

HUMAN SUSTAINABILITY: SAFETY IN CONSTRUCTION

By

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To my mom, dad, and sisters-
For all the support and love you have given me for my entire life

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TABLE OF CONTENTS

	<u>page</u>
ACKNOWLEDGEMENTS	4
LIST OF FIGURES	6
ABSTRACT	7
CHAPTER	
1 INTRODUCTION	9
Background	9
Statement of Purpose	9
Research Objectives	10
Scope of Study	10
2 LITERATURE REVIEW	11
3 METHODOLOGY	16
4 EXPECTED RESULTS	19
5 SURVEY AND INTERVIEW RESULTS	20
Company Profile	20
Respondent Profile	20
LEED Familiarity	20
Supporting LEED Practices	21
Safety Concerns	22
Adding Safety into LEED	27
Further Analysis:	30
6 CONCLUSIONS	54
7 RECOMMENDATIONS	56
APPENDIX	
A INTERVIEW INFORMED CONSENT	57
B SURVEY CONSENT & SURVEY	59
LIST OF REFERENCES	62
BIOGRAPHICAL SKETCH	63

LIST OF FIGURES

<u>Figure</u>	<u>page</u>
5-1 Respondents by type of company	35
5-2 Respondents by annual volume of their firms	36
5-3 Primary position.....	37
5-4 Years of personal construction experience	38
5-5 Familiarity with the USGBC and the LEED process	39
5-6 Number of LEED projects worked on	40
5-7 LEED Accredited Professional status.....	41
5-9 Safety concerns in the preconstruction phase	43
5-10 Promoting construction worker safety on the job-site	44
5-11 Safety representative continuously on-site	45
5-12 Protecting ducts and airways on every job.....	46
5-13 Job-site specific construction worker health and safety plan	47
5-14 Adding worker health and safety to the LEED rating system	48
5-15 Safety should be a Required Prerequisite or Optional Credit.....	49
5-16 How many points for worker health and safety	50
5-17 Existing category or new category.....	51
5-18 SafetyScore vs. Adding Safety into LEED.....	51
5-19 Comparison of the importance of LEED vs. adding safety to the LEED rating system	52
5-20 Comparison of familiarity with LEED vs. adding safety to the LEED rating system	52
5-21 Comparison of LEED Accredited Professionals vs. adding safety to the LEED rating system	53
5-22 LEED Familiarity vs. Adding Safety into LEED	53

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Is a Leadership in Energy and Environmental Design (LEED) certified building considered sustainable if construction workers are injured or even killed in the process? Construction worker health and safety should be the most important aspect of every project. Anything that can be done to further promote safety in construction should be implemented. LEED is considered by many owners as a marketing tool, and having a LEED certified project is highly sought after in the industry. Adding safety into the LEED rating system would get the owner invested in safe work practices. The LEED scorecard currently has 110 possible points and yet only one point is rewarded for the health and safety of workers during construction.

The purpose of this study is to evaluate the attitude among construction professionals about adding worker health and safety into the LEED rating system. Expert interviews were conducted with three construction professionals with different backgrounds. The primary source of data was a survey that was distributed among employees of General Contractors and Subcontractors. The study resulted in 463 completed surveys. The results of the survey indicate that construction professionals

have strong positive feelings towards safety, and have strong positive feelings for LEED, but the majority does not want to see the two combined. The individuals who are the most familiar with LEED do not want to see safety added into the LEED rating system.

CHAPTER 1 INTRODUCTION

Background

Since 1998 more than 14,000 Leadership in Energy and Environmental Design (LEED) certified projects have been registered globally. For every LEED project completed, safety has not been rewarded or recognized by the United States Green Building Council. To ensure the sustainability of all resources, construction worker safety should be the primary focus of every construction project, taking priority over issues of time, cost or quality. With the high incidence of construction worker fatalities and jobsite injuries, considerable efforts are warranted to promote jobsite safety. Currently the LEED rating system has 110 possible points and only one point is dedicated to the safety of the construction workers during project execution. The promotion of safety and successful efforts in reducing construction worker suffering on a project should be rewarded. The United States Green Building Council should care as much for the people who actually build the projects as they do for the people who own and occupy them.

Statement of Purpose

The LEED rating system takes into account the health and safety of the building occupants after the project is complete, but what about the safety of the workers who actually construct the project? There are currently no points awarded by the United States Green Building Council for having safe practices on a LEED certified project. The purpose of this study is to examine the attitudes of construction professionals regarding the advisability of adding construction worker health and safety into the LEED rating system.

Research Objectives

The intention of this study is to evaluate the need and demand to incorporate the health and safety of construction workers during project execution into the LEED rating system. Also, the purpose is to evaluate different options of how professionals in the construction industry think safety should be added into the LEED rating system.

Scope of Study

First, this research will review the literature concerning the importance of adding construction worker health and safety into the LEED rating system. Next, a description will be provided of how the data were collected to obtain information for this study. Then, the analysis of the results of this research will be described and interpreted.

CHAPTER 2 LITERATURE REVIEW

The Leadership in Energy and Environmental Design (LEED) rating system currently gives very little consideration to safety during construction project execution. The only issue that is addressed is Indoor Environmental Quality (IEQ) credit 3.1 and that is indoor air quality management during construction. The purpose of this is to protect the building occupants from potential air quality problems during the construction process and it will also protect construction workers. This is just one point out of 110 possible points on the new 2009 LEED rating system that can be construed as favorably impacting construction worker safety. This one point out of 110 is awarded despite the fact that construction worker safety should be the most important aspect of a project. It would appear appropriate that the United States Green Building Council should give greater consideration to the health and well-being of construction workers.

This literature review will show that little research has been conducted on this very important topic. A newspaper article was written after the sixth fatality occurred on the \$9.2 billion MGM Mirage City Center construction site in Las Vegas. This project was on track to being a LEED NC Silver Certified building. The author of the article conducted research and found that the word "Safety" only appeared one time in the LEED rating system. The author states that safety should be added to the LEED rating system and that it would be easy to incorporate.

LEED can close the health and safety loophole by adopting OSHA 29 CFR 1926 as a prerequisite, with provisions that allow local amendments, and awarding one credit if a project is completed without a serious injury or death. Certifications should be revocable where "accidental" injuries or deaths complicit with negligence or corruption occurred during construction, but were proved to be complicit with negligence after the certification was awarded. While such provisions might not be perfect preventative

measures, they provide the U.S. Green Building Council with rear-guard action to protect its name and that of LEED (Ivanovich 2008).

This article stresses that LEED should incorporate safety into the point system, but adding only one point for having zero injuries or deaths appears to be quite inadequate. The suggestion that a point should be awarded after project completion is a departure from the current rating system in which the points are accrued essentially at the design stage.

One of the most important yet under-recognized, and under-represented resources utilized during the construction process is the human capital that is needed to build projects. Green building initiatives and methodologies provide the driving mechanism for current sustainable practices, but the health and safety of the workers who construct the built environment are not added in the framework of the current rating systems. The safety policies of the construction firms and the amount of safety training offered during construction should be given merit in the LEED evaluation process. Safety policies of the builder and actual safety performance during construction of a green project could be considered, similar to commissioning or installation guidelines. The well-being of construction workers must also be sustained. Should a project be considered sustainable if it conserves energy, reduces water use, recycles materials, but where a worker was seriously injured or killed in the process? It would seem that construction workers should be part of the LEED process and considered the most valuable resource. Despite the significant changes in recent years to promote sustainability, little has been done to evaluate the well-being of the on-site construction workers (Hinze 2010).

An article in (Professional Safety Magazine) addresses the topic of safety in the LEED rating system. The article describes in detail the LEED rating system and how several prerequisites and credits relate directly or indirectly to occupant comfort and health. The LEED rating system is organized into five environmental categories: sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), indoor environmental quality (IEQ), and materials and resources (MR). This article discusses how in every category some credits and prerequisites will indirectly affect worker health and safety. An example is how through controlling erosion and sedimentation during construction this will limit worker exposure to airborne particulates.

As a larger issue, many of the sessions at ASSE's annual conferences have revolved around the idea that worker safety should be engineered into the built environment—for example; fall protection anchor points for use during construction should be formed into steel structure components during the building design stage rather than added by the safety manager once construction has started. Similarly, fall protection anchors for window washers should be designed into the structure rather than added after construction. The point has been made that safety by design is at the same time more protective of workers and more cost effective than safety by default. With these issues as a driving force (more protective, less costly), why isn't safety by design part of building codes everywhere? As noted, LEED is being incorporated into municipal building requirements, and is pulling its occupational safety benefits along with it. SH&E professionals and ASSE members can make a substantial contribution to the LEED program—and the LEED program can contribute a great deal to occupational safety and health (Silins 2009).

Building materials that are built with integral safety components could have a very positive impact toward promoting safety in construction.

Another study about safety on green building projects was done to answer three questions: Does green building design and construction affect the safety and health of construction workers? If yes, what green design and construction practices affect the safety and health of construction workers? What are the project member's perspectives

on the relationship between green building design and construction practices and construction worker safety and health? To answer these questions that study conducted five rounds of interviews on a 146,000 square ft. computer science building on the Oregon State University campus. The interviews included different people involved on the project from upper managers to laborers. Questions were asked about their role on the project, if they were aware if the project was a green building, did they feel that any aspects of the project being green affected health and safety, did they believe the project was safer because it was a green building, and did they feel that construction worker safety should be part of the LEED certification process?

(Gambatese et al. 2007) That study found that 83% of the people knew that the project was a green building, and 50% felt that green building construction was a little bit safer than a conventional building. Of all the respondents 79.2% felt that construction worker health and safety should be considered in the LEED rating system. The conclusions of that research also found that the current literature does not provide much evidence of the impacts of green construction and the safety of the workers.

If an injury or fatality occurs during the construction of a green building, is the project sustainable? Green building design focuses its attention to a large extent on the sustainability of the end users and the end use, while the process by which the building is constructed is somewhat ignored and may not necessarily be a truly sustainable process. Gilding, Humphries and Hogarth (2002) argue that many sustainability agendas are too narrowly focused on environmental issues and ignore occupational safety. The authors of this article propose that a more holistic view of green construction is needed—one that addresses safety and health over the entire life cycle of a constructed building—in order for the green process to be truly categorized as sustainable (Gambatese et al. 2007).

The article goes on to discuss a new rating system geared toward the safety and health of construction workers to make a project truly sustainable. They suggest that

further research is needed to connect the health and safety of workers to the green building process.

A health and safety plan should address the health of workers on the project site and the health of the building's future occupants. Neither LEED nor Green Globes requires a specific construction worker health and safety plan. A construction worker health and safety plan should take into account the building's air quality design. In building additions, adequate protection between occupied areas and construction areas should be provided. Ducts and airways should always be protected from moisture, dust, particulates, VOCs, and microbes that are generated by or distributed by construction activities. The plan should include increased ventilation / exhaust air on-site during construction. Even the best building design can be undermined by poor job-site construction practices (Kibert 2008).

CHAPTER 3 METHODOLOGY

The objective of this study was to obtain information about the value of including safety into the Leadership in Energy and Environmental Design (LEED) rating system. It was determined that the desired data could best be obtained through a survey. The number of questions was kept to a minimum in order to increase the response rate. The questions solicited multiple-choice responses to make the questions easy to answer. The literature review provided a basis for beginning the survey development. During the development of the survey, assistance was provided by Dr. Sullivan and Dr. Kibert and the survey went through several iterations. The completed survey was then approved by the University of Florida Institutional Review Board.

