining environmentally conscious clients by demonstrating the company is acting upon their values.

Table 6.6 illustrated potential correlations between these market advantage parameters. Appendix 8 provides select statistical output supporting this table. A statistically significant correlation (p=0.0140) was found with attracting new clients/talent and retaining clients/talent indicating consistency in these responses. Sustainable business practices may improve market advantage through attracting and retaining clients and talent.

The association between attracting new clients/talent and corporate social responsibility was also statistically significant (p=0.0049). Forty-four percent indicated an increase in corporate social responsibility and no responses indicated a decrease. This could be a market advantage for companies with sustainable business practices.

Table 6.6: Market Advantage Association Tests Summary

Dependent Variable	Independent Variable	P-Value
Attracts Talent & Clients	Retains Talent & Clients	0.0140
Attracts Talent & Clients	Sustainability is a Corporate Value	0.9970
Attracts Talent & Clients	Social Responsibility & Community Involvement	0.0049
Attracts Talent & Clients	Company Culture	0.9999
Retains Talent & Clients	Sustainability is a Corporate Value	0.9783
Retains Talent & Clients	Social Responsibility & Community Involvement	0.9583
Retains Talent & Clients	Company Culture	0.9724
Sustainability is a Corporate Value	Social Responsibility & Community Involvement	0.5350
Sustainability is a Corporate Value	Company Culture	1.0000
Social Responsibility & Community Involvement	Company Culture	0.6658

Figure 6.19 shows overall responses, and Figure 6.20 reports more detailed responses. Interview analysis indicated mixed opinions regarding changes to the company culture after focusing on sustainability with forty-two percent of responses positive, five percent negative, and fifty-four percent indicating no change or unsure.

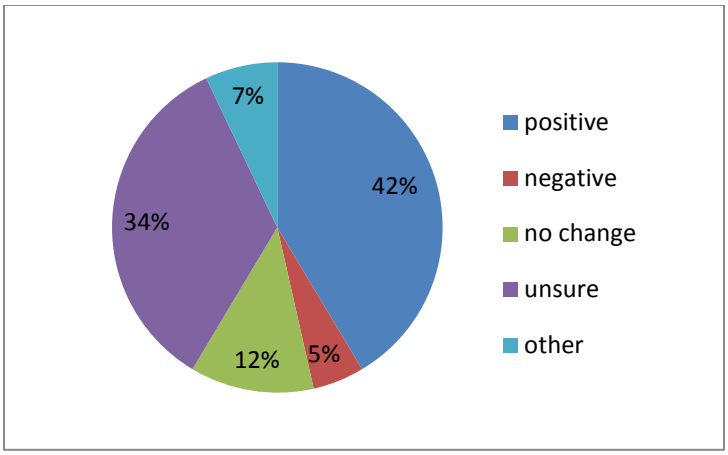

Figure 6.19: Aggregate culture changes

Figure 6.20 illustrates observations of company culture changes. Forty-nine percent (n=48) saw positive changes, thirty-five percent (n=34) were unsure, and twelve percent (n=12) saw no change regarding company culture. Five interviewees indicated negative effects due to reduced cohesiveness. Since 25 cited increased cohesiveness, the negative responses may be an abnormality. This suggested moderately positive improvements with the company culture after embracing sustainability.

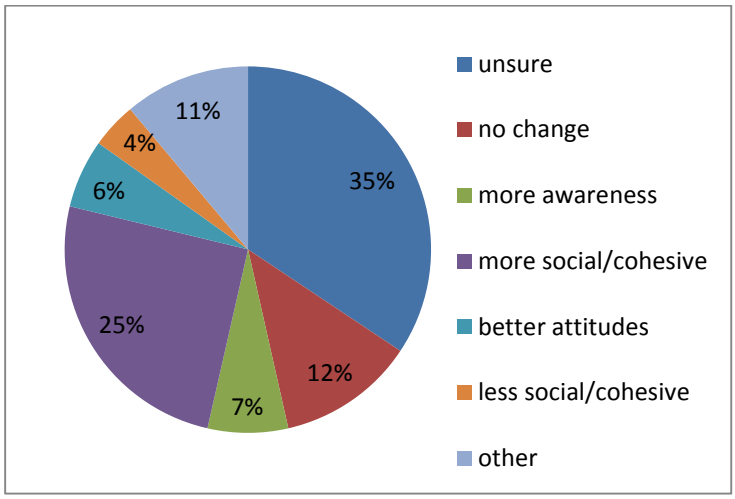

Figure 6.20: Detailed culture changes

As Figure 6.21 illustrates, some employees noticed positive changes on projects, planning, and executing projects, but many were unsure of any changes. No responses indicated negative changes on projects.

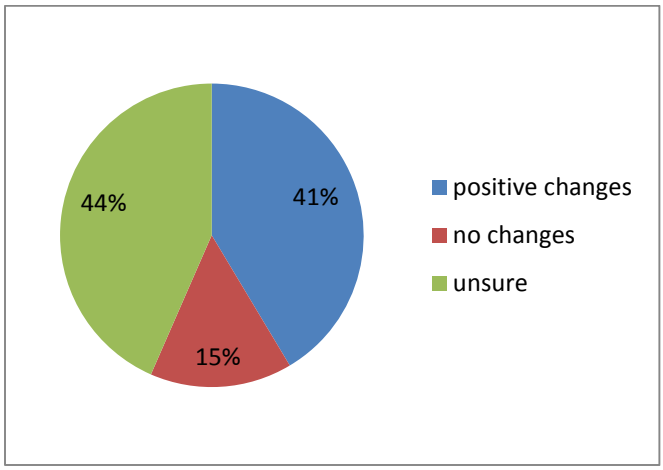

Figure 6.21: Changes Noticed on Projects

Figure 6.22 notes changes in planning and executing projects. Interviewees reported the company is "less wasteful" and "more efficient." Planning and executing projects "before was an afterthought, now we pre-plan." Interviewees also reported that they were "more organized." Once again, no responses indicated a negative effect.

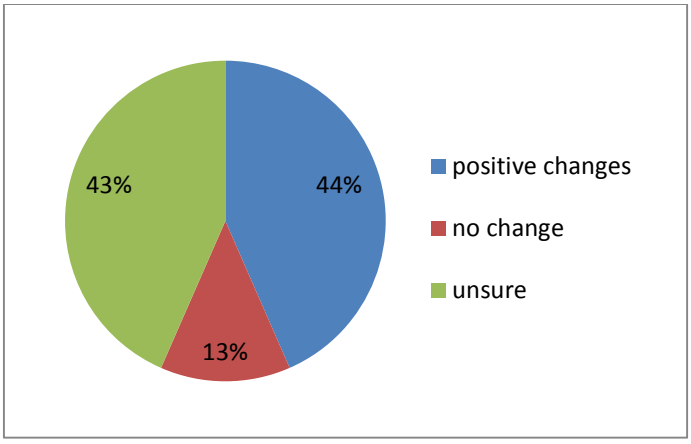

Figure 6.22: Changes Noticed for Planning and Executing Projects

The responses in Figures 6.19 through 6.22 showed positive and neutral responses for aspects related to market advantage. This indicated embracing sustainable business practices has a neutral to positive impact on market advantage.

6.7 – Contractor Sustainable Business Practices

JE Dunn, Tarlton, and A.L. Huber were leaders on sustainable efforts in the construction industry. Interviewing employees provided insight into the benefits of contractors embracing sustainable business practices. The interviews also provided awareness of areas to focus on growth and continued improvement of sustainable efforts.

6.7.1 – Current Conditions of Select Contractors

The most obvious sustainable business practice by JE Dunn, Tarlton, and A.L. Huber was the investment in sustainably conscious headquarters buildings. Building LEED certified headquarters or a sustainably focused renovated headquarters was a large capital investment and a visible reflection of their core values to their employees and the community. Each contractor had sustainability as a core company value and visibly displayed highlights of the sustainable features of their headquarters as a teaching tool for employees and visitors. Employees were happy with the sustainable building and saw positive impacts on business.

As illustrated in sections 6.4 through 6.6, the responses were positive regarding the companies' initiatives to implement sustainable business practices. Each company remained receptive to growth and continuously improving on their sustainable journey.

Several individuals noted how their company sustainable efforts made them more aware of their choices in relation to sustainability and that effort carried over into their personal lives. The sustainable culture promoted "more awareness" and a "personal commitment" to be more sustainable. For example, interviewees stated the sustainable "changes at work carry over to home," and because of work, it made some "rethink (their) home." Becoming more conscious of sustainability impacts helped individuals make more sustainably informed decisions in their daily lives.

6.7.2 – Growth Opportunities

With this study, seventy-five percent (n=74) of interviewees drove to work with an average distance of nineteen miles. Twenty-five percent (n=25) of interviewees had fuel-efficient vehicles. JE Dunn and Tarlton offered company-paid bus passes to those committed to use public transportation. Unfortunately, the existing public transportation options at each of the offices were limited. Options may improve if the needs of these areas grow to increase public transportation demand. Carpooling may be another way to improve transportation impacts. Individual transportation is an area for employees to strive to improve.

The companies should address employee acoustical concerns with the open office environments. As suggested by interviewees, this may be achieved by implementing white noise, educating employees on open office etiquette, and providing access to small work rooms for conference calls and confidential conversations.

Areas for business improvement include infiltrating all projects regardless of contract requirements with sustainable business practices as a conscious decision.

Barriers to this may include project costs, being competitive on bid projects, and contracting requirements. Each company has the opportunity to market and promote their sustainability efforts more. The interviews display benefits of the companies' sustainable efforts and getting their stories out in an open and honest way would provide a market advantage.

6.8 – Summary

The interviews at JE Dunn, Tarlton, and A.L. Huber confirmed sustainable business practices and commitment to sustainability. Since implementing sustainable business practices, work conditions improved. Positive impacts were observed for individual workspaces, common areas, and meeting rooms. Acoustical conditions were the only notable concern with the work conditions. High satisfaction levels were observed with daylighting, indoor air quality, and visual conditions. Employee morale was driven by coworker helpfulness and work conditions. Sustainable efforts positively impacted employee satisfaction.

Sustainable cultural shifts were observed. Projects incorporated sustainable efforts regardless of requirements. The findings suggest increased project opportunities. The sustainable efforts helped attract and retain clients and talent. Some observations indicated improved planning efforts and project execution. Market advantage also improved since embracing sustainable business practices.

