



Safety Management in the Construction Industry:

Identifying Risks and Reducing Accidents to Improve Site Productivity and Project ROI

Premier Corporate Partner:



Premier Partner:



Premier Corporate Partner:



Association Partner:



SmartMarket Report

McGraw Hill Construction

President

Keith Fox

Vice President, Product Development

Kathryn E. Cassino

McGraw Hill Construction Dodge Research & Analytics/ Industry Insights & Alliances

Vice President, Industry Insights & Alliances

Harvey M. Bernstein, F.ASCE, LEED AP

Senior Director, Research & Analytics

Burleigh Morton

Director, Research Communications

Michele A. Russo, LEED AP

Reproduction or dissemination of any information contained herein is granted only by contract or prior written permission from McGraw Hill Construction.

Copyright © 2013,
McGraw Hill Construction,
ALL RIGHTS RESERVED

Safety Management in the Construction Industry: Identifying Risks and Reducing Accidents to Improve Site Productivity and Project ROI SmartMarket Report

Executive Editor

Harvey M. Bernstein, F.ASCE, LEED AP

Editorial Director

Michele A. Russo, LEED AP

Managing Editor

Donna Laquidara-Carr, Ph.D., LEED AP

Editor

Enver Fitch, LEED Green Associate

Director, Design & Production

William Taylor

Manager, Content Operations

Juan Ramos

Art Director

Alison Lorenz

Contributing Art Director

AD-BOUTIQUE, INC.

Hisako Fujishima

Contributors

Steve Jones

Belle Communications, LLC

Bruce Buckley

Research Project Manager

Dana Gilmore, MRA, PRC

For further information on this
SmartMarket Report or for any
in the series, please contact:

**McGraw Hill Construction
Research & Analytics
34 Crosby Drive, Suite 201
Bedford, MA 01730**

1-800-591-4462

MHC_Analytics@McGraw-Hill.com



About McGraw Hill Construction

McGraw Hill Construction provides essential data, news, insights, and intelligence to better inform construction professionals' decisions and strengthen their market position.

McGraw Hill Construction's data, analytics, and media businesses—*Dodge, Sweets, Architectural Record, GreenSource, and Engineering News-Record*—create opportunities for owners, architects, engineers, contractors, building product manufacturers, and distributors to strengthen their market position, size their markets, prioritize prospects, and target and build relationships that will win more business. McGraw Hill Construction serves more than one million customers through its trends and forecasts, industry news, and leading platform of construction data, benchmarks, and analytics, including Dodge MarketShare™, Dodge Build-Share® and Dodge SpecShare®. Construction data is available for North American and global markets.

To learn more,
visit www.construction.com.

Introduction

Over the last 20 years, the practice of construction has undergone profound changes. The types of projects, the manner in which those projects are delivered and the tools used for design and communication, all have changed dramatically. Additionally, new technologies, such as building information modeling (BIM), have enabled projects to become more complex. Therefore, it is essential for contractors to have a fully integrated, extensive safety program that can respond to evolving industry needs and allow them to stay competitive.

The results of the study on project safety featured in this *SmartMarket Report* demonstrate that the adoption of safety practices are different between general contractors and subcontractors, as well as between small and large firms (though these factors are correlated).

While over two thirds (67%) of the industry overall report having a fully inclusive and widely observed safety program, an extensive program is far more common for large firms:

- **92% of firms with over 500 employees report this high level of safety program.**
- **48% of firms with less than 50 employees report the same.**

In order to increase adoption of stronger safety management programs, firms, especially smaller firms, need data to help make the case for these programs. This study reveals some of the key benefits of these programs:

- **Faster Project Schedule: Reported by 43%, with half of these expecting savings of a week or more.**
- **Higher Project ROI: Reported by 51%, with 73% of these expecting an increase by 1% or more.**
- **Project Budget: Reported by 39%, with 73% of these expecting decreases of 1% or more.**

A good safety program also improves competitiveness in less tangible ways. Eighty-two percent report the positive impact of their safety program on their company's reputation, a factor that helps attract talent and new business.

The study also demonstrates that critical industry trends, such as the use of BIM and prefabrication, are having powerful positive impacts on project safety.

- **BIM: 43% of the firms using BIM report that it improves site safety.**
- **Prefabrication/Modularization: 49% of firms using prefabrication/modularization find it improves site safety.**

The importance of these trends is reinforced by the fact that firms using BIM or prefabrication have significantly higher adoption levels of nearly all the safety practices measured in the survey.

As the industry looks to increase productivity and competitiveness, lowering project risk through strong safety practices is increasingly important. We would like to thank our primary partners, ClickSafety and CPWR, for helping us bring this critical information to the construction industry.



**Harvey M. Bernstein
F.ASCE, LEED AP**
Vice President
Industry Insights & Alliances
McGraw Hill Construction



**Michele A. Russo
LEED AP**
Director
Research Communications
McGraw Hill Construction



**Donna Laquidara-Carr,
Ph.D., LEED AP**
Manager, Industry Insights &
Research Communications
McGraw Hill Construction

Harvey M. Bernstein, F.ASCE, LEED AP, has been a leader in the engineering and construction industry for over 30 years. Currently, he has lead responsibility for MHC's market research group as well as MHC's thought leadership initiatives in areas such as green building, BIM, interoperability, innovation and global construction markets. Previously, Bernstein served as the President and CEO of the Civil Engineering Research Foundation. He currently serves as a member of the Princeton University Civil and Environmental Engineering Advisory

Council and as a visiting Professor with the University of Reading's School of Construction Management and Engineering in England. Bernstein has an M.B.A. from Loyola College, an M.S. in engineering from Princeton University and a B.S. in civil engineering from the New Jersey Institute of Technology.