The survey consisted of 17 questions that addressed the following topic areas: demographics of the respondents and the employing firm, general view about construction safety, experience with LEED, and a few other related topics. The key question pertained to the view of the respondent concerning the inclusion of construction worker safety in the LEED rating system. The consent form and final survey are included in Appendix B.

The survey was placed in Survey Monkey for data retrieval. The population to survey was then identified. All contacts with potential respondents were made via email. The emails soliciting participation in the study were sent to the author's personal contacts and to an official list of alumni and friends maintained by the M.E. Rinker School, Jr. of Building Construction. Each email also had a specific request for each respondent to forward the survey to other contractors and subcontractors. The email message contained a web address to access the survey via Survey Monkey. Through

this means the identity of respondents was never made known to the author. A total of 463 responses were received. At least 2,700 emails were sent by the author, but some respondents indicated that they had forwarded the survey information to other firms, so the total potential respondents was some larger but unknown number. Most respondents answered all of the questions. Additionally, some respondents felt compelled to send separate emails to the author to more specifically describe their views on certain issues. These emails were not solicited but such messages were received from 11 respondents.

In addition to the survey results it was decided that personal interviews should be conducted with three industry experts who were known to be familiar with the subject of this research. These experts were personally known by the author, but they were each employed by different general contractors. The experts were asked the same questions that appeared in the survey, but they were encouraged to elaborate more in their answers.

Expert # 1 (Management) was employed by a mid-sized general contractor with annual revenues around \$100 million. The company is based in Gainesville, Florida. This interview was conducted in person. This expert had accumulated 15 years of construction experience and his primary position was Senior Project Manager. This expert is a LEED Accredited Professional under version 2.0 and has worked on four LEED certified projects.

Expert # 2 (Safety) is the Safety Director for a mid-sized general contractor based in Gainesville, Florida. This interview was conducted in person. This contractor has annual revenues of around \$100 million. Expert # 2 has over 20 years of

construction experience and has worked on seven LEED certified projects. This expert is not a LEED Accredited Professional.

Expert # 3 (Field) is a Superintendent for a large general contractor with annual revenues of over \$500 million and is based in Atlanta, Georgia. This expert is currently working on a hospital in New Hampshire and the interview was conducted over the telephone. Expert # 3 has seven years of construction experience and has never worked on a LEED certified project. This expert is a LEED Accredited Professional under version 2.2 and is very familiar with the LEED process.

Data analysis was conducted by using the analysis function of Survey Monkey. The data was then converted to an SPSS file for more detailed analysis.

CHAPTER 4 EXPECTED RESULTS

The objective of this study was to assess the attitudes of construction professionals about the merits of adding safety into the Leadership in Energy and Environmental Design (LEED) rating system. It was assumed that most construction professionals would place a high value on safety and also a high value on the merits of LEED. Furthermore, it was expected that the survey would show that professionals throughout the construction industry all feel that the LEED rating system should incorporate worker health and safety. This is a very current and important topic and it was assumed that there would be a high response rate for the survey.

CHAPTER 5 SURVEY AND INTERVIEW RESULTS

Company Profile

The survey was sent out to general contractors and subcontractors. The majority of the respondents worked for general contractors. The first questions in the survey solicited information about the companies that employed the respondents. One question asked about the type of company that employed the respondent. While the intended audience was employees of general contractors and subcontractors, some respondents worked in firms that were categorized as “other”. Most (63.9%) of the respondents were employed by a general contractor and 20.6% were employed by subcontractors (Figure 5-1). To obtain information on the size of the employing company, a question was asked about the annual volume of work that was performed by the company. Most of the respondents reported that their employing companies performed an annual volume of business ranging from \$25 million to \$500 million.

Respondent Profile

Two questions were to solicit additional information about the respondents: the respondent’s primary position, and the amount of construction experience? The majority of the respondents worked in upper management, project management, or project engineering (Figure 5-3). Over 45% of the respondents have 15 or more years of construction experience (Figure 5-4). This means that the majority of the respondents were seasoned professionals in the construction industry.

LEED Familiarity

A series of questions were asked to provide information on the level of familiarity that the respondents had with the Leadership in Energy and Environmental Design

(LEED) process. The first question was simply asked, are you familiar with the United States Green Building Council and the LEED process? The results show that a large majority (91.5%) of the respondents were familiar with LEED (Figure 5-5). To determine the extent of the respondents hands-on knowledge of LEED, a question was asked about the number of LEED projects on which the respondents had worked. Most (68%) of the respondents have worked on one or more LEED projects (Figure 5-6). The last question about the respondents familiarity with LEED asked if they were a LEED Accredited Professional? The survey showed that almost 40% of the respondents were LEED Accredited (Figure 5-7).

Supporting LEED Practices

Survey participants were asked if they supported LEED practices for all projects. This question was asked to determine the respondents' views about the value of the LEED practices. This question solicited a Likert-type response on a 1 to 5 scale with "1" being Least Important and "5" being Most Important. Slightly over 50% of the participants responded that the support of LEED practices was either important or most important (Figure 5-8).

When the three expert interviewees were given this question, they all stated that supporting LEED practices on all projects was most important. Expert # 1 (management) stated that because the construction industry is responsible for such a large amount of waste, following LEED practices can have a huge impact on the planet. Supporting LEED practices in construction can have a trickle down effect on almost all industries because of the amount of materials used in construction. Following the LEED practices in construction can result in putting pressure on other industries that produce building materials to provide sustainable alternatives. He concluded that the

construction industry is the biggest consumer of materials, so following LEED practices on all projects is very important.

Expert # 2 (safety) stated that LEED is a great thing when it works and that the good outweighs the bad. LEED is owner-driven and comes with an additional cost. For contractors this is good from a revenue perspective because the added project costs can be billed to the owner. LEED practices are also good for the planet and that is important.

Expert # 3 (Field) mentioned that supporting LEED practices should be a company standard because it is just good business. Recycling on a project will save money because it will cut back on sending debris to the landfill. This expert also stated that maintaining air quality is also a good practice that should always be done.

One of the survey participants felt compelled to send the author an email to clarify their feelings about supporting LEED practices. The respondent stated, "The industry needs to do a better sales job on the value of LEED."

Safety Concerns

Several questions were asked about the respondents' views on different safety practices. The first question asked if safety concerns should be considered and designed for in the preconstruction phase. As for all the safety-related questions, the Likert-type response being solicited answers from 1 to 5 with "1" being "strongly disagree" to "5" being "strongly agree". Over 80% of the respondents stated that they either agree or strongly agree that safety should be considered in the design phase (Figure 5-9).

Expert #1 (management) felt neutral about considering safety in the preconstruction phase. He stated that the means and methods should always be left for

the contractor to decide. Safety concerns should be deferred to the contractor because it is too risky for the architect to take responsibility for safety issues. He contended that accessibility and maintainability for the people who will occupy the building should be considered in the design phase, but the safety of the construction workers is rarely mentioned in preconstruction.

Expert #2 (safety) and expert #3 (field) both stated that they “strongly agree” that safety should be considered and designed for in the preconstruction phase. Expert #2 (safety) contended that architects should always consider safety concerns in the design of a project. He stated that instead of designing parapet walls with a 24” height, they should be designed with a 48” height and that will be adequate for fall protection on the roof. Steel tie-offs for fall protection should be added for steel workers. Davits should be built into the structure as part of the design. Accessibility during construction and after construction should also be addressed in the design. This expert stated that these are examples of easy ways to incorporate safety into the LEED rating system.

Expert #3 (field) agreed with Expert #2 and stated that designing for safety is a great way to add safety into LEED because it is easily documented and it would be very helpful to promote safety on-site. Tag lines, eye hooks, rail systems, and anchors are all items that will help promote safety on-site and can be designed for in preconstruction.

The second safety question in the survey asked if the respondents agreed that construction worker safety should be supported continuously on the job-site? None of the respondents disagree that safety should be continuously supported on the job-site.

Over 97% of the respondents either agree or strongly agree that safety should always be supported on the job-site.

The three experts were in agreement and strongly agreed that safety should be continuously supported on a project. The responses from the experts were that safety should always be the top priority on every project without question. Weekly safety meetings with the project staff should be on every project. Getting every worker home safely is the most important goal everyday. One stated that having a great safety record will help a company to get jobs and having no lost time on a project will save money. He concluded by saying that injuries and fatalities are very expensive for a project so promoting safety will also save money.

The third safety related question asked if a safety representative should continuously be in the job-site. Nearly half of the respondents agree or strongly agree that a safety representative should always be on the job-site (Figure 5-11). It is also noteworthy that 23.1% of the respondents stated that they either disagree or strongly disagree with the practice.

The three experts either agreed or strongly agreed that a safety representative should be on the job-site at all times. They felt that having a safety representative continuously on-site is dependent on the size of the project based on a dollar amount. They felt that a full time safety representative should be on-site once a project is in excess of \$50 million. They also stated that under special circumstances a project could have a full-time safety representative on a smaller job. Expert # 1 (management) and expert # 3 (field) stated that all field staff working for the general contractor should be OSHA 30-hour certified, continuously take safety classes, and be first aid certified

regardless of the job size. The experts recommended that this would be a good way to incorporate safety into the LEED rating system because it is effective and easy to document for the United States Green Building Council.

An email response was received from one of the respondents that stated an opinion about having a safety representative on-site at all times, "There are multiple factors that decide what safety measures are implemented. On some smaller sites a full time safety person is not required - essentially safety is everyone's job - not just one person."

The fourth safety related question has to do with protecting the air on the job-site during construction. Specifically, it asked, "Should protecting ducts and airways from moisture, dust, VOCs, particulates, and microbes that result from construction activities be considered on every job?" Over 82% of the respondents either agreed or strongly agreed that ducts and airways should be protected on every job.

The three experts strongly agreed that ducts and airways should be protected at all times during construction. The experts stated that hanging drywall, cutting drywall, sanding, welding, and many other construction activities cause particulates to enter into the ductwork if it is not sealed properly. Protecting the ducts and airways should always be done for the health and safety of the construction workers and the people who will occupy the completed building. Workers are on-site when these systems get turned on so this practice should be implemented on LEED and non LEED jobs. Expert # 2 (safety) stated that the building envelope is another hot point right now for safety and should be considered as well.

One of the survey participants felt compelled to email the author regarding this question. The email stated, “Regarding the HVAC duct. There is a bit of a challenge to this. Once you lay carpet/paint/ceiling tiles, it is imperative that the space be conditioned so as not to allow heat and humidity to ruin the products. Running HVAC units circulates debris in the air through the system and infiltrates the duct. We protect the return air diffusers and use high efficiency filters to minimize this, but it is impossible to prevent 100% of the particles.”

The fifth safety-related question asked, “Should all projects have a job-site specific construction worker health and safety plan?” Over 80% of the respondents either agreed or strongly agreed that each project should have a site-specific construction worker health and safety plan.

Expert # 1 (management) agreed that each project should have a site specific construction worker health and safety plan. He stated that having a job-site specific construction worker health and safety plan should be dependant on the size of the job. The current project that the expert is working on is a 30,000 square foot project and he felt that it did not require a specific safety plan. The expert stated that large scale projects should always have a site specific construction worker health and safety plan for job-site layout, accessibility, and an evacuation plan. Site specific safety plans should also be on projects of a complicated nature and projects with high worker density.

Expert # 2 (safety) and expert # 3 (field) strongly agreed that every project should have a job-site specific construction worker health and safety plan. These experts stated that OSHA will mandate this soon. The expert stated that every project is

different with different safety issues occurring on every project, warranting that each should have its own health and safety plan. All projects should have a safety manual that is specific to that project because all projects are completely differently. Different materials are used on projects and some can be very hazardous. If a chemical or material is hazardous it needs to have a Material Safety Data Sheet (MSDS).