These contractors exceeded the sustainable efforts in the construction industry. Some suggestions for continued improvements included addressing employee transportation and building acoustics. The interview results revealed that

embracing sustainable business practices was advantageous for construction businesses.

CHAPTER 7: CASE STUDY ANALYSIS AND RESULTS

7.1 – Introduction

This study included a select case study to provide a detailed, project level view at impacts of sustainable business practices. This case study was executed following the survey and interview data collection and analysis. Yin (2014) was referenced in detail for the design and execution for this case study. This chapter confers the case study selection, procedures, project details, and findings.

7.2 – Case Study Selection

The JE Dunn headquarters project case study was chosen to support and verify the survey and interview findings, and provide a detailed analysis of one sustainable project. This case study was critical to the research as a third and more detailed component addressing sustainable business practices in the construction industry.

The principal differences of this project compared to other projects was that JE Dunn was the owner, and there was high visibility of the project within the company. This was a LEED project because the company sought to set a good example and illustrate a core value.

This JE Dunn headquarters project was selected primarily since it was a crucial turning point for JE Dunn embracing sustainable business practices. This project was built by one of the three contractors highlighted in the interview section of the study. There was already a relationship with this company and support for the research; therefore, this project was more accessible. Additionally, the project was geographically close to the investigator which facilitated multiple site visits, multiple interviews, and access for follow up and verification.

7.3 – Case Study Procedures

As outlined in the methodology chapter, this case study was comprised of several components. The case study chapter was composed concurrently and succeeding these procedures. The case study procedures were conducted based on the following six steps:

1. Review Project Documentation and Onsite Project Investigation
2. Develop Interview Questions
3. Identify, Contact, and Schedule Interviews with Key Project Team Members
4. Conduct In-depth Interviews of Key Project Team Members
5. Review and Assimilate Project Documentation, Observations, and Interviews
6. Review and Discussion of Chapter with Case Study Interviewee

In step 1, archived documentation for the project was obtained electronically from JE Dunn. Documentation included project design and construction documentation for the project. Select items were allowed to be disclosed for support of this study. Most information obtained was confidential and was allowed only for review and aggregate information purposes only. The most helpful documentation for this project consisted of the design plans, specifications, LEED submittals, and the post-construction documentation. Extensive time spent in the headquarters building observing work conditions was also useful in gaining an understanding of the project.

Table 7.1 Case Study Interview Questions

Emphasis	Case Study Interview Questions
Individual Details	What is your current role at JE Dunn and how long have you worked for this company?
	Did you participate in the previous survey or interview sections of this study?
	Describe your role on the JE Dunn headquarters project.
	What was the timeframe of your involvement?
Project Details	Briefly describe the project.
	How was this project different from other projects you have worked on?
	Why was this project a LEED project?
	How was the budget affected by the sustainability requirements of the project?
	What were the benefits of this project being more sustainable?
	What were the drawbacks of this project being more sustainable?
Individual Impacts	How has your work related performance changed since working on this project?
	How has your work life changed since working on this project?
	Has this project changed your perspective at work? If so, in what ways?
	How do you consider sustainability in your current work role?
	How has exposure to LEED projects influenced actions in your personal life?
Strategic Performance Impacts	Describe how this project has influenced the company.
	Have company sustainability efforts influenced employee satisfaction?
	How has employee morale changed?
	How has coworker helpfulness changed?
	How have company sustainability efforts influenced work conditions?
	How have you approached projects differently since working on the headquarters project?
	Have company sustainability efforts influenced project opportunities?
	How have company sustainability efforts influenced community involvement?
	How have company sustainability efforts influenced attracting and retaining clients?
	How have company sustainability efforts influenced client actions?
	How have company sustainability efforts influenced attracting and retaining employees?
	How have company sustainability efforts influenced employee actions?
	How have company sustainability efforts influenced market advantage?
	How has company culture changed since this project?

In step 2, the case study interview questions were developed, and were reviewed with the committee chair and a research colleague. Questions were adjusted after the first case study interview to minimize repetition and gather additional information. The primary questions were outlined in Table 7.1, which are organized by the emphasis of each question. Focus was primarily on strategic performance impacts, but also considered individual details, project details, and individual impacts. These questions were primarily questions to gain insight into how and why the project has impacted the company.

In step 3, the key team members were discovered during the documentation review. A separate email folder was set up for correspondence regarding the case study. One team member went to work for another company and one retired prior to this case study. Since their private contact information was not available, they could not be reached to arrange an interview. Personalized emails were sent to the key individuals on January 24, 2015 requesting participation in the study. Each of those contacted responded, indicated that they were willing to help, and interviews were scheduled for times convenient for the interviewees.

In step 4, in-depth interviews of team members for the JE Dunn headquarters project were conducted to discover insight into this project and impacts on JE Dunn. All of the key project team members who still work for JE Dunn were interviewed. The interviews were all conducted within six consecutive business days. Handwritten notes were taken by the author during each of the interviews. Four of the interviews were in-person, and two were phone interviews due to distant locations of the participants. The interviewees were anonymous for this study. Each interview was

approximately forty-five minutes. All six interviewees were involved in the construction phase of the project, and most were involved with the preconstruction, closeout, and warranty phases as well. The interviewees averaged over 14 years of experience at JE Dunn Construction.

In step 5, the data collected was reviewed and assimilated. Following the interviews the information was transcribed into Excel and color coded to aide with the review of the responses. The strategic performance impacts were the principal focus in this discovery process.

In step 6, one case study participant reviewed the case study chapter. The reviewer confirmed that the case study was an accurate portrayal of the project. No changes were suggested.

7.4 – Overview of the JE Dunn Headquarters Project

JE Dunn Construction, which was established in 1924, is a privately held, four generation, family owned business. As part of the growing company and integration of services, JE Dunn sought to combine their five downtown Kansas City locations into one building. The goals of this headquarters project included LEED Gold certification, a high productivity work environment, attraction for talent, showcase the company's expertise, and contribute to visible improvements in the east village core of Kansas City, Missouri.

The JE Dunn headquarters building was a design build project lead by the owner and contractor JE Dunn Construction. This project consisted of a 200,000 square foot headquarters building and a 783 car parking structure. The parking structure component is owned by the city and leased to JE Dunn as part of a public

private partnership. The project costs were $41 million and $18 million respectively. Figure 7.1 illustrates the completed project located at 10th and Locust Street in Kansas City, Missouri.

Figure 7.1: JE Dunn Headquarters Building

It is noted that the building has an open floor plan with only 20% enclosed. Daylighting and views were a primary design focus which also correlate with LEED components. The project featured gathering spaces on each floor, artwork, a cafeteria, training facilities, a recreation room, and a fitness center. The following sections discuss the LEED attributes and sustainable aspects of this project.

7.5 – LEED and Sustainable Attributes

The LEED scorecard in Appendix 9 summarized key sustainability efforts on this project. As the scorecard conveys, this project earned 42 of 69 possible points meriting recognition as the first LEED Gold certification in Kansas City, Missouri.

For LEED guidelines regarding sustainable sites, this project had several sustainable components. The site selection was an existing urban site with access to

public transportation. Design features included bicycle storage, changing rooms, showers, and parking for fuel efficient vehicles. Control of storm water management and pollution prevention during construction and occupancy were also important aspects of the project.

For water efficiency, water efficient landscaping was utilized and no potable water was used for irrigation. Low-flow water fixtures including waterless urinals and low consumption water closets with automatic battery powered flush meters comprised some of the water reduction efforts. A greywater, water recycling system capable of treating 1000 gallons of water a day was installed which recycled sink and shower water by treating it and then using this water for water closets. The greywater system was the only noted drawback for this project. After occupation, the greywater system process required filter changes multiple times a day and produced an undesirable smell on the lower level. Therefore, the greywater system was decommissioned until an acceptable solution is discovered.

In alliance with energy and atmosphere LEED guidelines, minimum energy standards were exceeded by over 14%. This was achieved by utilizing demand control ventilation, underfloor HVAC, T5 lighting and the glazing system. The mechanical system was isolated by floor and the underfloor system allows for lower supply air temperature and lower supply air volume. Staff had control to adjust floor grilles in their workspace. Energy efficient equipment included two McQuay Turbo Core Chillers with variable speed fans that have performance ratings between 0.297 and 0.599 kW/ton. Setbacks reduced temperature settings during unoccupied times to

save energy. The data center Liebert units utilized chilled water when available and dry cooling when needed.

For sustainable materials and resources, wooden floors throughout the building were reclaimed timber. Over 20% of the materials are regional and over 15% of the materials for the project included recycled content. Waste diversion was achieved by sorting waste into separate dumpsters for recycling and reuse. Sorting the waste impacted manpower costs and occupied considerable space on site. Many waste companies now offer comingled recycling options that are sorted offsite and minimize project impact.

To sustain indoor environmental quality, the lighting system was fully automated including adjustable scheduling to reduce lighting levels when unoccupied. The lighting controls also had override capabilities by zone when lighting is necessary beyond normal work hours. Motion sensors controlled lighting in private offices and conference rooms. The glazing system had energy efficient glass on the western exposure with a shading coefficient of 0.32.

Indoor air quality (IAQ) was also key component to the LEED indoor environmental quality design aspects of this project. This included plans and protocol for IAQ during the construction process and air flush out procedures prior to occupancy. IAQ also included low-emitting materials for adhesives, sealants, paints, coatings, and carpet. The low emitting paint on this project was a challenge since it took more coats of paint than anticipated to provide necessary wall coverage. Since this project, the quality of many low-emitting products has improved.

LEED included up to four innovation and design process credits and one credit for a LEED accredited professional involved the design and construction process. Innovation in design credits were intended for innovative performance not specified by LEED or exceptional performance above LEED requirements. Innovation points were received for 40% water reduction, 95% waste diversion, an educational program integrated with the facility, and a transportation and carbon offset program.

Noted benefits of LEED for this project included energy efficiency, better working environment, and an accessible example of a sustainable project. The challenging design to meet daylighting and glazing requirements appeared worthwhile based on consistently positive feedback by employees.

LEED for this project impacted the budget slightly with an approximately 2-5% premium of initial costs driven primarily by mechanical equipment and glazing systems. Most of the energy efficient appliances, equipment, and lighting already realized their five year anticipated payback.

Beyond LEED, this project utilized building information modeling technology, online submittal service, and focused on sustainability in construction processes. This facility has a fully integrated building with the building automation system, fire, and security on one platform with remote access and cell phone notification. The property has an automated snow melt system utilizing a hot water boiler system for the main entry drive as a safety feature that reduces maintenance manpower.

7.6 – Case Study Findings

The key project team members saw consistently positive impacts from this project and company sustainable business practices. Strategic performance impact responses were 93% positive, and 7% are neutral responses. No negative responses were received in the case study interviews. The key project team members consistently observed positive impacts from this project and company sustainable business practices as a whole. The following sections discuss strategic performance impacts in detail.

7.6.1 – Employee Satisfaction

The better work conditions in the newer space included daylighting, views, and amenities improved work conditions considerably. Indoor air quality was better and controls of ventilation and lighting are good improvements. The environment was more inviting, which supported both the employee satisfaction and the customer satisfaction component of strategic firm performance.

The case study interviewees indicated that employee morale improved overall. The open office environment amplified collaboration and increases overall moods. One noted “people want to come here every day” and another stated employees “are happier.” Regarding impact on sustainability on employee satisfaction an interviewee indicated that “the ripple effect is enormous.” The more collaborative environment contributed to increasing coworker helpfulness through improved communication and teamwork. Employee satisfaction reportedly was substantially higher and the sustainability efforts have had a positive effect. All of these observations echoed the interview results providing compounding validation that sustainable business

practices positively influence strategic firm performance through employee satisfaction.

7.6.2 – Project Opportunities

Since JE Dunn was previously involved in outreach, community involvement levels did not necessarily change significantly since the headquarters project. Several tour groups visited the building to view LEED attributes, and the facility provided the opportunity to host more community events.

The sustainability efforts had a positive impact on attracting and retaining clients. Clients "give more thought to JE Dunn" as one case study interviewee stated. According to interviewees, this building most impacted clients who are sustainably conscious. The building was a tangible example of the slogan "think green, build blue," which emphasized conscious sustainability efforts in the building process. JE Dunn's sustainability efforts influenced some client actions by providing an example, offering feedback from experience, and some carry this practice forward.

This project highlights "the way we want to go about business." The headquarters project transformed some business development and marketing strategies. The building helped attracts clients and even selection interviews were conducted at the headquarters building. This project also provided experience that translates to winning more work. This project demonstrated a strong case example for positive impacts on project opportunities.

7.6.3 – Market Advantage

This project helped attract and retain employees by providing a great place to work through daylighting, views, and temperature controls with an open and

collaborative environment. Many visitors were amazed by the facility and the sustainable commitment of JE Dunn. This project illustrated a company philosophy, and the commitment to doing the right thing. As an interviewee noted, the project "helped establish sustainability as a core value." Company culture shifted to be more collaborative and interactive. One case study interviewee noted the "more open building and attitude" enhanced the company's community involvement. Lines of communication were more open, and interdepartmental collaboration was apparent. Attitudes and morale benefited and teams were working better together.

The company continued to practice sustainability beyond the initial building. Since occupying the building, the company continued to make sustainable operations decisions including adding solar energy panels to the roof. Waste reduction was evident including utilizing glassware in lieu of disposable options. The building continued to utilize roof rainwater, storm water from the garage, and air handler unit condensate water for irrigation.

Building information modeling, electronic submittal processes, and proprietary, interactive, computer-based, operations manuals were just a few of the more sustainable business processes that are standard for JE Dunn projects today. Interviewees recognized the purposeful decisions behind the sustainable business practices have a "huge impact on every way (JE Dunn conducts) business."

Market advantage was positively impacted through client interest and differentiators for contractor selection. JE Dunn acted on their values, and consequently, was in a better position to pursue similar projects and to work for clients with similar goals and values. The JE Dunn headquarters project was a

showpiece providing an accessible example of JE Dunn's work. Similar to project opportunities, this project showed a strong case example of market advantage through sustainable practices.

7.6.4 – Individual Impact

The case study brought to light some individual impacts in addition to strategic performance drivers. Positive individual impacts were noticed with the case study analysis. Interviewees noted being more mindful of their decisions and that the project influenced their mindset, such that several note carrying over sustainable practices into their personal life. Examples included recycling, composting, fuel efficient vehicles, energy usage, purchasing sustainable energy, and better informed consumer choices.

The team members indicated that they were grateful for the opportunity and trusted to be an integral member of the project. Most perceived this project as a good experience, and the lessons learned were applied to other projects. One interviewee noted the project helped "increase pride in what I do." For the team members, this project lead to more responsibility and career advancement. Exposure through this project forged relationships that might otherwise not have been possible. The individual impacts amplified the positive comments from the interview analysis.

7.6.5 – Revenue Consideration

Revenue trends were also considered with this case study. Since JE Dunn is a large national contractor, annual revenue was public information through publications such as Engineering News Record. Looking at the ten year revenue trend for JE Dunn

in Figure 7.2, the impact of the recession that affected the United States from December 2008 through June 2009 was apparent.

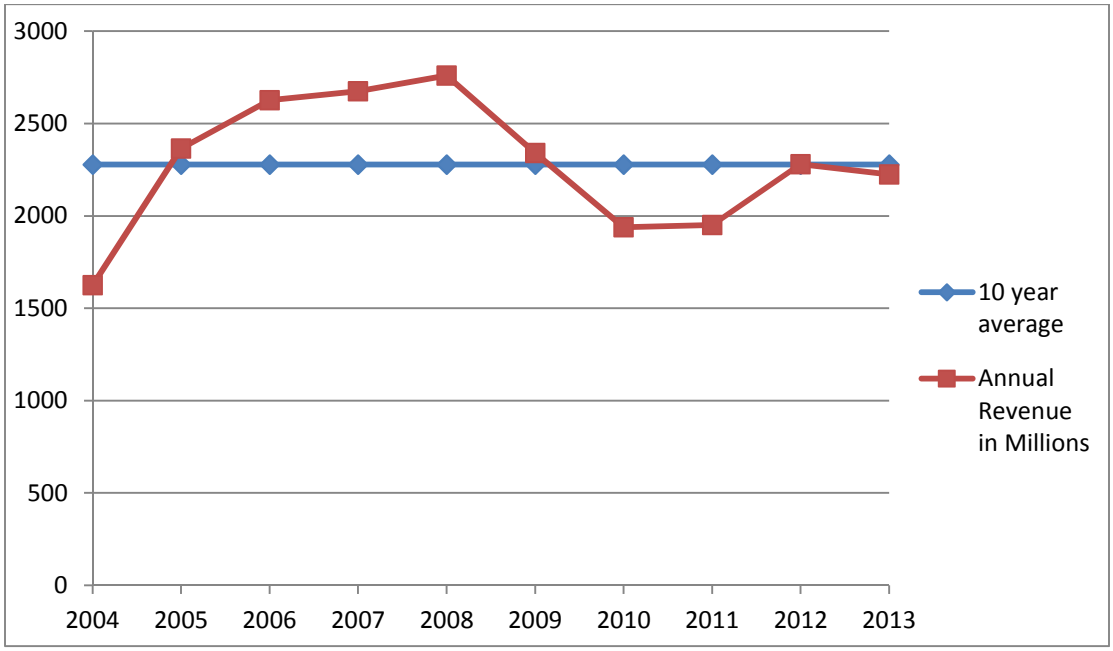

Figure 7.2: JE Dunn Annual Revenue from 2004 through 2013

Economic impacts were delayed in the construction industry and JE Dunn was no exception. Because of the recession, it was difficult to determine if JE Dunn's sustainable business practices had an effect on project opportunities through revenue consideration. Future study further examining revenue may be beneficial.

7.7 – Summary

This case study investigated the JE Dunn headquarters project with a thorough review of the project following detailed procedures. A review of the LEED and sustainable attributes of the project provided insight into the project details.

Findings from this case study supported the survey and interview results. Specifically, the case study of the JE Dunn Headquarters project provided additional support that JE Dunn was ahead of the overall construction industry sustainable

efforts established in the survey analysis. The case study results supported positive impacts on employee satisfaction and are even more conclusive regarding positive impacts on project opportunities and market advantage.

The case study indicated that sustainable business practices may have a significant impact on individual staff. While revenue was considered, no trends were discovered likely due to an economic recession. The case study verified positive impacts of sustainable business practices on strategic firm performance through employee satisfaction, project opportunities and market advantage.

CHAPTER 8: FINDINGS

8.1 – Introduction

This study employs a three dimensional approach with surveys, interviews and a case study to examine the impact of sustainable business practices on performance. As Figure 8.1 illustrates, the general and specialty contractor surveys provide a snapshot of the construction industry which suggest opportunity for sustainability improvements. The interviews at three general contractors that embrace sustainable business practices discover a positive impact on strategic firm performance. The case study supports the findings from the surveys and interviews with regards to the sustainable business practices impact on a project level analysis.

Figure 8.1 Summary of Findings

This study addresses the current state of sustainability in construction. It investigates the impact of sustainable business practices. The findings from this study also indicate a paradigm shift or fundamental change in approach is occurring at the contractors interviewed. The next three sections elaborate upon these findings.

8.2 – Current State of Sustainability in Construction

The construction industry has opportunities for sustainable improvements. Initial efforts by contractors include a relatively high rate of recycling both on site and at the office. Other aspects of sustainable business practices have relatively low levels of participation. Minimal efforts are made regarding energy efficient mechanical, electrical, plumbing systems, and controls. Not many contractors have sustainability as a component of mission statements, corporate strategic plans, and operational business plans. For most contractors, there are limited plans for sustainability improvements.

Many contractors expressed anticipation for more regulations involving sustainability and a belief that LEED is a passing trend. It was no surprise that contractors have vested interest in improving productivity, project opportunities, and market advantage, yet there is a misalignment between performance expectations and sustainability efforts.

While initial efforts in sustainability have been taken, the construction industry has a long way to go to become more sustainable. Sustainability is not a key value or concern for most construction companies. Minimal efforts regarding sustainable business practices in the construction industry are apparent with the surveys. Myers (2005) indicated the complexity of the construction industry impedes the ability to make rapid or drastic improvements. This study substantiates this indication.