Evacuation plans will be different on every project. During renovations or when a building is partially occupied during construction, an Interim Life Safety Measures (ISLM) plan needs to be in place. The ISLM plan is only geared toward the occupants and not for the construction workers. Projects are constantly changing so the Life Safety Plan needs to be constantly updated and discussed with all of the workers on-site. Taking additional safety measures like this should be added into the LEED rating system so that more companies will follow through with it.

Adding Safety into LEED

The question was asked, "Should construction worker health and safety be added into the LEED rating system?" The majority (68.6%) of the respondents were either neutral or disagreed (at some level) that construction worker health and safety should be added into the LEED rating system (Figure 5-14).

Expert # 1 (management) agreed that construction worker health and safety should be added into the LEED rating system. This expert stated that safety is the most important aspect of a construction project and anything that will help promote safety should be done. He stated that in his opinion it will never be done because not all parties involved in the construction process will agree with this.

Expert # 2 (safety) and expert # 3 (field) strongly agreed that construction worker health and safety should be added into the LEED rating system. They said anything

that mandates safety should be implemented. If construction worker health and safety were added into LEED, it would get the owner invested in safety. Money controls the construction business and anything that will get the owner invested in safety will help. If the owner gets involved, that will then get the architect involved with safety in the design phase. Also, if the owner is invested in safety through LEED, the contractor will have an incentive to select subcontractors with strong safety records and this will enhance project safety. He further stated that adding safety into LEED would add more incentive to have a safe job-site which is great because most companies will not take the initiative to be safe. Most companies will only do what is asked of them because of time and money.

Several survey participants sent the author their thoughts about this particular question. There was one positive or supporting response regarding this issue.

- I applaud your study and I am always one to share my opinion. I am a tree hugger and a “green” guy; 3.0 is an improvement, but I believe that the LEED movement is not directed in the correct direction. I work for a company that recycles whether there are points involved or not, tries to utilize indigenous materials, sustainable materials are always thought of as paramount, and beyond our mantra of Integrity, Quality and Partnership, we sell SAFETY! With over 1,000,000 man-hours worked and an EMR of .61, that speaks volumes. This is all just good smart business. All of the elements that you noted being considered should be mentioned and embedded in the preconstruction process; it’s just good responsible spec writing and an admirable construction practice.
- Five negative responses about adding safety into the LEED rating system were received from the participants.
- Please let Safety Education on the jobsite be handled without adding further restrictive requirements.
- Specific safety measures for key systems in the LEED ratings might be worth considering but for general construction this is probably impractical.

- Honestly, I don't think adding construction worker health and safety to the LEED rating system is necessary. It's already part of the rating system when you look at the low-emitting materials credits. It is aimed not only at the well-being of the building occupants but also the material installers. Outside of this, worker safety is already mandated by the construction industry. To me, being green is going above and beyond what's already required by law/code. How can you go above and beyond the existing requirements of keeping everyone safe?
- Couple of things to consider. OSHA already requires safety oversight; in addition, most workers' compensation insurance providers either require additional safety measures, or encourage it with incentives - they frequently spot check jobsites and contractors do not want their rates to go up so they abide by their rules. Adding LEED to the mix unnecessarily increases the layers of bureaucracy that contractors contend with and also deflects the original purpose of LEED, which is to build in an environmentally sustainable manner, and focus on energy consumption.
- Safety requirements (OSHA) can be such a complex process that my early opinion is that putting it in the LEED process may lead to confusion, conflicts, and be impractical to implement.

In the survey the question was asked, "If safety were added into LEED should it be a required prerequisite or an optional credit?" Over 42% of the respondents did not feel that safety should be added into the LEED rating system. The remainder of the respondents slightly favored safety being included as an optional credit. Of the respondents that felt safety should be added into LEED as an optional credit, the majority suggested that the safety inclusion should be worth 1 to 3 points.

The three experts were unanimous in their opinions that safety should be added as a required prerequisite. They stated that safety should be a mandatory requirement and not something to be regarded as a bonus or reward. Safety should not carry any weight in the LEED rating system; it should just be required. Also, safety should be a prerequisite because it will put pressure on the owners to get buy in from their contractors. This will result in the owners getting better quality subcontractors.

The question was asked, “If safety was added into the LEED rating system, should it be a new category or added into an existing category?” Of the respondents that felt safety should be added into LEED, the majority felt that safety should be added as a new category (Figure 5-17).

The three experts felt that safety should be added into LEED as a new category. The reason the experts gave for adding safety as a new category was that if safety were added into the LEED rating system, it should be done thoroughly. Safety is a big topic with lots of issues to cover and it requires an entire new category to cover it adequately. Safety should have a new category so that it does not get left off. Expert # 2 (safety) stated that sustainability should be for the work force and not just for the building. Safety best practices are anything that goes above and beyond OSHA regulations and that is how safety should be incorporated into LEED. LEED practices are on a higher standard, and that is how safety should be added, namely by doing things that are not mandated but that go beyond the regulations to enhance safety. An example would be to require safety glasses to always be worn on-site, or that seat belts should always be worn on all equipment, regardless of exceptions in the regulations.

Further Analysis:

In this further analysis section, the intent is to show key relationships that were identified between the responses for different questions. The responses related to safety are compared with the response regarding adding construction worker safety to LEED. Also, the levels of understanding of the LEED requirements are compared with the responses regarding adding construction worker safety to LEED.

Out of the seventeen questions in the survey, four were specifically targeted toward safety in construction. These questions consisted of the following:

- “Safety concerns should be considered and designed for in the preconstruction phase?”
- “Promoting construction worker safety should be continuously supported on the job-site?”
- “A safety representative should be continuously on-site?”
- “All projects should have a job-site specific construction worker health and safety plan?”

These questions solicited answers ranging from 1 to 5 for strongly disagree to strongly agree. From these four questions a new variable, called SafetyScore, was created that was an aggregate of the four responses. This new variable was assumed to reflect the overall commitment of each respondent to safety. Since there are 4 questions each with possible answers ranging from 1 to 5, the possible range of the values of the SafetyScore was from a low value of 4 (if all answers were rated as 1) to 20 (if all answers were rated as 5). The actual sums or values of SafetyScore ranged from 6 to 20. Since SafetyScore consisted of the aggregate sums of four safety-related questions, those respondents with the highest values were assumed to be those with the strongest commitment to safety while those with the lowest scores were assumed to have the least commitment to safety.

SafetyScore was examined in terms of the responses given to the question, “Construction worker health and safety should be added to the LEED rating system?” This latter question also solicited answers from 1 to 5 for strongly disagree to strongly agree. Of the respondents, 93 had a SafetyScore of less than 15 and their mean score to the question about adding safety to the LEED rating was below average at 2.27. This shows that the respondents that did not feel strongly about safety also did not feel that safety should not be added to the LEED rating system. On the other extreme, a total of

110 respondents had a SafetyScore of 19 or 20 and their mean score to this question was above average at 3.32 (Figure 5-18). This shows that the respondents who felt strongly about safety also felt more strongly about adding safety to LEED. A test of these 2 means was conducted and the z-value was computed to be 6.27, revealing that the differences of the two means are statistically significant at the level of less than .001.

A closer examination was conducted of the responses given for the two questions, “Rate the importance of supporting LEED practices for all projects”, and “Construction worker health and safety should be added to the LEED rating system?” The analysis showed that the more supportive the respondents were of the LEED practices, the higher the mean value of the responses for adding safety into LEED. Of the respondents, 231 felt supportive of the LEED practices and they had an above average mean score of 3.08 for adding safety into LEED. Of the respondents, 60 did not support LEED practices and they had a below average mean score of 2.08 for adding safety into LEED. A test of these 2 means was conducted and the z-value was computed to be 6.13. Based on the z-value, the results showed a statistically significant difference between the two means.

Further analysis was conducted with the responses to the question, “Are you familiar with the United States Green Building Council and the LEED process?” The responses were compared with those regarding the addition of construction worker health and safety into the LEED rating system. Of the respondents 422 were familiar with the LEED process and they had a below average mean score of 2.79 for adding safety to the LEED rating system. A total of 34 respondents were not familiar with the

LEED rating system and they had an above average mean score of 3.44 for adding safety to LEED. A test of the difference of these two means revealed that the difference was statistically significant, with a z-value of 3.129.

A further evaluation was conducted with the responses to the question, “Are you a LEED Accredited Professional?” These responses were examined in comparison with the responses to questions concerning the support for adding construction worker health and safety into the LEED rating system. Of the respondents, 181 were LEED Accredited Professionals and they had a below average mean score of 2.56 for adding safety into LEED. A total of 271 respondents were not LEED Accredited and they had an above average mean score of 3.02 in favor of adding safety into LEED. A test of the difference of these two means revealed that the difference was statistically significant, with a z-value of 3.95.

Additional analysis of three LEED-related questions was conducted by creating a new variable that was an aggregate of the responses from three LEED questions. This new variable represented the level of familiarity that the respondents had with LEED. The questions were, “Are you familiar with the United States Green Building Council and the LEED process?”, “Number of LEED projects you have worked on” and “Are you a LEED Accredited Professional”. The response to the second question about the number of LEED projects was recoded to simply indicate whether LEED projects had been worked on or not. Thus, the lowest LEED familiarity variable scores represented respondents who were most familiar with LEED and higher scores represented a lower level of familiarity with LEED. The results showed that 138 respondents were very familiar with LEED and they had a below average mean score of 2.54 for adding safety

to LEED. A total of 27 respondents were considered to not be familiar with LEED and they had an above average mean score of 3.62 for adding safety into LEED. A test of the difference of these two means revealed that the difference was statistically significant, with a z-value of 4.359.