The study confirms the need for sustainability improvements in the construction industry. If sustainability efforts help business aspects such as

productivity, project opportunities, or market advantages, contractors should further consider sustainability practices in their business. This study demonstrates that there is considerable opportunity for improving sustainability efforts in commercial building construction.

Investigating impacts from sustainable business practices discovers neutral and positive consequences. Findings from this study show contractors that embrace sustainability practices experience positive impacts following this commitment. Bansal and Roth (2000) asserted that the human dimension is significant in sustainability design and construction. The case study extends that finding and supports that sustainability focused projects have positive impacts on their occupants as well.

8.3 – Impact of Sustainable Business Practices

The interviewed contractors embrace sustainable business practices and exceed the sustainability efforts of the construction industry. These selected companies emphasize sustainability and sustainable actions in both the office and field. The case study of the JE Dunn Headquarters project echoed the positive impact of sustainability on strategic firm performance thus providing validation to the interview analysis.

Embracing sustainable business practices showed clear indication of improving employee satisfaction through enhanced work environments, employee behaviors, communication, and collaboration. Furthermore, previous research indicated that employee satisfaction positively stimulated strategic performance (Santos and Brito 2012).

The surveys indicate productivity is important and improving productivity generally improves performance. Employees enjoy coming to work, as the interviews and case study illustrate, so employees are likely to be more engaged, have fewer absences, and enhance firm performance.

Sustainable business practices are capable of increasing project opportunities through attracting and retaining both clients and talent. This finding is supported by the literature. Leiper et al. (2003) suggested that sustainability is a market advantage when securing a university construction contract. In addition, the findings from this current study show that embracing sustainable business practices enhances social responsibility and community involvement. Additionally, previous research indicated that social performance influenced strategic firm performance (Santos and Brito 2012).

Researchers showed that the market is willing to reward socially responsible behavior by supporting premiums for ethically produced goods (Trudel and Cotte 2009). The current study expands upon this idea by illustrating market advantage in the construction market because clients may support premiums for ethical projects and contractors over less ethical. This study also aligns with the research by Riley et al. (2003) that illustrated since few contractors embrace environmental policy, it is a market differentiator.

Shen et al. (2007) emphasized that consistency for the entire project team is necessary for sustainability to succeed and offers a sustainability checklist to get project team members aligned. Similarly, this study illustrated some benefits from a contractor embracing sustainability overall and not just in silos for specific projects or

clients. The benefits of a holistic approach to sustainability by both the project team and the company have the potential to multiply advantages. In summary, embracing sustainable business practices has an overall positive effect on strategic firm performance.

8.4 – Paradigm Shift

Some cultural changes are observed in this study. Project execution and processes improve after embracing sustainable business practices. Olson (2008) found that sustainable business practices influence company culture, impact decisions, and reduce costs in manufacturing. This study expands that finding to the construction industry.

Riley et al. (2003) suggested that a paradigm shift is necessary to advance sustainability efforts in the construction industry. Fundamental changes in approach are observed in employee thought processes and procedures. Employees are more aware of project impacts regarding sustainability. Sustainability has infiltrated companies to the point that it is inseparable from day to day business processes. Individuals are carrying sustainable practices home to their personal actions and decisions. A sustainability paradigm shift appears to be occurring at the contractors observed.

8.5 – Summary

The surveys found the construction industry was involved in LEED, yet exposure to LEED projects did not seem to impact sustainable business practices. The construction industry has not prioritized sustainability and does not anticipate making

changes to become more sustainable. Furthermore, sustainability is not perceived as a performance driver.

Contractors who embrace sustainable business appear to see a ripple effect of positive impacts on strategic performance drivers. The contractor interviews revealed improvements including positive impacts on employee satisfaction, project opportunities, and market advantage. The case study verified the interview results on a project level and found additional individual impacts on employees. The interviews and case study found sustainable business practices impact individuals in addition to projects and companies. Embracing sustainable business practices appears to ignite a paradigm shift in the company.

CHAPTER 9: CONCLUSION AND FUTURE STUDY

9.1 – Dissertation Summary

This dissertation began with an introduction to the observed problem and research questions. A comprehensive literature review provided an overview of sustainability and a review of sustainability in business. The research methodology was explained for each of the components of this study. The specialty and general contractor surveys indicated that incremental steps of sustainability are observed including recycling efforts and indoor air quality plans. However, sustainability was not a principal consideration in the construction industry.

Revisiting the supporting research questions, the interviews at three general contractors that embrace sustainable business practices found positive impacts on employee satisfaction through work conditions, employee morale and coworker helpfulness. Enhancements in project opportunities were observed through community involvement and by attracting and retaining clients and talent. Market advantages were observed through company culture shifts, improvement in project execution.

The case study of the JE Dunn Headquarters project helped verify the interview findings and confirm benefits of embracing sustainability on a project level. This study discovered that contractors experience positive impacts from sustainable business practices on strategic firm performance through employee satisfaction, project opportunities and market advantage.

9.2 – Contributions to Academia

This study provided a novel piece in an extensively large puzzle of sustainability in the commercial building construction industry. The surveys found minimal variation between types of construction companies and sustainable business practices. The study illustrated with the surveys that many contractors make minimal sustainability efforts and are not motivated to make sustainable changes.

This study expanded and confirmed positive effects of sustainable practices in previous studies (Leiper et al 2003, Trudel and Cotte 2009, Olson 2008). This study also leads to additional knowledge on sustainability in the construction industry. The conceptual contribution is sustainable business practices positively impact strategic firm performance at commercial building contractors through employee satisfaction, project opportunities, and market advantage. This was found on both the contractor level with 99 individual interviews and on a project level with the JE Dunn headquarters building case study.

This commercial building construction study may open new lines of sustainability research other areas of construction including bridges, highways, infrastructure, utilities, and residential. Future studies may expand upon these findings to advance the understanding sustainability in construction. This study provided a springboard for several future research opportunities as outlined later in this chapter.

9.3 – Contributions to the Construction Industry

This study found embracing sustainable business practices had a positive effect on firm performance as it relates to employee satisfaction, project

opportunities, and market advantage. These positive impacts suggest additional positive factors could be realized when contractors implement sustainable business practices. This was observed on both a company level with the interviews and on a project level through the case study. Sustainable efforts must enhance firm performance for sustainable endeavors to be successfully implemented industry-wide. Sustainability efforts should not be perceived as added cost, but as a smart business decision for contractors. The findings from this study may result in more contractors becoming sustainable after recognizing the potential return on investment. Education and outreach regarding sustainable best practices will increase its likelihood to advance in the industry.

With multiple studies on the benefits of sustainable efforts across various industries, regulations should continue to evolve to require sustainable aspects of project design. Regulations and policy should expand sustainability requirements in construction processes in order to accelerate improvements in the industry.

This study may challenge conventional thought in the construction industry. Sustainability efforts benefit the community, environment, and business. Expanding sustainability efforts in construction could help mitigate negative perceptions of the industry and have an exponential impact on society.

9.4 – Limitations and Future Studies

This section reflects upon research limitations and suggests prospective lines of research that would help extrapolate on this study and open other avenues of investigation. First of all, this study was bounded by limited data. Since most construction companies are privately held, information shared in this study was

restricted to protect proprietary information. Demographics, financials, and client information could not be disclosed. The case study selection was also limited to projects the contractors were both willing and contractually permitted to disclose. Future multiple case studies of publicly held companies would be advantageous to review financial firm performance pertaining to sustainable business practices. Additional case studies of contractors that are not considered sustainable or in the process of implementing sustainable business practices would also be beneficial. Additional investigation into how planning efforts impact sustainability and performance is also of interest. Long term studies on the evolution of sustainable practices in construction from micro-levels (i.e. project and team levels) and macro levels (i.e. industry levels) would be a significant contribution.

Second, a rival theory became apparent during the investigation that a new building consolidating all local company employees could have an impact on strategic firm performance. While that is a valid consideration, sustainable business practices had a more significant impact than a new office building alone. The majority of interviewees highlighted sustainable aspects of the project and referenced sustainable business practices that are in place. The results of the interviews indicated there was no apparent difference the company with a renovated project and the companies with new projects. Future case studies attempting to isolate sustainable business practices from sustainable buildings would be worthwhile. A case study of a sustainable contractor with primarily telecommuters and/or remote employees might tackle this question.

Third, this study is confounded by a great recession that made project opportunities and revenue considerations analysis problematic. Some information regarding these aspects were helpful; however, expanding this study during a more stable and typical economic period could provide additional insight. Investigating publicly held contractors would also provide additional insight into profitability.

Finally, the case study of the JE Dunn Headquarters project investigated a project that the sustainable-conscious contractor both built and occupied. Construction projects that embrace sustainability may also contribute to tenant business performance. Possibly sustainable contractors provide a better project and process than their less sustainable competitors. This case study generates a question of whether occupying a sustainable building, sustainable practices, or the combination of both have the greatest impact on performance. Future investigation looking at how contractor sustainable business practices impact the project client and building occupants would be helpful to look into the value of sustainability to clients. Investigation into how sustainability is a value-added service could indicate what premiums on sustainability practices are tolerated by the market.

9.5 – Conclusion

In summary, sustainable business practices are beneficial to society and favorable for construction business. Embracing sustainable business practices has a positive impact on strategic firm performance for commercial building contractors through employee satisfaction, project opportunities, and market advantage. Sustainable business practices extend into the lives of individuals involved which exceedingly impacts society. The construction industry has advanced sustainability

efforts, but there is a long way to go on the journey to being better stewards of the environment and resources.

REFERENCES

Agresti, Alan (2007). An Introduction to Categorical Data Analysis. John Wiley and Sons, New Jersey.

"A.L. Huber." <www.alhuber.com> Accessed: August 2014.

"ASHRAE." <www.ashrae.org> Accessed: October 2009.

ASHRAE Standard 90.1. *ANSI/ASHRAE/IES Standard 90.1: Energy Standard for Buildings Except Lo-Rise Residential Buildings*. Release 2010.

Bansal, Pratima and Kendall Roth (2000). Why Companies Go Green: A Model of Ecological Responsiveness. *The Academy of Management Journal*. 43, 4, 717-736.

Barry, M. (2003). Corporate social responsibility – unworkable paradox or sustainable paradigm? *Engineering Sustainability I56*. ES3, 129-130.

Becker, Egon and Thomas Jahn (1999). *Sustainability and the Social Sciences: A Cross-Disciplinary Approach to integrating Environmental Considerations into Theoretical Reorientation*. Zed Books, London.

Beheiry, Salwa M.A., Wai Kiong Chong, and Carl T. Hass (2006). Examining the Business Impact of Owner Commitment to Sustainability. *Journal of Construction Engineering and Management*. 132, 4.

Bergeson, Lynn L. (2002). Leveraging its Buying Power: The Federal Government Goes Green. *Environmental Quality Management*. 12:1, 75-81.

Bilec, Melissa, Robert Ries, H. Scott Matthews and Aurora L. Sharrard (2006). Example of a Hybrid Life-Cycle Assessment of Construction Processes. *Journal of Infrastructure Systems*. 12:4, 207-215.

Bogenstatter, Ulrich (2000). Prediction and optimization of life-cycle costs in early design. *Building Research & Information*. 26, 5, 376-386.

Bon, Ranko and Keith Hutchinson (2000). Sustainable construction: some economic challenges. *Building Research & Information*. 28, 5, 310-314.

Bossink, Bart A. G. (2004). Managing Drivers of Innovation in Construction Networks. *Journal of Construction Engineering and Management*. 337-346.

Bossink B.A.G. and H.J.H. Brouwers (1996). Construction Waste; Quantification and Source Evaluation. *Journal of Construction Engineering and Management*. p. 55-60.

Braithwaite, P. (2007). Improving company performance through sustainability assessment. *Engineering Sustainability I60*. ES2, 95-103.

Cerin, Pontus and Staffan Laestadius (2003). The efficiency of becoming eco-efficient. *Management of Environmental Quality*. 14: 2/3, 221-241.

Cheshire, David (2007). Briefing: New guidance on sustainability. *Engineering Sustainability I60*. ES3, 114-117.

Cooperrider, David l. and Jane E. Dutton, ed. (1999). *Organizational Dimensions of Global Change: No Limits to Cooperation*. Sage Publications, Thousand Oaks, CA.

Creswell, John W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Sage Publications Thousand Oaks, CA.

Creswell, John W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications, Thousand Oaks, CA.

Dainty, Andrew R.J. and Richard J. Brooke (2004). Towards improved construction waste minimisation: a need for improved supply chain integration? *Structural Survey*. 22, 1, 20-29.

Dawe, Neil K. and Kenneth L. Ryan (2003). "The Faulty Three-Legged-Stool Model of Sustainable Development." *Conservation Biology*. 17, 5, 1458-1460.

Dummett, Kel (2006). Drivers for Corporate Environmental Responsibility (CER). *Environment, Development and Sustainability*. 8: 375-389.

Fellows, Richard and Anita Liu (2008). *Research Methods for Construction*. Wiley-Blackwell, Oxford.

Formoso, Carlos T., Lucio Soibelman, Claudia De Cesare, and Eduardo L. Isatto (2002). Material Waste in Building Industry: Main Causes and Prevention. *Journal of Construction Engineering and Management*. 128, 4, 316-325.

Glavinich, Thomas E. (2008). *Contractor's Guide to Green Building Construction*. John Wiley and Sons. New Jersey.

Groat, Linda and David Wang (2002). *Architectural Research Methods*. Massachusetts, John Wiley and Sons, Inc.

Halliday, Sandy (2008). *Sustainable Construction*. Butterworth-Heinemann. Massachusetts.

Hansen, Gary S. and Birger Wernerfelt (1989). "Determinants of Firm Performance: The Relative Importance of Economic and Organizational Factors." *Strategic Management Journal*. 10:5, 399-411.

Higgins JPT, Green S ed. (2009). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.2* [updated September 2009]. The Cochrane Collaboration, 2008. Available from www.cochrane-handbook.org.

Hill, Richard C. and Paul A. Bowen (1997). Sustainable construction: principles and a framework for attainment. *Construction Management and Economics*. 15, 223-239.

Horvath, Arpad (2004). Construction Materials and the Environment. Annual Review of *Environmental Resources*. 29, 181-204.

Horvath, Arpad and H. Scott Matthews (2004). Editorial: Advancing Sustainable Development of Infrastructure Systems. *Journal of Infrastructure Systems*. 77-78.

"JE Dunn." <www.jedunn.com> Accessed: August 2014.

Kibert, Charles J. (2008). *Sustainable Construction: Green Building Design and Delivery*. John Wiley and Sons. New Jersey.

Koger, Susan M. and Britain A. Scott (2007). Psychology and Environmental Sustainability: A Call for Integration. *Teaching of Psychology*. 34:1, 10-18.

Krizov, Clair and Brad Allenby (2004). Social Value Added: A Metric for Implementing Corporate Social Responsibility. *Environmental Quality Management*. 14:2, 39-47.

Kunz, John (2012). "CIFE Research Questions and Methods." Presentation. Center for Integrated Facility Engineering: Stanford.

Lawson, Nigel, Ian Douglas, Stephen Garvin, Codagh McGrath, David Manning and Jonathan Vetterlein (2001). Recycling construction and demolition wastes – a UK perspective. *Environmental Management and Health*. 12, 2, 146-157.

Lee, Y. S., & Guerin, D. A. (2009). Indoor environmental quality related to occupant satisfaction and performance in LEED-certified buildings. *Indoor and Built Environment*, *18*(4), 293-300.

Leiper, Q., N. Fagan, S. Engstrom, and G. Fenn (2003). A strategy for sustainability. *Engineering Sustainability I56*. ESI, 59-66.

Leiserowitz, Anthony A., Robert W. Kates, and Thomas M. Parris (2006). Sustainability Values, Attitudes, and Behaviors: A Review of Multinational and Global Trends. *Annual Review of Environmental Responsibility*. 31: 413-444.

McAdam, Rodney and Denis Leonard (2003). Corporate social responsibility in a total quality management context: opportunities for sustainable growth. *Corporate Governance*. 3, 4, 2003, 36-45.

Molcho, G. and M. Shpitalni (2006). A business-oriented approach to the project life cycle. *Innovation in Life Cycle Engineering and Sustainable Development*. Springer Publishing, 17-31.

Mora, E. P. (2007). Life cycle, sustainability and the transcendent quality of building materials. *Building and Environment*, *42*(3), 1329-1334.

Myers, Danny (2005). A review of construction companies' attitudes to sustainability. *Construction Management and Economics*. 23, 781-785.

National Trust for Historic Preservation (1981). *New Energy from Old Buildings*. Washington DC.

Ofori, George (1992). The environment: the fourth construction project objective? *Construction Management and Economics*. 10, 369-395.

Olson, Eric G. (2008). Creating an enterprise-level "green" strategy. *Journal of Business Strategy*. 22-30.

Orecchini, Fabio (2007). A "measurable" definition of sustainable development based on closed cycles of resources and its application to energy systems. *Sustainable Science*. 2: 245-252.

Parkin, S., F. Sommer and S. Uren (2003). Sustainable development: understanding the concept and practical knowledge. *Engineering Sustainability I56*. ESI, 18-26.

Pearlmutter, David (2007). Architecture and Climate: The Environmental Continuum. *Geography Compass*. 1:4, 752-778.

Peng, Chun-Li, Domenic E. Scorpio and Charles J. Kibert (1997). Strategies for successful construction and demolition waste recycling operations. *Construction Management and Economics*. 15, 49-58.

Pimentel, D., A. Pleasant, J. Barron, J. Guadioso, N. Pollock, E. Chae, Y. Kim, A. Lassiter, C. Schiavoni, A. Jackson, M. Lee and A. Eaton (2004). US Energy Conservation and Efficiency: Benefits and Costs. *Environment, Development and Sustainability*. 6: 279-305.

Poon, C.S., Ann T. W. Yu, and L. Jaillon (2004). Reducing building waste at construction sites in Hong Kong. *Construction Management and Economics*. 22, 461-470.

Prahalad, C.K. and Kenneth Lieberthal (1998). The End of Corporate Imperialism. *Harvard Business Review*. 109-117.

Price, Edmund E. and Donald R. Coy (2001). Life cycle management at 3M: A practical approach. *Environmental Management and Health*. 12:3, 254-259.

Reed, Bill, Joel Ann Todd, and Nadav Malin (2005). Expanding Our Approach to Sustainable Design – An Invitation. *BuildingGreen, Inc*. 1-24.

Riley, David, Kim Pexton, and Jennifer Drilling (2003). Procurement of sustainable construction services in the United States: the contractor's role in green buildings. *Sustainable Building and Construction*.

Rodriguez, Miguel A., Joan E. Ricart and Pablo Sanchez (2002). Sustainable Development and the Sustainability of Competitive Advantage: A Dynamic and Sustainable View of the Firm. *Creativity and Innovation Management*. 11:3, 135-146.

Santos, Juliana Bonomi, and Luiz Artur Ledur Brito (2012). "Toward a subjective measurement model for firm performance." *Brazilian Administration Review*. 9: 95-117.

Saparauskas, Jonas (2003). "Multiple criteria evaluation of buildings with emphasis on sustainability." *Journal of Civil Engineering and Management*. 9:4, 234-240.

Shelbourn, Mark A., Dino M. Bouchlaghem, Chimay J. Anumba, Patricia M. Carillo, Malik M.K. Khalfan, and Jacqueline Glass (2006). Managing Knowledge in the context of sustainable construction. *ITcon*. 11, 57-71.

Shen, L. Y., Li Hao, J., Tam, V. W. Y., & Yao, H. (2007). A checklist for assessing sustainability performance of construction projects. *Journal of civil engineering and management*, *13*(4), 273-281.

Shireman, Bill and Tachi Kiuchi (2002). Doing Business Like a Rainforest: Feedback and Closed-Loop Systems. *Environmental Quality Management*. 12:1, 9-17.

"Statistics." <www.statistics.com> Accessed June 2014.

Strecker, Nanja (2009). *Innovation Strategy and Firm Performance: an empirical study of publicly listed firms*. Wiesbaden: Gabler.

Tanzil, Dicksen and Beth R. Beloff (2006). Assessing Impacts: Overview on Sustainability Indicators and Metrics. *Environmental Quality Management*. 10, 41-56.