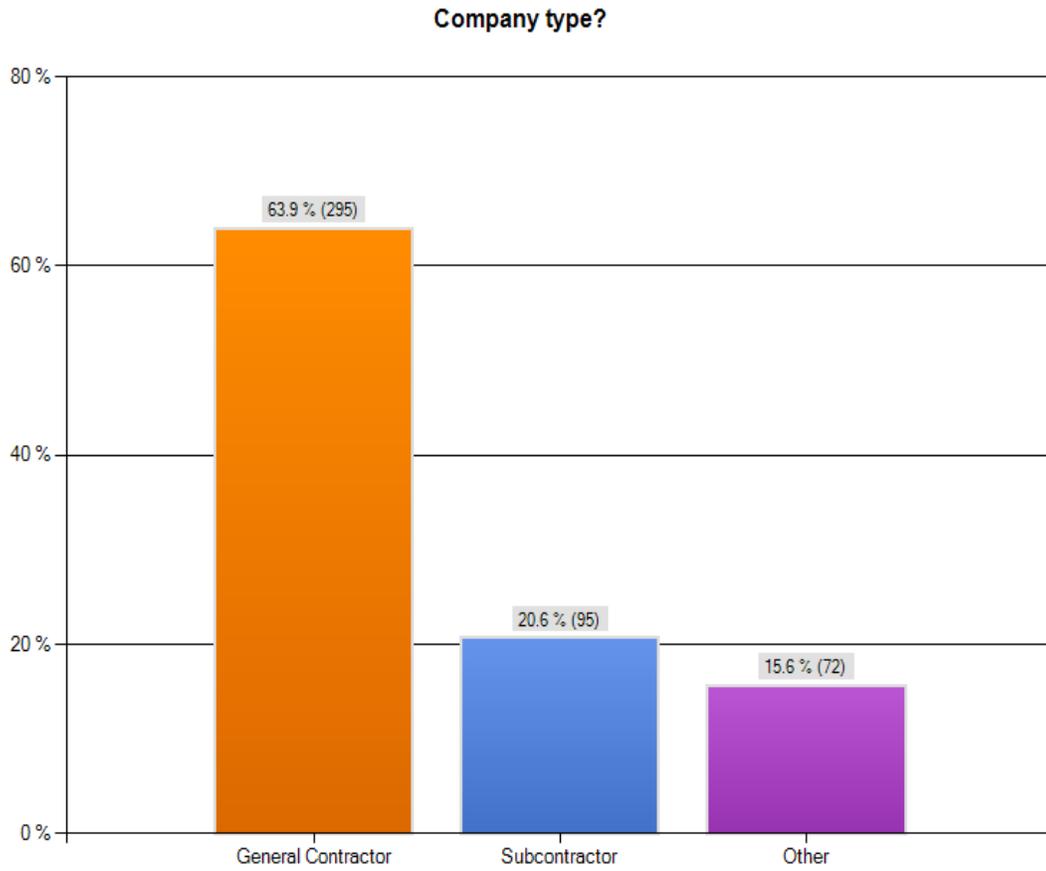


Figure 5-1. Respondents by type of company

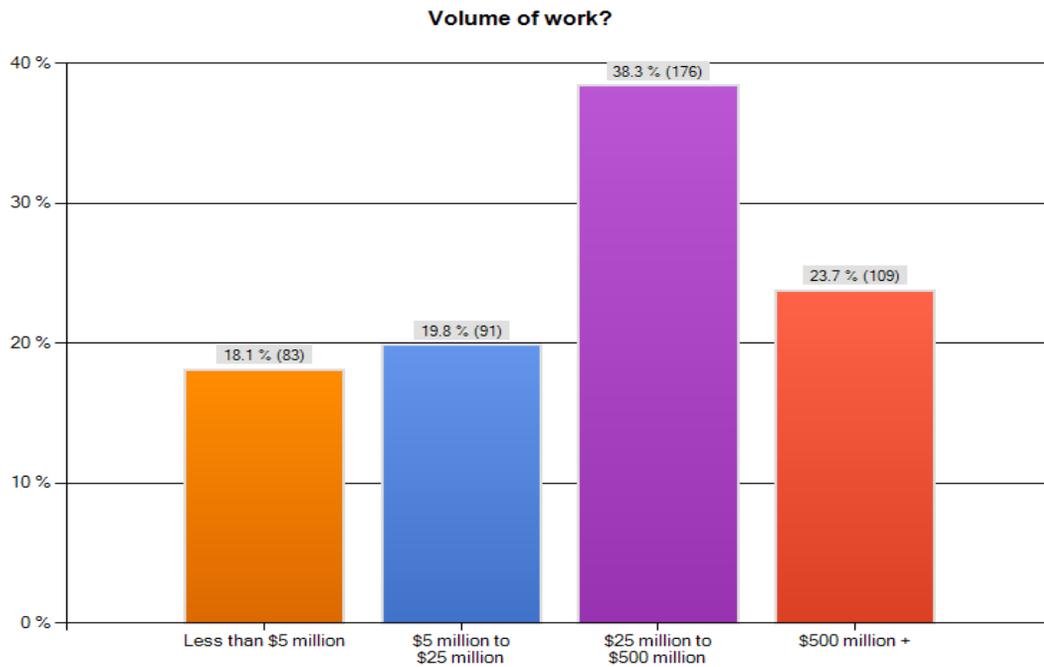


Figure 5-2. Respondents by annual volume of their firms

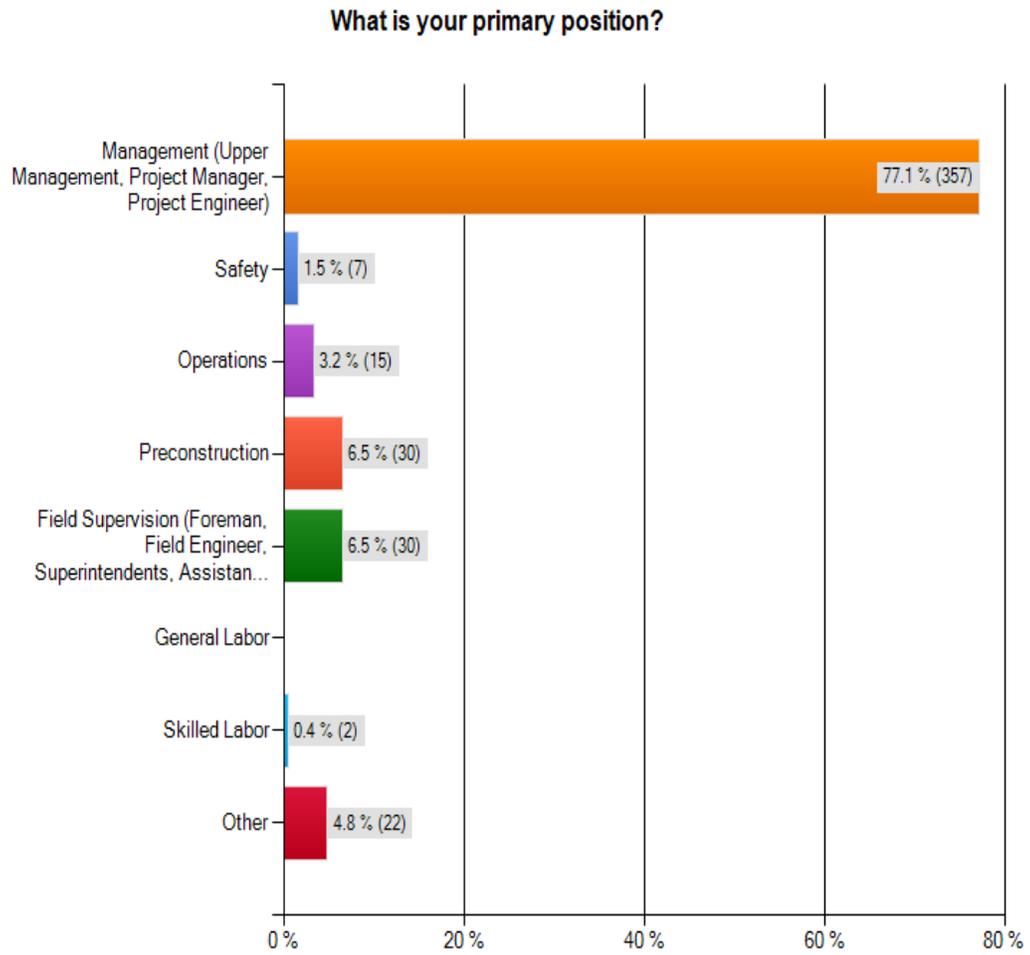


Figure 5-3. Primary position

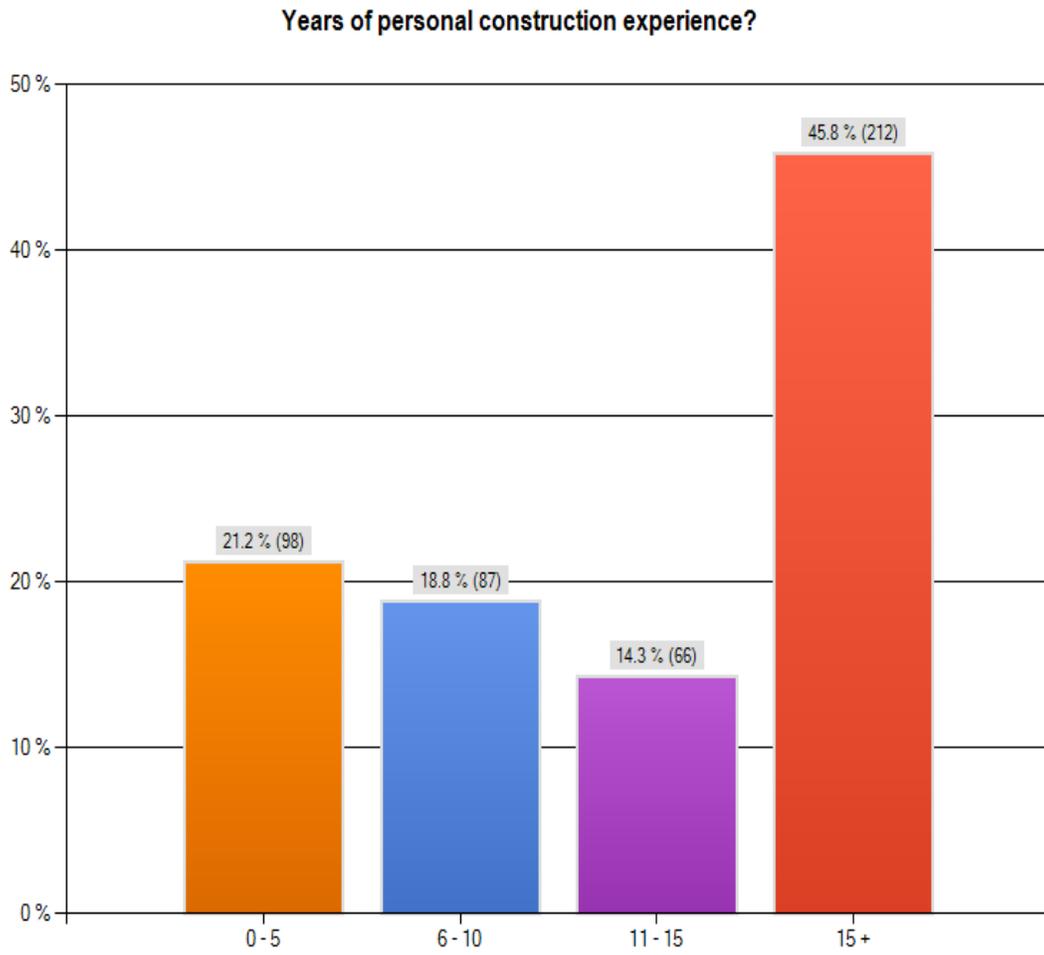


Figure 5-4. Years of personal construction experience

Are you familiar with the United States Green Building Council and the LEED process?