"Tarlton Corporation." <www.tarltoncorp.com> Accessed: August 2014.

Teo, M.M.M. and M. Loosemore (2001). A theory of waste behaviour in the construction industry. *Construction Management and Economics*. 19, 741-751.

Trudel, Remi and June Cotte (2009). Does it pay to be good? *MIT Sloan Management Review*. 50, 7, 61-68.

"United States Energy Information Administration: Independent Statistics and Analysis." <http://www.eia.gov/totalenergy/data/annual/#consumption> Accessed: May 2015.

United States Green Building Council. *LEED Reference Guide for Green Building Operations and Maintenance*. 2009 Ed.

"United States Green Building Council." <www.usgbc.org> Accessed: September 2009.

Van Bueren, Ellen M. and Hugo Priemus (2002). Institutional barriers to sustainable construction. *Environment and Planning*. 29, 75-86.

Watson, Kevin, Beate Klingenberg, Tony Polito and Tom G. Geurts (2004). Impact of environmental management system implementation on financial performance: A comparison of two corporate strategies. *Management of Environmental Quality*. 15: 6, 622-628.

WeiBo, Zheng, Sharan Kaur, and Tao Zhi (2010). "A critical review of employee turnover model (1938-2009) and development in perspective of performance." *African Journal of Business Management*. 4:19.

Wernerfelt, B. (1984). "A Resource-based view of the firm." *Strategic Management Journal,* 5(2), 171-180.

Woodall, R., I. Cooper, D. Cowhurst, M. Hadi and S. Platt (2004). MaSC: managing sustainable companies. *Engineering Sustainability I57*. ES1, 15-21.

Yin, Robert K. (2014). *Case Study Research: Design and Methods*. 5th Edition. Thousand Oaks, California; Sage Publications.

Zeisel, John (2006). *Inquiry By Design*. W. W. Norton, New York.

Appendix 1 – Specialty Contractor Survey

IMPACT OF ADOPTING SUSTAINABLE BUSINESS PRACTICES ON SPECIALTY CONTRACTING FIRM PERFORMANCE

Specialty contractors are increasingly becoming involved in "green" construction projects that require them to adopt certain sustainable construction practices in the field. Firms have found that these projects have required them to revise their traditional construction practices in order to meet contractual third-party green-building rating system requirements. Some specialty contracting firms have reported increased project profit due to improved productivity and reduced costs as a result of adopting sustainable construction practices.

There have been recent reports in the business literature that manufacturing firms adopting sustainable business practices perform better than their peers. To date, there have been no studies in the construction industry exploring the connection between sustainable construction and business practices and specialty contracting performance. The objective of this research is to determine if there is a connection between adopting sustainable construction and business practices and specialty contracting firm performance as measured by stakeholder satisfaction and financial metrics.

Sustainable business and construction practices are defined broadly in this study and look beyond the typical "green" building practices encountered in the field. Sustainable practices include any practice that is environmentally sensitive and promotes ongoing profitable operations. This could include initiatives such as the reduction of material waste through prefabrication or conservation of the field workforce through an effective ergonomics program.

To begin the data gathering portion of this research project, we would appreciate it you would complete a short on-line survey about your firm's current and planned sustainability practices. This survey is part of Heather Eiler's dissertation research for her Ph.D. in construction management at KU. The following link will take participants to the survey: http://www.surveymonkey.com/s/specialtycontractors

Reponses will be kept anonymous and the results of the survey and study will be provided to participants upon request. This is just the first step in this research and participants will have the opportunity to participate further if they want to. If participants have any questions about the survey or study, they can contact the researchers as follows:

Heather Eilers, P.E., LEED AP
The University of Kansas
e-mail: eilers@ku.edu

Thomas E. Glavinich, D.E., P.E.
Director, ARCE & Construction Programs
Civil, Env & Architectural Engineering Department
The University of Kansas
Telephone: (785) 864-3435
e-mail: tglavinich@ku.edu

Thank you in advance for completing this survey and your assistance in this research.

Specialty Contractor Current Practices

1. General Questions

Thank you for taking the time to participate in this research. This information will be anonyomous and will not be tied to you or your company.

We are collecting this information to review current practices by specialty contractors and attempting to assess future directions of the industry. This research project has been approved by the University of Kansas Human Subjects Committee HSCL #18677. Feel free to contact me if you have any questions or comments.

Heather Eilers
eilers@ku.edu

1. What is your primary area of business?

2. In what state is your company based?

3. In approximately how many states does your company do business?

4. Your company performs work in the following regions (select all that apply)

- ☐ Western
- ☐ Midwest
- ☐ Southern
- ☐ Eastern
- ☐ Alaska
- ☐ Hawaii
- ☐ International

5. Your company is a

- ☐ DBE
- ☐ MBE
- ☐ WBE
- ☐ None of the above

Specialty Contractor Current Practices

6. Your company has worked on how many LEED (Leadership in Energy and Environmental Design) projects?

7. Approximately what percentage of your projects in 2009 are LEED certified?

8. Approximately what percentage of your projects are competitively bid?

9. Approximately what percentage of your equipment do you own?

- 0%
- 1-25%
- 26-50%
- 51-75%
- 76-99%
- 100%

10. What is your primary concern for the future of your company?

11. Which range best describes your company's annual revenue?

- Under $2 million
- $2-5 million
- $5-10 million
- $10-20 million
- $20-30 million
- Over $30 million

12. Approximately how many office and management personnel are employed by your company?

Specialty Contractor Current Practices

13. Approximately how many tradespeople are employed by your company?

14. Your company is

- ○ Union
- ○ Non-union
- ○ Both of the above
- ○ Not applicable

15. Your company's mission statement includes the following (select all that apply)

- ☐ Sustainability
- ☐ Environmental responsibility
- ☐ Social responsibility
- ☐ None of the above
- ☐ Not applicable

16. Your company's strategic plan includes the following (select all that apply)

- ○ Sustainability
- ○ Environmental responsibility
- ○ Social responsibility
- ○ None of the above
- ○ Not applicable

17. Your company's operational or business plan includes the following (select all that apply)

- ☐ Sustainability
- ☐ Environmental responsibility
- ☐ Social responsibility
- ☐ None of the above
- ☐ Not applicable

Specialty Contractor Current Practices

2. Administration

1. The following have been implemented at your office (select all that apply)

- ☐ HVAC adjustments during unoccupied times
- ☐ Automated mechanical controls
- ☐ Energy efficient HVAC
- ☐ Energy efficient appliances
- ☐ Building insulation improvements
- ☐ None of the above

Other (please specify)

2. Your company has implemented the following at your office (select all that apply)

- ☐ Energy efficient lighting
- ☐ Automated lighting controls
- ☐ Daylight controls
- ☐ Efficient water fixtures
- ☐ None of the above

Other (please specify)

3. Your company regularly incorporates the following practices (select all that apply)

- ☐ Recycling
- ☐ Purchasing recycled materials
- ☐ Composting
- ☐ Carpooling
- ☐ None of the above

Other (please specify)

Specialty Contractor Current Practices

4. Your company is considering the following changes (select all that apply)

- ☐ Office building energy efficiency changes
- ☐ Reducing water consumption
- ☐ Adding recyling and/or composting
- ☐ None of the above

Other (please specify)

5. Your company incorporates the following for project planning (select all that apply)

- ☐ Pre-construction planning meetings
- ☐ Project handoff meetings
- ☐ Progress planning meetings
- ☐ Post-construction review meetings
- ☐ None of the above

Other (please specify)

6. Please rate the following as it pertains to your company.

	Never	Rarely	Somewhat unlikely	Somewhat likely	Usually	Always	N/A
Plans ahead to minimize deliveries.	○	○	○	○	○	○	○
Maintains an inventory of frequently used materials.	○	○	○	○	○	○	○
Seeks out "green" projects.	○	○	○	○	○	○	○
Sustainability is considered in business decisions.	○	○	○	○	○	○	○
Recycles in the office.	○	○	○	○	○	○	○
Tracks proposal/bid sucess rates.	○	○	○	○	○	○	○
Searchign for opportunities in sustainable markets.	○	○	○	○	○	○	○

7. How does your company pre-plan projects?

8. How does your company consider environmental impacts in business decisions?

Specialty Contractor Current Practices

3. Construction Practices

1. Please answer the following as it pertains to your company.

	Never	Rarely	Somewhat unlikely	Somwhat likely	Usually	Always	N/A
Your employees propose alternative methods for executing project tasks.	○	○	○	○	○	○	○
Your management is actively involved in evaluating installation methods.	○	○	○	○	○	○	○
Your company recycles or reuses demolition and scrap material.	○	○	○	○	○	○	○
Your company has a quality plan.	○	○	○	○	○	○	○
Your company has incentives for employee innovations.	○	○	○	○	○	○	○
Your company has an indoor air quality plan for projects.	○	○	○	○	○	○	○

2. How does your company address ergonomic issues?

3. How does your company enforce use of personal protective equipment to protect employee health and safety?

4. How does your company invest in improving productivity?

Specialty Contractor Current Practices

4. LEED

1. Please rate the following as it pertains to your company.

	Never	Rarely	Somewhat unlikely	Somwehat likely	Usually	Always	N/A
Qualified to participate in LEED projects.	○	○	○	○	○	○	○
Willing to participate in LEED projects.	○	○	○	○	○	○	○
Provided voluntary alternates for LEED credits.	○	○	○	○	○	○	○
Encourages employees to seek LEED accreditation.	○	○	○	○	○	○	○
Provides training pertaining to LEED and/or sustainability.	○	○	○	○	○	○	○
Considers LEED a passing trend.	○	○	○	○	○	○	○
Considers LEED as the best way to measure sustainability.	○	○	○	○	○	○	○
Anticipates more stringent sustainability regulations.	○	○	○	○	○	○	○

Specialty Contractor Current Practices

5. Conclusion

Thank you again for your time. Please contact me if you have any questions.

Heather Eilers
eilers@ku.edu

1. Please provide your contact information below if you are willing to participate in future research efforts related to this survey. Your information will not be shared.

2. Additional comments:

Appendix 2 – Office Sustainable Efforts Controlling for Type of Company

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S19a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.5158	0.4726
2	Row Mean Scores Differ	7	8.6190	0.2812
3	General Association	7	8.6190	0.2812

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S19b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.9887	0.3201
2	Row Mean Scores Differ	7	7.8034	0.3502
3	General Association	7	7.8034	0.3502

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S19c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.3050	0.1290
2	Row Mean Scores Differ	7	9.0234	0.2510
3	General Association	7	9.0234	0.2510

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S19d
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.5080	0.2194
2	Row Mean Scores Differ	7	4.7629	0.6889
3	General Association	7	4.7629	0.6889

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S19e
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.8425	0.3587
2	Row Mean Scores Differ	7	5.2080	0.6346
3	General Association	7	5.2080	0.6346

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S20a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.2893	0.5907
2	Row Mean Scores Differ	7	3.8729	0.7943
3	General Association	7	3.8729	0.7943

Effective Sample Size = 43
Frequency Missing = 2

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S20b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1085	0.7418
2	Row Mean Scores Differ	7	4.1781	0.7590
3	General Association	7	4.1781	0.7590

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S20c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.3238	0.5693
2	Row Mean Scores Differ	7	2.9841	0.8865
3	General Association	7	2.9841	0.8865

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S20d
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0402	0.8412
2	Row Mean Scores Differ	7	3.9165	0.7893
3	General Association	7	3.9165	0.7893

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S21a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.5432	0.2141
2	Row Mean Scores Differ	7	12.9616	0.0731
3	General Association	7	12.9616	0.0731

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S21b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.3742	0.5407
2	Row Mean Scores Differ	7	8.4700	0.2930
3	General Association	7	8.4700	0.2930

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S21d
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0758	0.7830
2	Row Mean Scores Differ	7	4.2394	0.7518
3	General Association	7	4.2394	0.7518

Total Sample Size = 45

Appendix 3 – Anticipated Changes Controlling for Type of Company

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S22a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	5.0793	0.0242
2	Row Mean Scores Differ	7	9.2154	0.2376
3	General Association	7	9.2154	0.2376

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S22b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.1279	0.1446
2	Row Mean Scores Differ	7	10.2133	0.1768
3	General Association	7	10.2133	0.1768

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S22c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.6569	0.4177
2	Row Mean Scores Differ	7	2.5269	0.9251
3	General Association	7	2.5269	0.9251

Total Sample Size = 45.00000032

Appendix 4 – Operations Sustainable Efforts Controlling for Type of Company

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S24
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.6111	0.1061
2	Row Mean Scores Differ	7	6.9095	0.4384
3	General Association	35	24.4315	0.9094

Effective Sample Size = 45.00000096

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S25
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1465	0.7019
2	Row Mean Scores Differ	7	6.1656	0.5206
3	General Association	49	33.3590	0.9572

Effective Sample Size = 45.00000128

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S26
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.0690	0.1503
2	Row Mean Scores Differ	7	9.0474	0.2493
3	General Association	49	37.3025	0.8893

Effective Sample Size = 45.00000128

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S27
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0735	0.7863
2	Row Mean Scores Differ	7	10.7567	0.1496
3	General Association	49	46.9315	0.5574

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S28
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.3069	0.5796
2	Row Mean Scores Differ	7	9.3094	0.2312
3	General Association	42	42.9837	0.4289

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S29
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.6489	0.4205
2	Row Mean Scores Differ	7	5.1444	0.6424
3	General Association	28	27.1315	0.5111

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S30
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1875	0.6650
2	Row Mean Scores Differ	7	7.0657	0.4221
3	General Association	49	28.7589	0.9907

Effective Sample Size = 45.00000128

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S31
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1522	0.6965
2	Row Mean Scores Differ	7	5.1337	0.6437
3	General Association	35	22.8454	0.9434

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S32
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.5929	0.4413
2	Row Mean Scores Differ	7	4.9754	0.6630
3	General Association	28	34.5557	0.1832

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S33
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0004	0.9844
2	Row Mean Scores Differ	7	4.4808	0.7230
3	General Association	35	31.7901	0.6239

Effective Sample Size = 45.00000096

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S34
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.2334	0.6290
2	Row Mean Scores Differ	7	3.1283	0.8729
3	General Association	21	27.7367	0.1478

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S35
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.2709	0.6027
2	Row Mean Scores Differ	7	5.7297	0.5716
3	General Association	49	56.8088	0.2070

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S36
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0031	0.9557
2	Row Mean Scores Differ	7	5.2081	0.6346
3	General Association	49	55.0704	0.2558

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S37
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.6090	0.4352
2	Row Mean Scores Differ	7	14.1953	0.0478
3	General Association	42	58.2750	0.0486

Effective Sample Size = 45.00000112

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S38
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.8938	0.3444
2	Row Mean Scores Differ	7	6.6520	0.4660
3	General Association	28	30.9963	0.3172

Effective Sample Size = 45.0000008

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S39
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.2615	0.2614
2	Row Mean Scores Differ	7	3.7708	0.8058
3	General Association	42	40.1718	0.5515

Effective Sample Size = 45.00000112

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S40
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1846	0.6675
2	Row Mean Scores Differ	7	0.5600	0.9992
3	General Association	42	43.4117	0.4110

Effective Sample Size = 45.00000112

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S41
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.8219	0.1771
2	Row Mean Scores Differ	7	6.8370	0.4460
3	General Association	42	41.6167	0.4877

Effective Sample Size = 45.00000112

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S42
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0171	0.8961
2	Row Mean Scores Differ	7	13.1260	0.0691
3	General Association	49	55.4350	0.2450

Effective Sample Size = 45.00000128

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S43
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.4024	0.5259
2	Row Mean Scores Differ	7	11.3009	0.1260
3	General Association	49	38.6587	0.8554

Effective Sample Size = 45.00000128

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S44
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.3910	0.5318
2	Row Mean Scores Differ	7	5.1070	0.6469
3	General Association	42	32.6567	0.8491

Effective Sample Size = 45.00000112

Appendix 5 – Corporate Messaging Controlling for Type of Company

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S16a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1161	0.7333
2	Row Mean Scores Differ	7	4.8027	0.6840
3	General Association	7	4.8027	0.6840

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S16b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.0284	0.3105
2	Row Mean Scores Differ	7	7.3235	0.3960
3	General Association	7	7.3235	0.3960

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S16c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.6782	0.4102
2	Row Mean Scores Differ	7	8.3686	0.3012
3	General Association	7	8.3686	0.3012

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S17a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1457	0.7027
2	Row Mean Scores Differ	7	6.1186	0.5260
3	General Association	7	6.1186	0.5260

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S17b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.8931	0.3446
2	Row Mean Scores Differ	7	13.0128	0.0718
3	General Association	7	13.0128	0.0718

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S17c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.4325	0.2314
2	Row Mean Scores Differ	7	7.2971	0.3986
3	General Association	7	7.2971	0.3986

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S18a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0388	0.8439
2	Row Mean Scores Differ	7	7.6781	0.3618
3	General Association	7	7.6781	0.3618

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S18b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.5981	0.4393
2	Row Mean Scores Differ	7	8.7818	0.2687
3	General Association	7	8.7818	0.2687

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for Business_area by S18c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.9466	0.0861
2	Row Mean Scores Differ	7	9.9469	0.1916
3	General Association	7	9.9469	0.1916

Effective Sample Size = 43
Frequency Missing = 2

Appendix 6 – Consistency in Corporate Messaging

The SAS System

The FREQ Procedure

Summary Statistics for S16a by S17a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	7.1222	0.0076
2	Row Mean Scores Differ	1	7.1222	0.0076
3	General Association	1	7.1222	0.0076

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S16a by S18a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	22.6788	<.0001
2	Row Mean Scores Differ	1	22.6788	<.0001
3	General Association	1	22.6788	<.0001

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S17a by S18a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	13.5729	0.0002
2	Row Mean Scores Differ	1	13.5729	0.0002
3	General Association	1	13.5729	0.0002

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S16b by S17b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.5415	0.1109
2	Row Mean Scores Differ	1	2.5415	0.1109
3	General Association	1	2.5415	0.1109

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S16b by S18b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	19.0089	<.0001
2	Row Mean Scores Differ	1	19.0089	<.0001
3	General Association	1	19.0089	<.0001

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S17b by S18b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.2548	0.1332
2	Row Mean Scores Differ	1	2.2548	0.1332
3	General Association	1	2.2548	0.1332

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S16c by S17c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	8.1298	0.0044
2	Row Mean Scores Differ	1	8.1298	0.0044
3	General Association	1	8.1298	0.0044

Total Sample Size = 45

The SAS System

The FREQ Procedure

Summary Statistics for S16c by S18c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	15.8674	<.0001
2	Row Mean Scores Differ	1	15.8674	<.0001
3	General Association	1	15.8674	<.0001

Effective Sample Size = 43
Frequency Missing = 2

The SAS System

The FREQ Procedure

Summary Statistics for S17c by S18c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	11.9638	0.0005
2	Row Mean Scores Differ	1	11.9638	0.0005
3	General Association	1	11.9638	0.0005

Effective Sample Size = 43
Frequency Missing = 2

Appendix 7 – Employee Morale Association Tests

The SAS System

The FREQ Procedure

Summary Statistics for Int6 by Int10
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	3.2497	0.0714
2	Row Mean Scores Differ	2	5.0655	0.0794
3	General Association	6	14.1239	0.0283

Effective Sample Size = 81.00000036

The SAS System

The FREQ Procedure

Summary Statistics for Int6 by Int13
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.0299	0.3102
2	Row Mean Scores Differ	2	1.1293	0.5686
3	General Association	12	5.1301	0.9535

Effective Sample Size = 91
Frequency Missing = 8

The SAS System

The FREQ Procedure

Summary Statistics for Int6 by Int14a
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	6.0180	0.0142
2	Row Mean Scores Differ	2	11.6791	0.0029
3	General Association	12	23.4301	0.0243

Effective Sample Size = 91
Frequency Missing = 8

The SAS System

The FREQ Procedure

Summary Statistics for Int7a by Int7b
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	4.4651	0.0346
2	Row Mean Scores Differ	5	6.9186	0.2268
3	General Association	25	28.9700	0.2652

Effective Sample Size = 99.00000108
Frequency Missing = 693.00000088

The SAS System

The FREQ Procedure

Summary Statistics for Int7a by Int7c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1564	0.6925
2	Row Mean Scores Differ	5	2.4680	0.7813
3	General Association	20	25.5358	0.1817