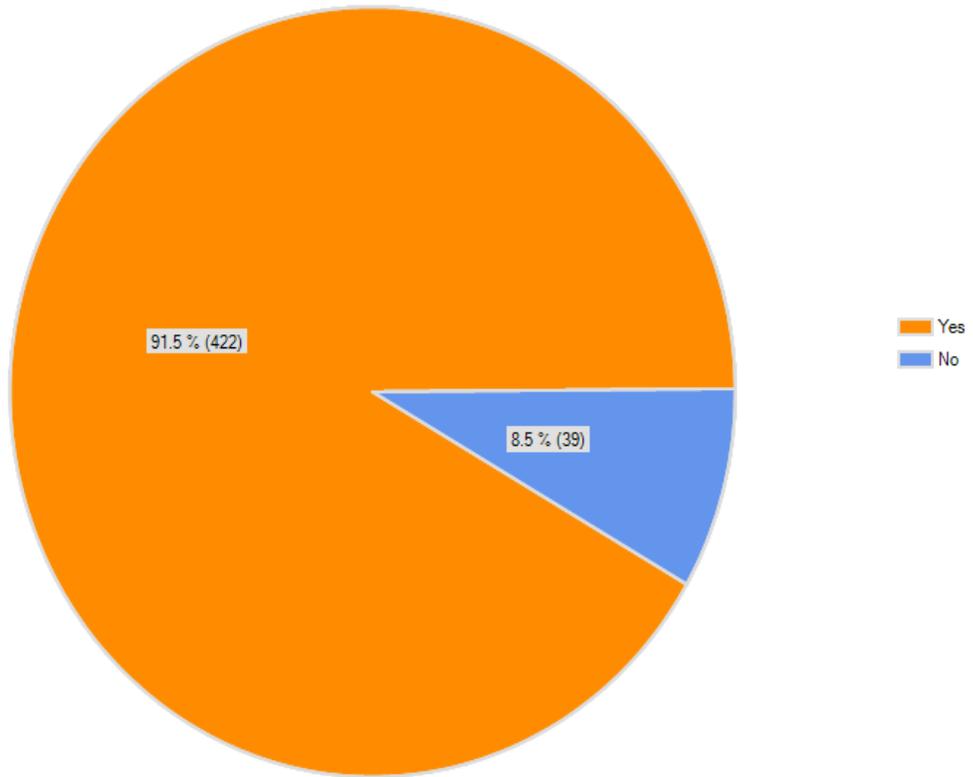


Figure 5-5. Familiarity with the USGBC and the LEED process

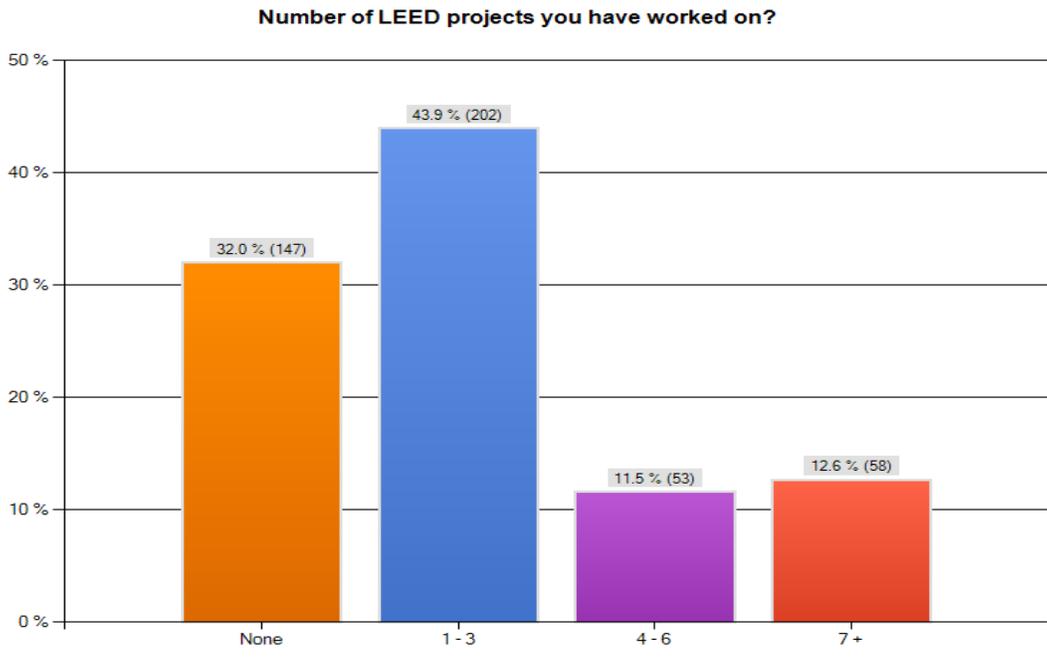


Figure 5-6. Number of LEED projects worked on

Are you a LEED Accredited Professional?

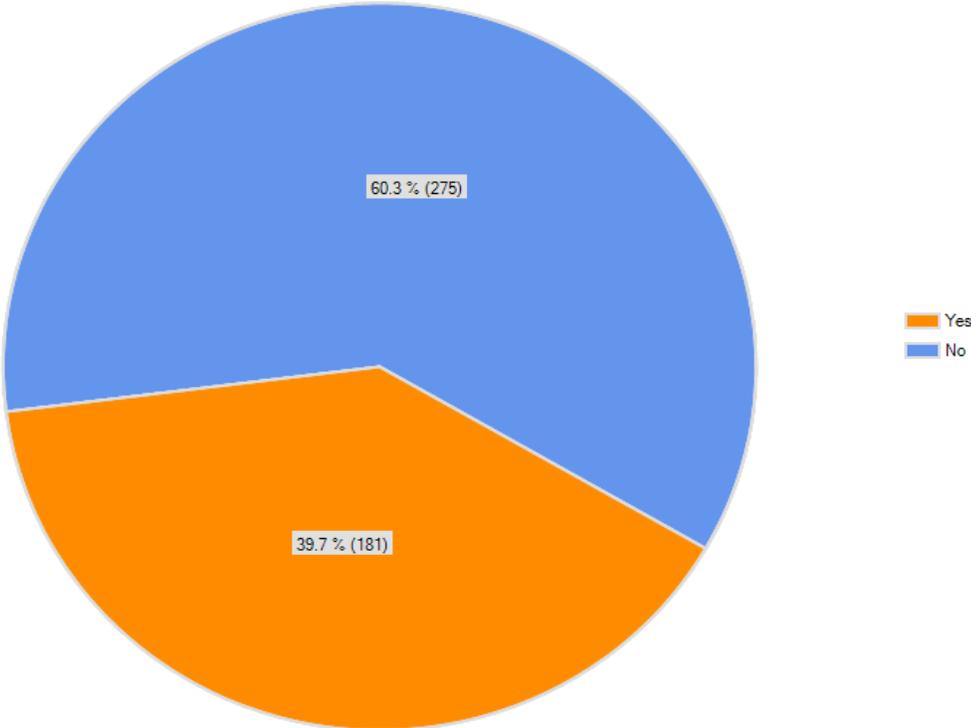


Figure 5-7. LEED Accredited Professional status

Rate the importance of supporting LEED practices for all projects.

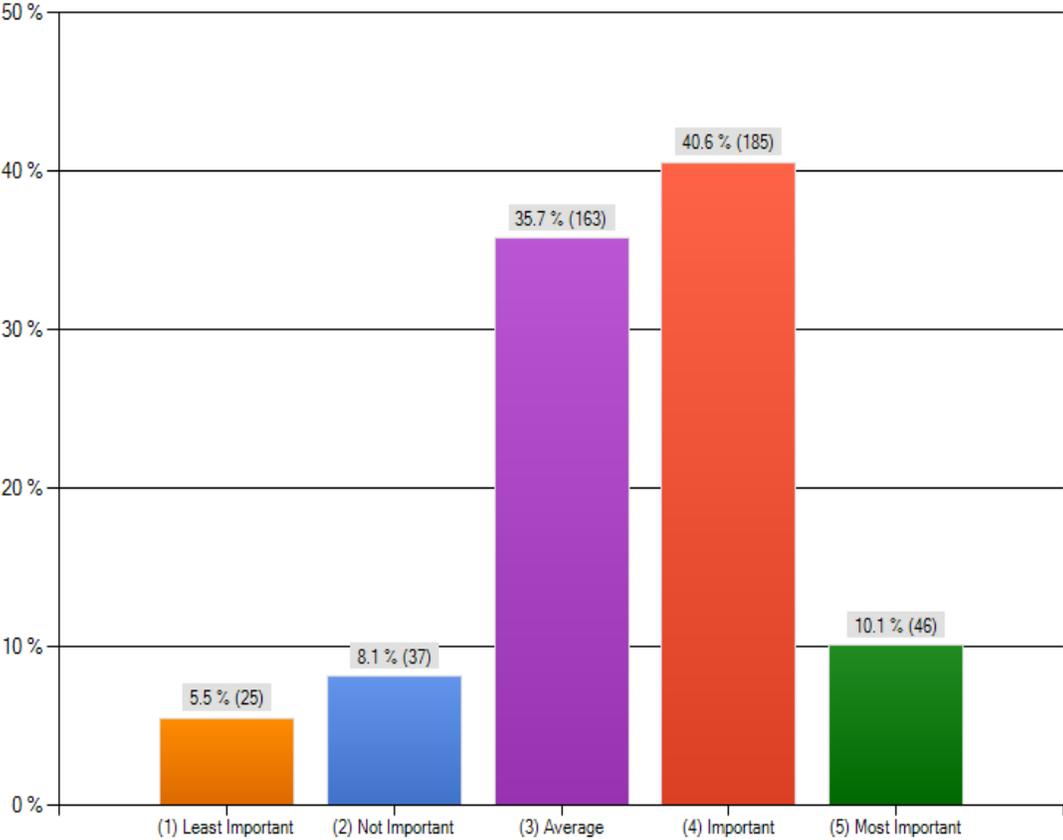


Figure 5-8. Supporting LEED practices for all projects

Safety concerns should be considered and designed for in the preconstruction phase.

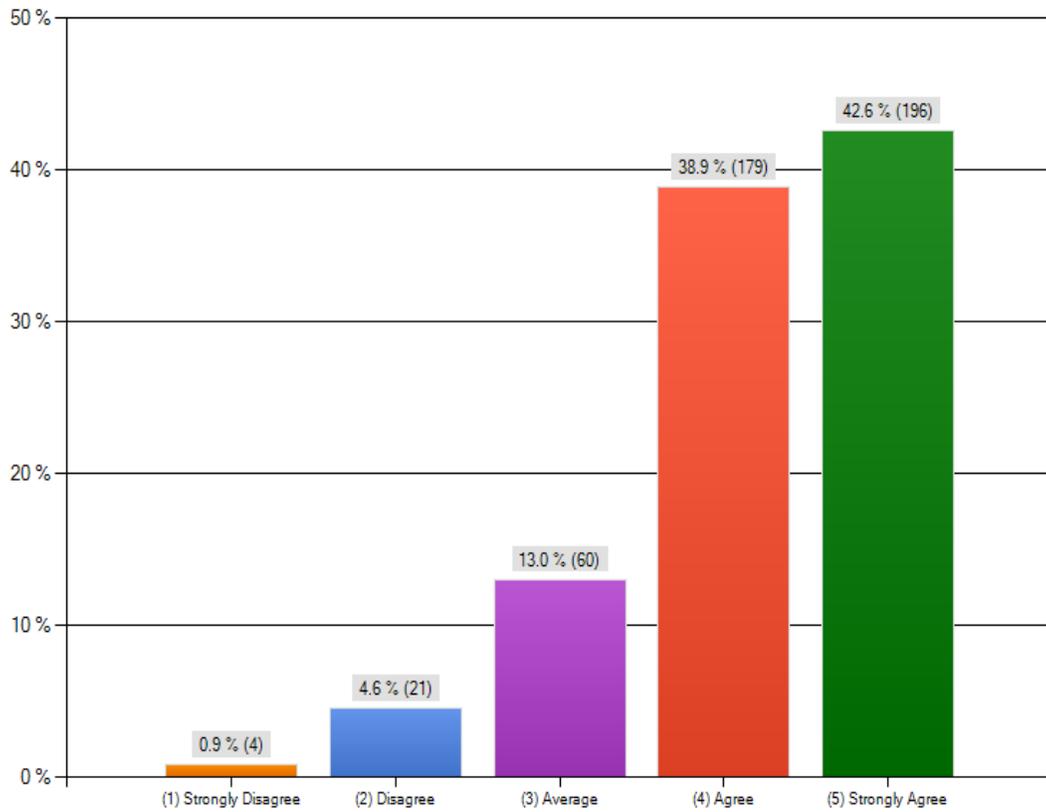


Figure 5-9. Safety concerns in the preconstruction phase

Promoting construction worker safety should be continuously supported on the job-site.