Effective Sample Size = 99.0000009

The SAS System

The FREQ Procedure

Summary Statistics for Int7a by Int7d
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	7.8705	0.0050
2	Row Mean Scores Differ	5	10.2469	0.0685
3	General Association	15	27.1741	0.0273

Effective Sample Size = 99.00000072

The SAS System

The FREQ Procedure

Summary Statistics for Int7b by Int7c
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	12.1711	0.0005
2	Row Mean Scores Differ	5	20.0546	0.0012
3	General Association	20	44.3889	0.0013

Effective Sample Size = 99.0000009

The SAS System

The FREQ Procedure

Summary Statistics for Int7b by Int7d
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	12.9125	0.0003
2	Row Mean Scores Differ	5	17.4737	0.0037
3	General Association	15	42.3724	0.0002

Total Sample Size = 99

The SAS System

The FREQ Procedure

Summary Statistics for Int7c by Int7d
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	12.1248	0.0005
2	Row Mean Scores Differ	4	15.8395	0.0032
3	General Association	12	27.6267	0.0063

Effective Sample Size = 99.0000006

The SAS System

The FREQ Procedure

Summary Statistics for Int23 by Int18
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	5.5069	0.0189
2	Row Mean Scores Differ	3	6.3366	0.0963
3	General Association	9	7.7370	0.5609

Effective Sample Size = 83
Frequency Missing = 16

The SAS System

The FREQ Procedure

Summary Statistics for Int23 by Int19
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.4400	0.5071
2	Row Mean Scores Differ	3	8.7292	0.0331
3	General Association	39	43.5694	0.2832

Effective Sample Size = 81.00000168

The SAS System

The FREQ Procedure

Summary Statistics for Int23 by Int20
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.3330	0.1267
2	Row Mean Scores Differ	3	5.8420	0.1196
3	General Association	9	15.3407	0.0820

Effective Sample Size = 75.00000048

The SAS System

The FREQ Procedure

Summary Statistics for Int23 by Int21
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.5517	0.4576
2	Row Mean Scores Differ	3	2.5336	0.4693
3	General Association	36	20.8824	0.9792

Effective Sample Size = 73.00000156

Appendix 8 – Market Advantage Association Tests

The SAS System

The FREQ Procedure

Summary Statistics for Int17 by Int18
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	7.9516	0.0048
2	Row Mean Scores Differ	5	13.8203	0.0168
3	General Association	15	29.4752	0.0140

Total Sample Size = 99

The SAS System

The FREQ Procedure

Summary Statistics for Int17 by Int19
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0184	0.8921
2	Row Mean Scores Differ	5	6.0149	0.3048
3	General Association	70	41.8013	0.9970

Effective Sample Size = 97.0000027

The SAS System

The FREQ Procedure

Summary Statistics for Int17 by Int20
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.6360	0.4252
2	Row Mean Scores Differ	5	14.0940	0.0150
3	General Association	15	32.8923	0.0049

Effective Sample Size = 76.00000072

The SAS System

The FREQ Procedure

Summary Statistics for Int17 by Int21
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0002	0.9896
2	Row Mean Scores Differ	5	4.1266	0.5313
3	General Association	60	26.6236	0.9999

Effective Sample Size = 73.00000234

The SAS System

The FREQ Procedure

Summary Statistics for Int18 by Int19
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0123	0.9118
2	Row Mean Scores Differ	3	3.5798	0.3106
3	General Association	42	25.6071	0.9783

Effective Sample Size = 97
Frequency Missing = 2

The SAS System

The FREQ Procedure

Summary Statistics for Int18 by Int20
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	2.1806	0.1398
2	Row Mean Scores Differ	3	2.7090	0.4387
3	General Association	9	3.1438	0.9583

Effective Sample Size = 76.00000048

The SAS System

The FREQ Procedure

Summary Statistics for Int18 by Int21
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0300	0.8625
2	Row Mean Scores Differ	3	0.5804	0.9009
3	General Association	36	21.5904	0.9724

Effective Sample Size = 73.00000156

The SAS System

The FREQ Procedure

Summary Statistics for Int19 by Int20
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0048	0.9447
2	Row Mean Scores Differ	13	8.0955	0.8373
3	General Association	39	37.5728	0.5350

Effective Sample Size = 76.00000168

The SAS System

The FREQ Procedure

Summary Statistics for Int19 by Int21
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.5549	0.2124
2	Row Mean Scores Differ	11	6.9958	0.7994
3	General Association	132	67.3588	1.0000

Effective Sample Size = 73.00000468

The SAS System

The FREQ Procedure

Summary Statistics for Int20 by Int21
Controlling for Company

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.6630	0.4155
2	Row Mean Scores Differ	3	6.0717	0.1082
3	General Association	36	31.8624	0.6658

Effective Sample Size = 72
Frequency Missing = 27

Appendix 9 – LEED Scorecard for JE Dunn Headquarters

41	0	28	**Total Project Score**			
8	**0**	**6**	**Sustainable Site**		Possible Points	**14**
Y	?	N				
Y			Prereq 1	**Construction Activity Pollution Prevention**		**0**
1			Credit 1	**Site Selection**		**1**
1			Credit 2	**Development Density & Community Connectivity**		**1**
		1	Credit 3	**Brownfield Redevelopment**		**1**
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access		**1**
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms		**1**
1			Credit 4.3	**Alternative Transportation**, Low Emmitting Fuel Efficient Vehicl		**1**
		1	Credit 4.4	**Alternative Transportation**, Parking Capacity & Carsharing		**1**
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Habitat		**1**
		1	Credit 5.2	**Reduced Site Disturbance**, Maximize Open Space		**1**
1			Credit 6.1	**Stormwater Management**, Quantity Control		**1**
1			Credit 6.2	**Stormwater Management**, Quality Control		**1**
1			Credit 7.1	**Heat Island Effect**, Non-Roof		**1**
		1	Credit 7.2	**Heat Island Effect**, Roof		**1**
		1	Credit 8	**Light Pollution Reduction**		**1**
5	**0**	**0**	**Water Efficiency**		Possible Points	**5**
Y	?	N				
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%		**1**
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation		**1**
1			Credit 2	**Innovative Wastewater Technologies**		**1**
1			Credit 3.1	**Water Use Reduction**, 20% Reduction		**1**
1			Credit 3.2	**Water Use Reduction**, 30% Reduction		**1**
6	**0**	**11**	**Energy & Atmosp**		Possible Points	**17**
Y	?	N				
Y			Prereq 1	**Fundamental Commissioning, Building Energy System**		**0**
Y			Prereq 2	**Minimum Energy Performance (ASHRAE 90.1, 2004)**		**0**
Y			Prereq 3	**Fundamental Refrigerant Management**		**0**
2			Credit 1.1	**Optimize Energy Performance**, 14% New, 7% Existing		**2**
		2	Credit 1.2	**Optimize Energy Performance**, 21% New, 14% Existing		**2**
		2	Credit 1.3	**Optimize Energy Performance**, 28% New, 21% Existing		**2**
		2	Credit 1.4	**Optimize Energy Performance**, 35% New, 28% Existing		**2**
		2	Credit 1.5	**Optimize Energy Performance**, 42% New, 35% Existing		**2**
		1	Credit 2.1	**On-Site Renewable Energy**, 2.5%		**1**
		1	Credit 2.2	**On-Site Renewable Energy**, 7.5%		**1**
		1	Credit 2.3	**On-Site Renewable Energy**, 12.5%		**1**
1			Credit 3	**Enhanced Commissioning**		**1**
1			Credit 4	**Enhanced Refrigerant Management**		**1**
1			Credit 5	**Measurement & Verification**		**1**
1			Credit 6	**Green Power**		**1**

5	0	8	Materials & Resources		Possible Points	13
Y	?	N				
Y			Prereq 1	**Storage & Collection of Recyclables**		0
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof		1
		1	Credit 1.2	**Building Reuse**, Maintain 95% of Existing Walls Floors & Roof		1
		1	Credit 1.3	**Building Reuse**, Maintain 50% Non-Structural Elements		1
1			Credit 2.1	**Construction Waste Management**, Divert 50%		1
1			Credit 2.2	**Construction Waste Management**, Divert 75%		1
		1	Credit 3.1	**Resource Reuse**, Specify 5%		1
		1	Credit 3.2	**Resource Reuse**, Specify 10%		1
1			Credit 4.1	**Recycled Content**, Specify 10% (p.c. + 1/2 p.i.)		1
		1	Credit 4.2	**Recycled Content**, Specify 20% (p.c. + 1/2 p.i.)		1
1			Credit 5.1	**Local/Regional Materials**, 10% Extracted, Processed, Manufactured		1
		1	Credit 5.2	**Local/Regional Materials**, 20% Extracted, Processed, Manufactured		1
		1	Credit 6	**Rapidly Renewable Materials**, 2.5%		1
1			Credit 7	**Certified Wood**, 50% of Wood Based Materials		1
12	0	3	Indoor Environmental Quality		Possible Points	15
Y	?	N				
Y			Prereq 1	**Minimum IAQ Performance** (ASHRAE 62.1, 2004)		0
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**		0
1			Credit 1	**Outdoor Air Delivery Monitoring**		1
		1	Credit 2	**Increase Ventilation** (ASHRAE 62.1, 2004 or CIBSE 1998)		1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction		1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy		1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants		1
1			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings		1
1			Credit 4.3	**Low-Emitting Materials**, Carpet Systems		1
		1	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products		1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**		1
1			Credit 6.1	**Controllability of Systems**, Lighting		1
1			Credit 6.2	**Controllability of Systems**, Thermal Comfort		1
1			Credit 7.1	**Thermal Comfort**, Design - Comply with ASHRAE 55-2004		1
1			Credit 7.2	**Thermal Comfort**, Verification		1
		1	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces		1
1			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces		1
5	0	0	Innovation & Design Process		Possible Points	5
Y	?	N				
1			Credit 1.1	**Innovation in Design**: 40% Water reduction		1
1			Credit 1.2	**Innovation in Design**: 95% construction waste		1
1			Credit 1.3	**Innovation in Design:** Transportation and Carbon Offset Program		1
1			Credit 1.4	**Innovation in Design:** Educational program		1
1			Credit 2	**LEED® Accredited Professional**		1