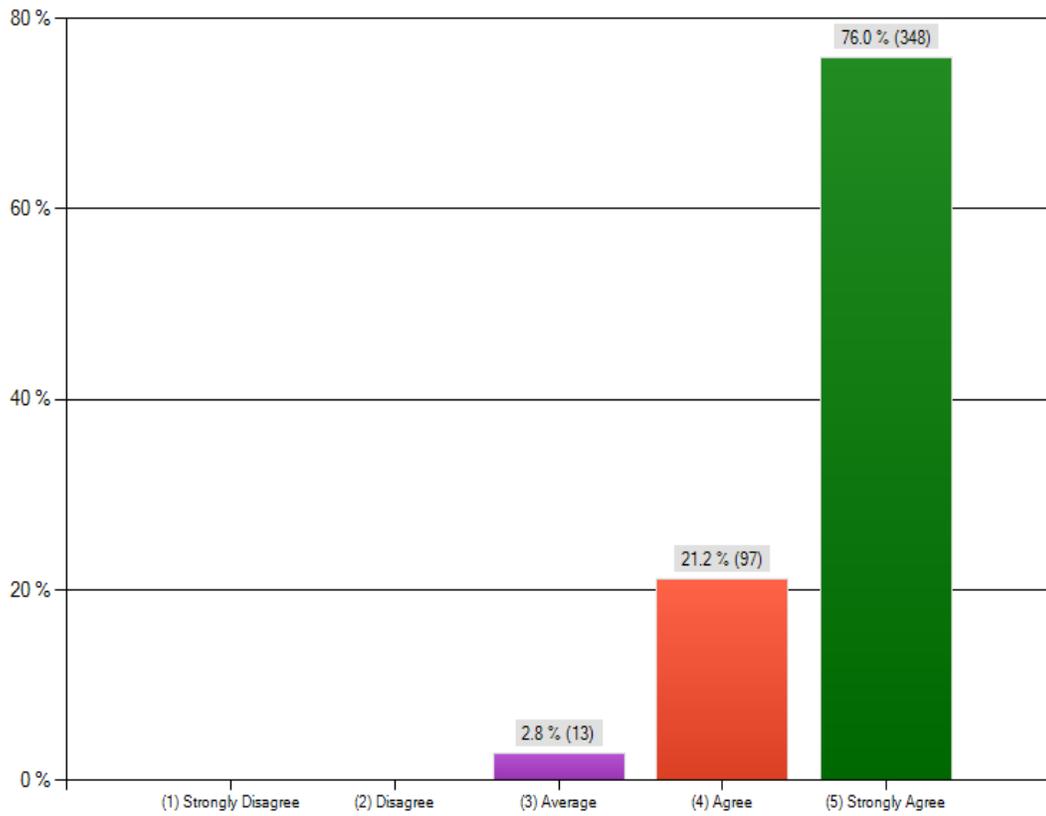


Figure 5-10. Promoting construction worker safety on the job-site

A safety representative should continuously be on-site.

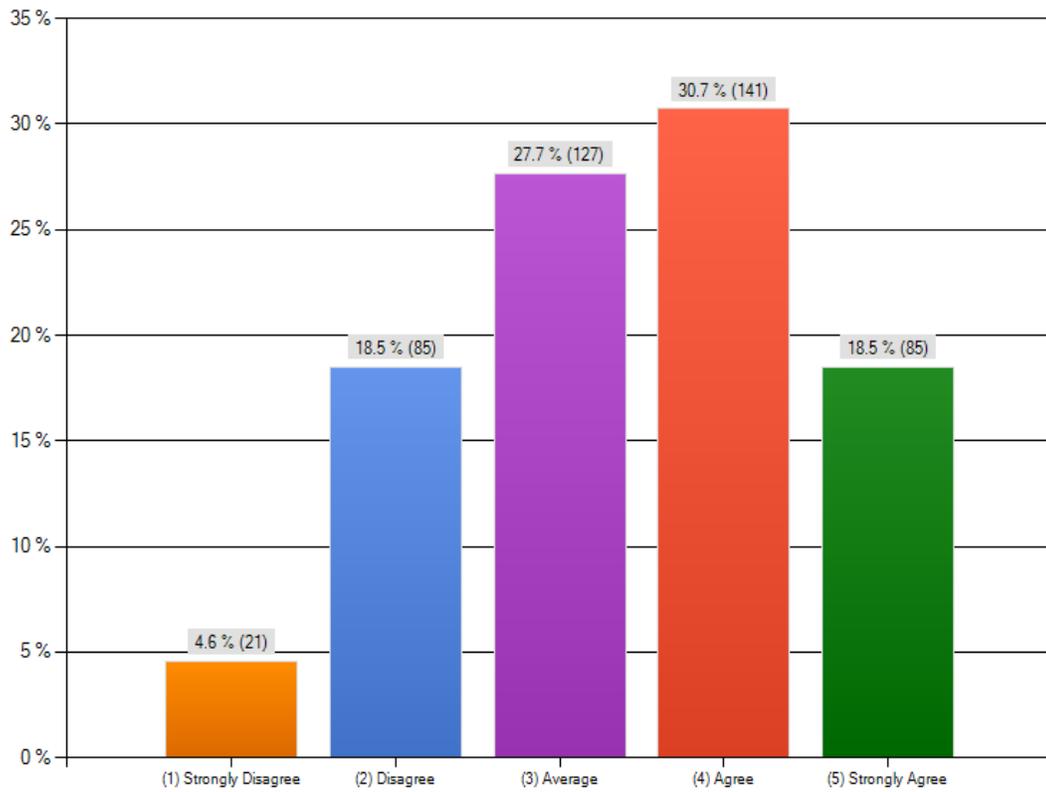


Figure 5-11. Safety representative continuously on-site

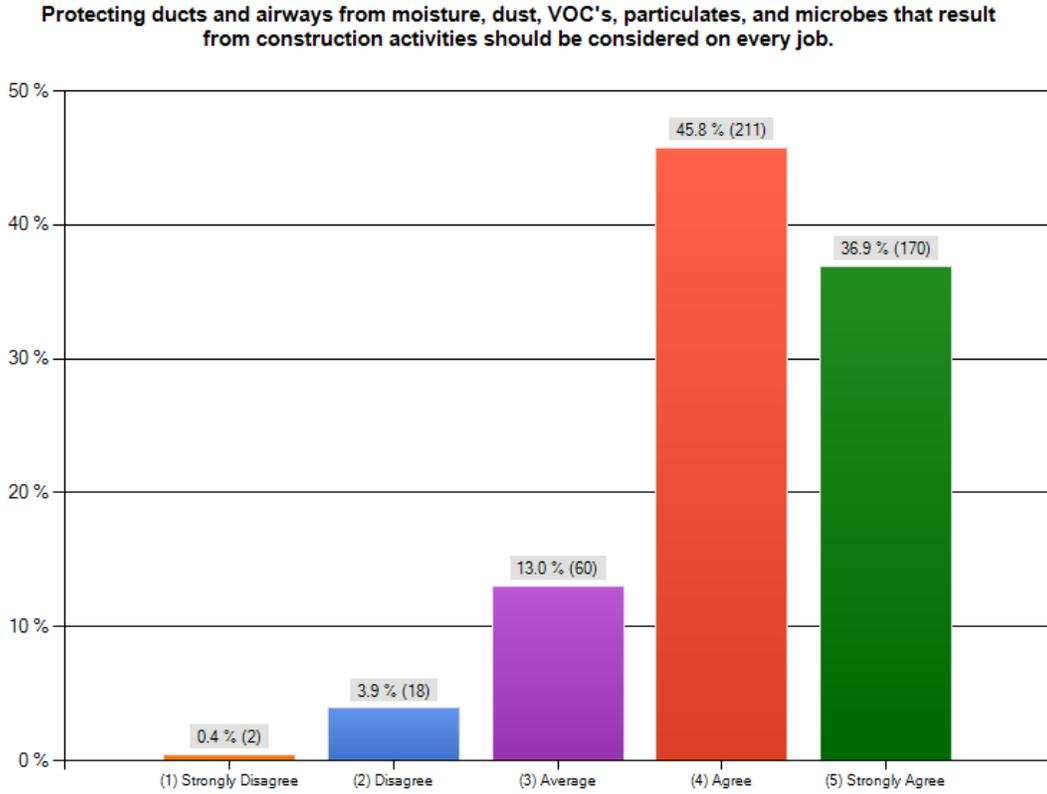


Figure 5-12. Protecting ducts and airways on every job

All projects should have a job-site specific construction worker health and safety plan.

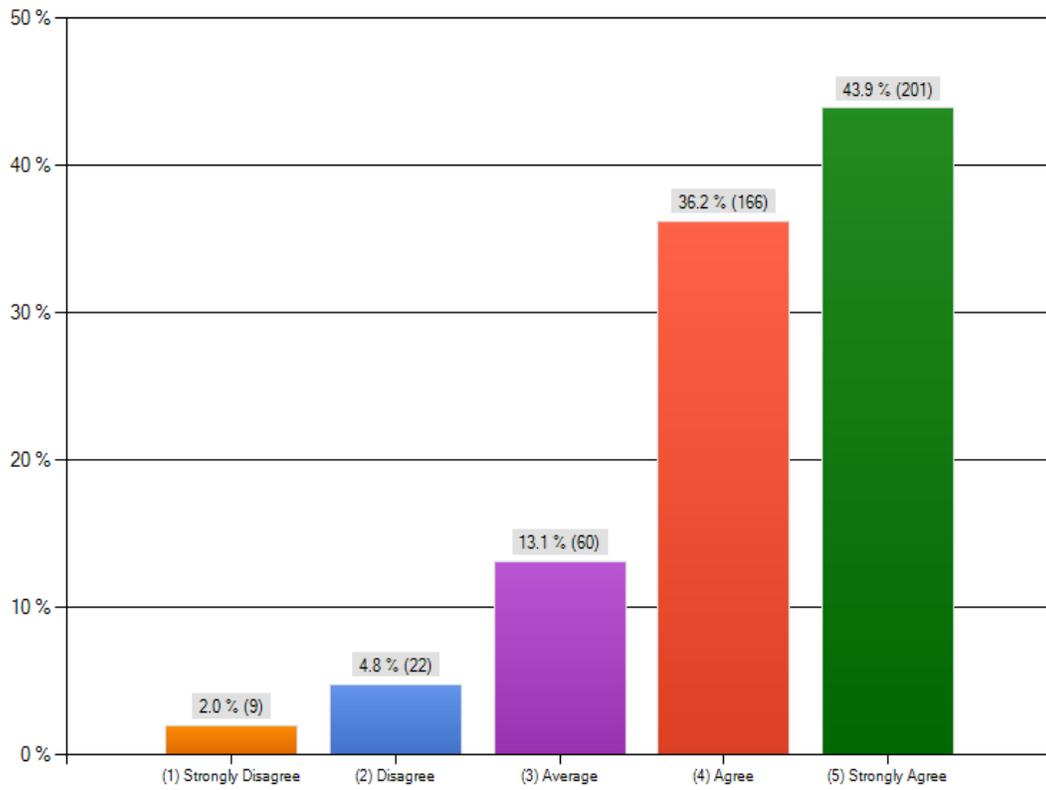


Figure 5-13. Job-site specific construction worker health and safety plan

Construction worker health and safety should be added to the LEED rating system.

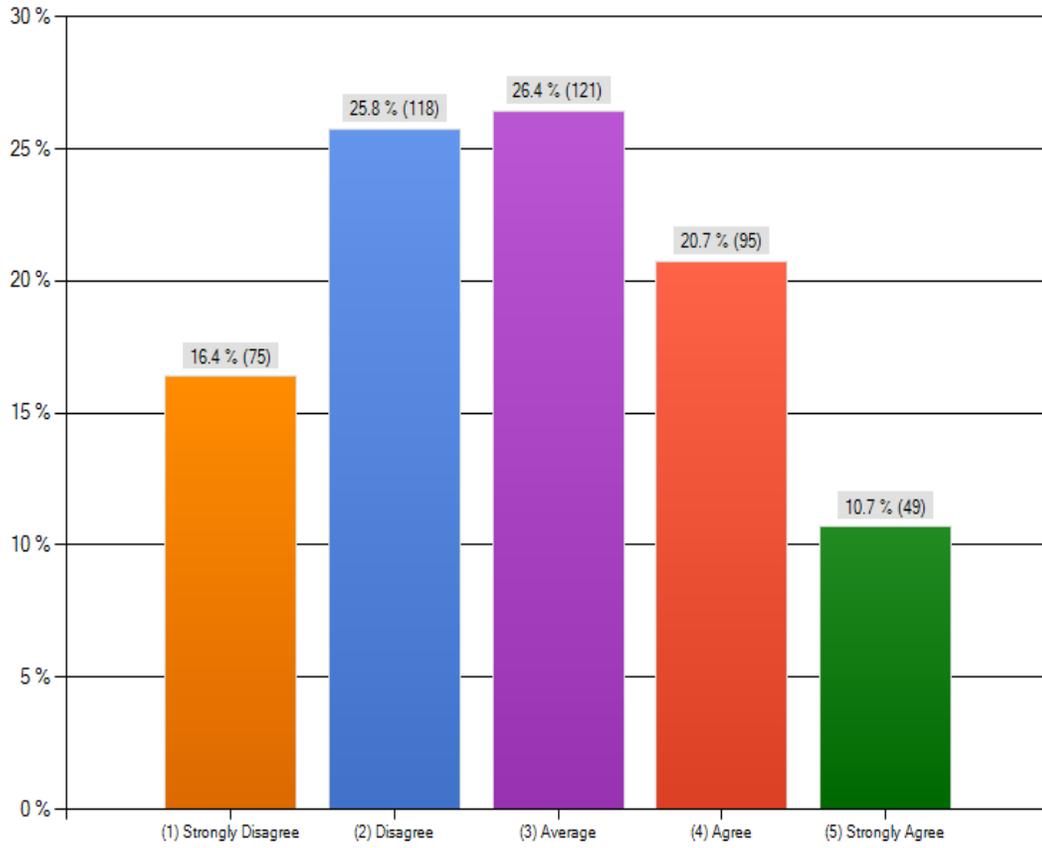


Figure 5-14. Adding worker health and safety to the LEED rating system

If safety were added to the LEED rating system it should be a:

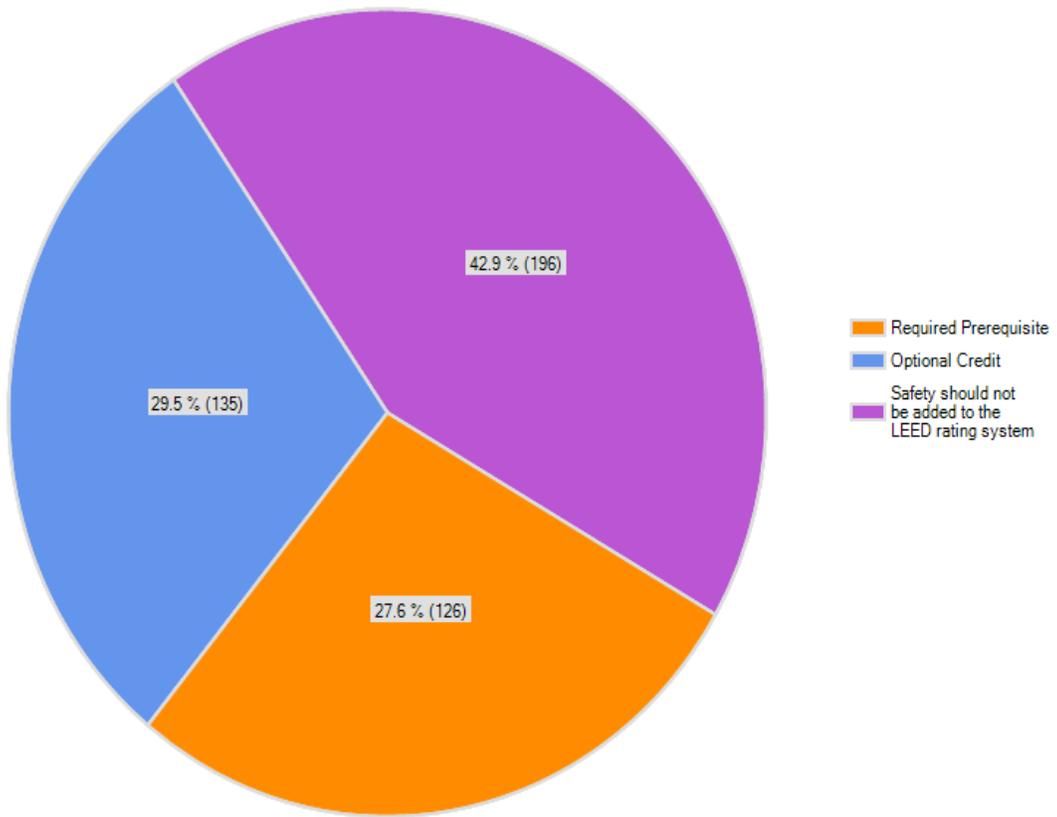


Figure 5-15. Safety should be a Required Prerequisite or Optional Credit

If you chose "Optional Credit" in the previous question then how many total points should worker health and safety have? The new LEED rating system has 110 possible points.

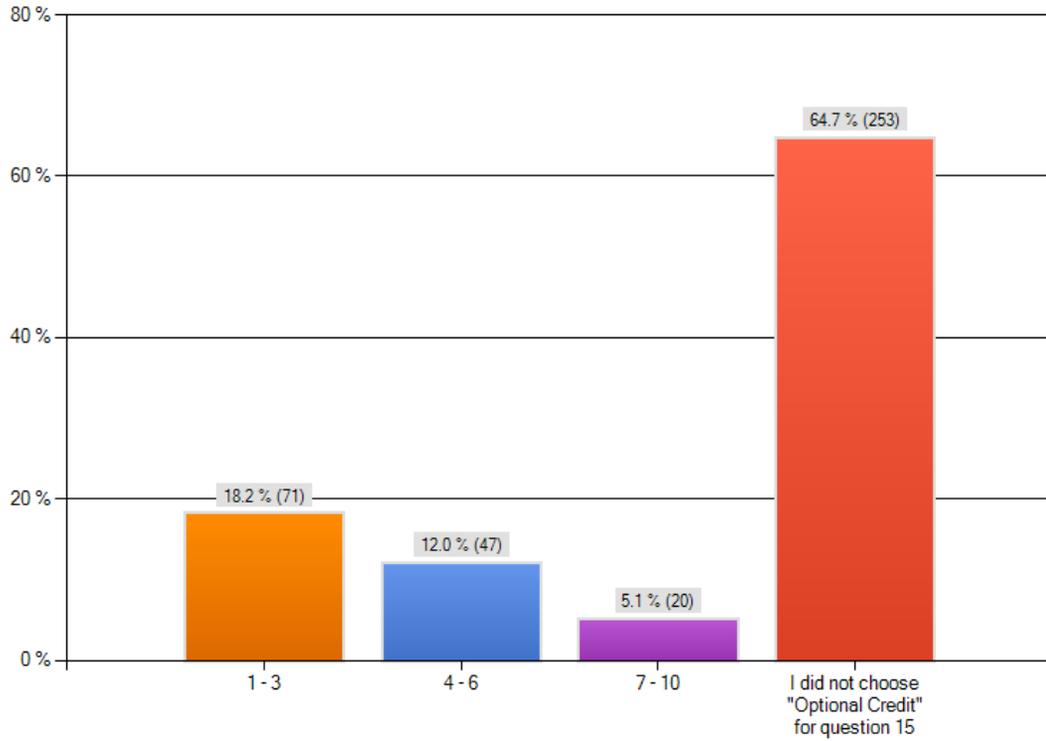


Figure 5-16. How many points for worker health and safety

If construction worker health and safety were added to the LEED rating system it should be:

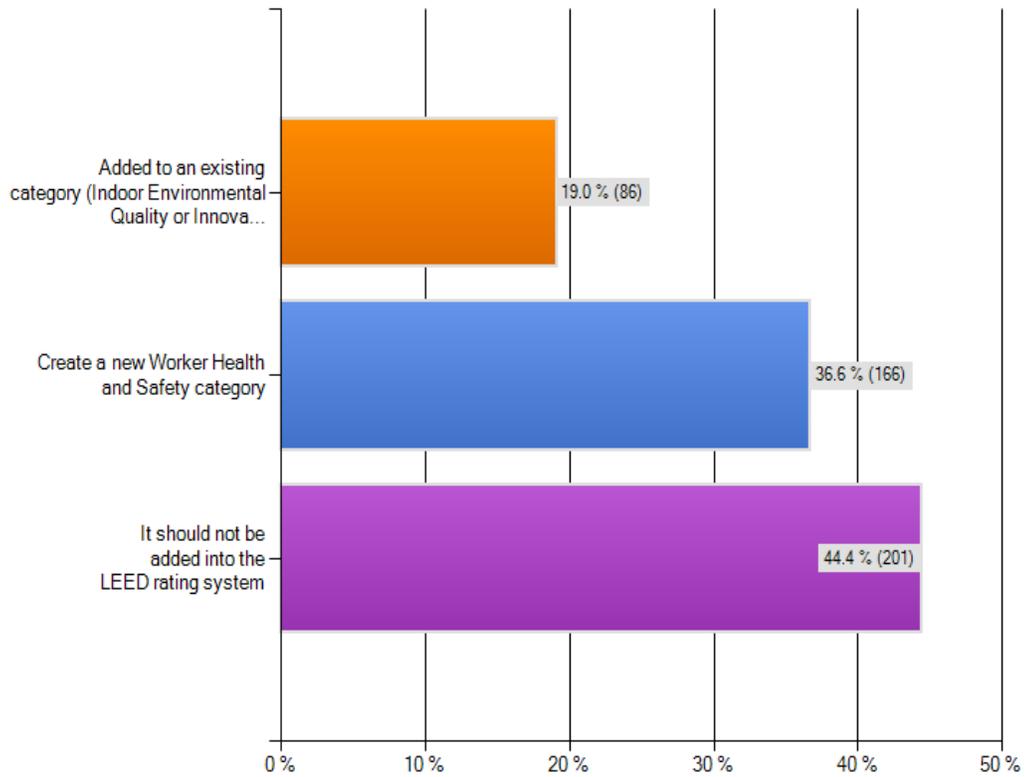


Figure 5-17. Existing category or new category



Figure 5-18. SafetyScore vs. Adding Safety into LEED

Construction worker health and safety should be added to the LEED rating system.							
Rate the importance of supporting LEED practices for all projects. – Choose one							
Answer Options	(1) Least Important	(2) Not Important	(3) Average	(4) Important	(5) Most Important	Rating Average	Response Count
Choose one							
(1) Strongly Disagree	11	11	26	21	6		
(2) Disagree	9	11	45	44	8		
(3) Average	1	10	46	51	11		
(4) Agree	1	4	34	47	8		
(5) Strongly Agree	1	1	12	22	13		
	1.78	2.27	2.76	3.03	3.30	2.83	454
						<i>answered question</i>	454
						<i>skipped question</i>	2

Figure 5-19. Comparison of the importance of LEED vs. adding safety to the LEED rating system

Construction worker health and safety should be added to the LEED rating system.				
Are you familiar with the United States Green Building Council and the LEED process?				
Answer Options	Yes	No	Rating Average	Response Count
Choose one				
(1) Strongly Disagree	72	2		
(2) Disagree	112	5		
(3) Average	111	10		
(4) Agree	85	10		
(5) Strongly Agree	42	7		
	2.79	3.44	2.84	456
			<i>answered question</i>	456
			<i>skipped question</i>	5

Figure 5-20. Comparison of familiarity with LEED vs. adding safety to the LEED rating system

Construction worker health and safety should be added to the LEED rating system.				
Answer Options	Are you a LEED Accredited Professional?		Rating Average	Response Count
	Yes	No		
Choose one				
(1) Strongly Disagree	39	35		
(2) Disagree	56	61		
(3) Average	45	73		
(4) Agree	27	67		
(5) Strongly Agree	14	35		
	2.56	3.02	2.84	452
<i>answered question</i>				452
<i>skipped question</i>				4

Figure 5-21. Comparison of LEED Accredited Professionals vs. adding safety to the LEED rating system

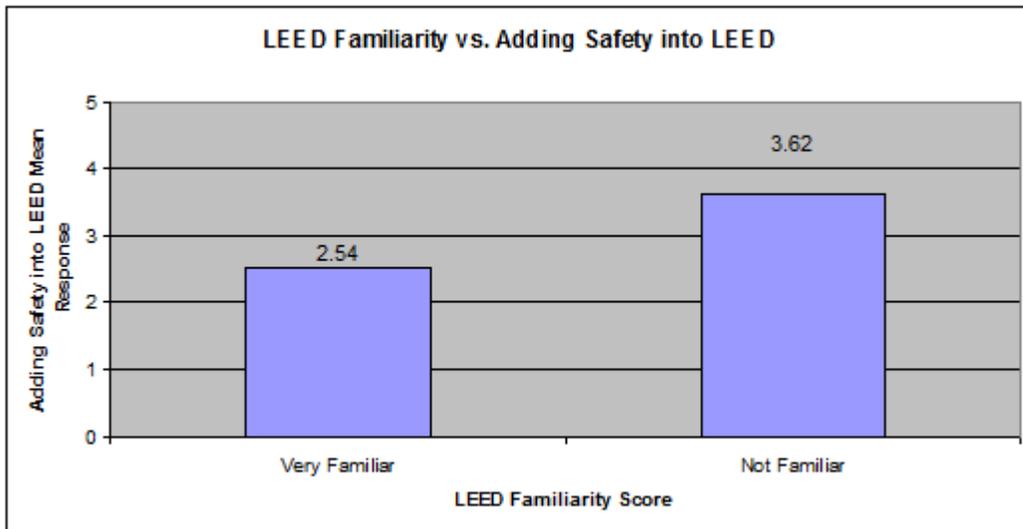


Figure 5-22. LEED Familiarity vs. Adding Safety into LEED

CHAPTER 6 CONCLUSIONS

The results of the interviews with experts would indicate that there is support for adding construction worker health and safety into the Leadership in Energy and Environmental Design (LEED) rating system. The results from the survey show that most respondents do not favor adding safety into LEED. When professionals in the construction industry that support LEED practices are singled out in the survey, the results show that they agree with adding worker health and safety into LEED. Note that it is not intuitive because individuals who are familiar with LEED tend to oppose including safety and health in the LEED rating. It is concluded that individuals who have studied the LEED requirements and have become familiar with them are reluctant to see the rating system change. Individuals who are the most knowledgeable with LEED do not support adding safety to the LEED rating. It is assumed that individuals who work on LEED projects do not want the added burden of factoring in safety and having to learn a new process. Those individuals who are not very familiar with LEED are more likely to support the incorporation of safety in LEED. It is concluded that this opinion is based on a more philosophical viewpoint.

Construction professionals who are the most safety conscious are more supportive of adding construction worker health and safety into the LEED rating system than people who are less safety conscious. This is probably because the professionals who are very safety oriented want to promote safety in any way that they can, i.e., including safety in the LEED rating system further promotes their objective of promoting safety.

Of the respondents that felt that construction worker health and safety should be added to the LEED rating system, the majority felt that safety should be for optional

credits and that it should not be a required prerequisite. The same individuals who felt that safety should be added as optional credits felt that safety should only be worth 1 to 3 points. The individuals who were more neutral about adding worker safety into LEED do not want to see safety as something required in the LEED scorecard. The respondents that strongly agreed that safety should be added into LEED also felt strongly that safety should be a required prerequisite. This is because the safety-oriented construction professionals want to make sure that safety would be required and not just something optional for points. Of the respondents that felt safety should be added to LEED the majority felt that safety should be a new category and not added into an existing category. Apparently, respondents feel that safety does not belong in an existing category: it should have a new category. Also, the respondents who felt safety should be added to LEED are those who are less familiar with the LEED system. This means that the respondents may not have been fully knowledgeable about what they were answering.

The results of the survey were not as expected, as it was assumed that most respondents would favor adding safety in the LEED rating. The majority of the respondents feel strongly about safety and they feel strongly about LEED, but do not want to see the two objectives merged in a common measure. From the results of the survey, it can be concluded that professionals in the construction industry do not want to be burdened by adding worker health and safety into the LEED rating system.

CHAPTER 7 RECOMMENDATIONS

To continue with this study, further research will need to be done with other parties in the construction process. Additional surveys should be conducted with architects, engineers, safety professionals and owners to find out if they have any motivation to add construction worker health and safety into the Leadership in Energy and Environmental Design (LEED) rating system. It is recommended that the first step is to conduct an owner's survey since the owner is the primary party who chooses to pursue LEED certification for their projects. A similar survey could be conducted with employees of different development companies. The results of the owner's survey should determine if they are willing to spend extra money to support safety in construction. If the research shows that there is more support among owners to add worker health and safety into LEED, then the architects, engineers, contractors, and subcontractors would also support it because it will be mandated.

Another suggestion is to devise a LEED rating scheme with safety integrated into the final number. This could be implemented as a pilot study on a construction project to assess the pros and cons of adding safety to the rating.

An additional study could also be done with individuals in the construction industry who are familiar with the Green Globes System. Green Globes is a building environmental design and management tool very similar to LEED. Professionals in the construction industry that follow Green Globes practices might have a different outlook about adding construction worker health and safety into their rating system.

APPENDIX A
INTERVIEW INFORMED CONSENT

**M.E. Rinker, Sr., School of Building Construction
P.O. Box 115703, Gainesville, FL 32601**

Informed Consent

Dear Construction Expert,

I am a graduate student at the University of Florida pursuing my Master's of Building Construction. As part of my thesis research I am conducting an interview, the purpose of which is to show that there is a need and demand to add construction worker health and safety to the LEED rating system. I am asking you to participate in this interview because you have been identified as an expert in the construction industry. Interviewees will be asked to participate in an interview lasting no longer than 30 minutes. The structure of the interview is enclosed with this letter. You will not have to answer any question you do not wish to answer. Your interview will be conducted by phone or at your office after I have received a copy of this signed consent from you in the mail or signed in-person. Your identity will be kept confidential to the extent provided by law and your identity will not be revealed in the final manuscript.

There are no anticipated risks, compensation or other direct benefits to you as a participant in this interview. You are free to withdraw your consent to participate and may discontinue your participation in the interview at any time without consequence.

If you have any questions about this research protocol, please contact me at (678) 642-9686 or my faculty supervisor, Dr. Jimmie Hinze, at (352) 273-1167. Questions or concerns about your rights as a research participant rights may be directed to the IRB02 office, University of Florida, Box 112250, Gainesville, FL 32611; (352) 392-0433.

Please sign and return this copy of the letter in the enclosed envelope. A second copy is provided for your records. By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted to my faculty supervisor as part of my thesis.

Kyle Frandsen

I have read the procedure described above for the Thesis Research Interview. I voluntarily agree to participate in the interview and I have received a copy of this description.

Signature of participant

Date

I would like to receive a copy of the final "interview" manuscript submitted to the instructor. YES / NO

APPENDIX B SURVEY CONSENT & SURVEY

The purpose of this study is to prove that there is a demand to add worker health and safety to the LEED rating system.

Thank you very much for taking the time to fill out this survey. The survey will only take five minutes at most. Please answer the questions to the best of your knowledge. There will be no direct risk or benefit involved in participating in this study. No compensation will be provided if you participate. Your identity will be kept completely confidential. You will have the right to withdraw from this study at anytime without consequence.

By filling out this survey you are giving your voluntary consent to participate in this study.

If you have any questions you may contact:

Kyle Frandsen, LEED AP (Graduate Student), Rinker School of Building Construction, kylefrandsen@yahoo.com

If you have any questions about your rights as a research participant please contact:

IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 352-392-0433.

Please circle your answers

1. Company type

- General Contractor
- Subcontractor
- Other

2. Volume of work

- Less than \$5 million
- \$5 million to \$25 million
- \$25 million to \$500 million
- \$500 million +

3. What is your primary position?

- Management (Upper Management, Project Manager, Project Engineer)
- Safety
- Operations
- Preconstruction
- Field Supervision (Foreman, Field Engineer, Superintendents, Assistant Superintendents)

- General Labor
- Skilled Labor
- Other

4. Years of personal construction experience

- 0 – 5
- 6 – 10
- 11 – 15
- 15 +

5. Are you familiar with the United States Green Building Council and the LEED process?

- Yes
- No

6. Number of LEED projects you have worked on

- None
- 1 – 3
- 4 – 6
- 7 +

7. Are you a LEED Accredited Professional

- Yes
- No

8. Rate the importance of supporting LEED practices for all projects.

- Least Important 1 2 3 4 5 Most Important

9. Safety concerns should be considered and designed for in the preconstruction phase.

- Strongly Disagree 1 2 3 4 5 Strongly Agree

10. Promoting construction worker safety should be continuously supported on the job-site.

- Strongly Disagree 1 2 3 4 5 Strongly Agree

11. A safety representative should continuously be on-site.

- Strongly Disagree 1 2 3 4 5 Strongly Agree

12. Protecting ducts and airways from moisture, dust, VOCs, particulates, and microbes that result from construction activities should be considered on every job.

- Strongly Disagree 1 2 3 4 5 Strongly Agree

13. All projects should have a job-site specific construction worker health and safety plan.

- Strongly Disagree 1 2 3 4 5 Strongly Agree

14. Construction worker health and safety should be added to the LEED rating system.

- Strongly Disagree 1 2 3 4 5 Strongly Agree

15. If safety were added to the LEED rating system should it be a:

- Required Prerequisite
- Optional Credit
- Safety should not be added to the LEED rating system

16. If you chose "Optional Credit" in the previous question then how many total points should worker health and safety have? The new LEED rating system has 110 possible points.

- 1 – 3
- 4 – 6
- 7 – 10
- I did not choose "Credit" for question 15

17. If construction worker health and safety were added to the LEED rating system it should be:

- Added to an existing category (Indoor Environmental Quality or Innovation and Design)
- Create a new Worker Health and Safety category
- It should not be added into the LEED rating system

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BIOGRAPHICAL SKETCH

Kyle Gregory Frandsen was born in Charleston, South Carolina in 1983. He graduated from Harrison High School in 2001. He then went on to graduate from the University of Georgia with a degree in Consumer Economics in fall of 2005. After graduation Kyle worked for two and a half years and then decided to pursue his master's degree at the University of Florida. In the fall of 2008 Kyle started his master's at the M.E. Rinker, Sr. School of Building Construction. Kyle Interned at PPI Construction Management for the entire duration of his time at Rinker. Kyle will graduate from the prestigious M.E. Rinker, Sr. School of Building Construction with a 3.8 GPA. Upon completion of his master's degree, Kyle plans to start his career in construction at Bechtel working in Colorado as a Quality Assurance Engineer.