Michele A. Russo, LEED AP, is responsible for managing MHC's *SmartMarket Report* series and market insights program, leading to over 30 key industry trend reports produced since 2005. Drawing from her

more than 18 years of experience tracking environmental policy trends, Michele also helps direct the green content across MHC's portfolio of products and services. Previously, she served as Executive Director of the Clean Beaches Council and Deputy Director of the National Pollution Prevention Roundtable. Russo has a B.S. in chemical engineering from Cornell University and a master's in public policy from Harvard University's Kennedy School of Government.

Donna Laquidara-Carr, Ph.D., LEED AP, currently

provides editorial direction, analysis and content to MHC's *SmartMarket Reports*. Prior to starting this position in 2008, she worked for nearly 20 years with MHC's Dodge division, where she gained insight into the construction news industry. From 2005–2008, she served as Editorial Training and Policy Manager, responsible for educating over 250 reporters on key trends in the industry. Laquidara-Carr has a Ph.D. from Tulane University, an M.A. from Boston University and a B.A. from Middlebury College.

TABLE OF CONTENTS

4 **Executive Summary**

- 4 Executive Summary
- 6 Recommendations

7 **Data**

8 **Types of Safety Practices**

- 8 Types of Practices Used to Promote Safety on Projects
- 10 Top Practices to Increase Safety on Projects
- 11 Implementing New Safety Practices in the Next Three Years
- 12 Level of Integration of Safety Policies and Programs
- 13 Aspects of a World-Class Safety Program
- 15 **SIDEBAR Integration of Safety and Quality Management**

16 **Impact of Safety Practices/Programs on Business**

- 16 Impact of Safety Practices on the Success of Projects
- 18 Impact of Safety Practices on Project Schedule
- 19 Impact of Safety Practices on Project Budget
- 20 Impact of Safety Practices on Project ROI
- 21 Impact of Safety Practices on Injury Rates
- 22 **SIDEBAR Using Leading Metrics to Improve Safety Management**

23 **Influence Factors**

- 23 Factors Driving Adoption of Current Safety Management Practices
- 24 Factors Encouraging Future Investment in More Extensive Safety Management Practices
- 25 Factors Discouraging Investment in More Extensive Safety Management Practices
- 26 Top Influential People Impacting Improvement of Safety Management Practices

28 **Communication and Education**

- 28 Impact of Safety Training and Orientation on Construction Firm Employees
- 29 Entities that Conduct Safety Training for Jobsite Workers
- 29 Safety Training Conducted Online
- 30 Requiring OSHA 10 and OSHA 30 Training
- 31 Types of Safety Training and Orientation for Jobsite Workers
- 32 Types of Safety Training and Orientation for Foremen and Supervisors
- 33 Importance of Safety Training for Jobsite Workers
- 34 Value of Safety Training for Senior Management
- 35 Frequency of Formal Safety Training for Jobsite Workers
- 36 **SIDEBAR Safety Training in the Construction Industry**
- 37 Most Effective Means of Communicating About Safety with Employees
- 38 Top Sources of Health and Safety Information



39 Technology and Safety Management

- 39 Impact of Building Information Modeling (BIM) on Site Safety
- 40 Top BIM Functions for Improving Safety
- 40 **SIDEBAR Use of Building Information Modeling (BIM) in Construction**
- 41 Stages in BIM Process at Which Safety Personnel Get Involved
- 42 **SIDEBAR Emerging Ways to Use BIM to Enhance Safety**
- 43 Use of Mobile Devices on the Jobsite
- 45 Staff Using Mobile Devices
- 46 Impact of Mobile Devices on Safety

47 Building Processes and Safety Management

- 47 Impact of the Use of Prefabrication and Modularization on Safety
- 48 Aspects of the Use of Prefabrication and Modularization That Contribute to Project Safety
- 49 **SIDEBAR Renewed Interest in Prefabrication and Modularization in Construction**
- 50 Specific Safety Training for Green Technologies, Practices or Products
- 50 **SIDEBAR Green Projects and Safety**

Thought Leader Interviews

- 27 Charles A. Bacon, III, Chairman & CEO, Limbach Facility Services
- 51 Yancy Wright, Director, Sellen Sustainability

52 Methodology

53 Resources

Executive Summary

Contractors are seeing significant positive impacts from investing in strong safety management programs, benefits that can help drive wider adoption of safety practices in the industry.

The positive impacts reported by firms include reduced injury rates and improved reputations, as well as improved project ROI and decreased schedules and budgets. Large firms are more widely adopting safety management practices and benefiting from these outcomes than small firms. In addition, important industry trends, such as the use of building information modeling (BIM) and prefabrication and modularization, are improving safety outcomes for firms that have embraced these new approaches.

Contractors are Experiencing Positive Business Outcomes From Safety Programs

Contractors experience strong productivity improvements due to their adoption of safety, including schedule, budget and project ROI benefits. Clearly, investments in a safety management program offer strong dividends on individual projects. Among firms that report these positive impacts, the level of benefit they achieve is also striking.

- 50% report a decrease in project schedule by one week or more.
- 73% report decrease of project budget by 1% or more, with 24% noting a decrease of greater than 5%.
- 73% also report increase in project ROI by 1% or more, with 20% noting an increase of greater than 5%.

In addition, contractors also see other types of business benefits, such as:

- Improved Reputation: 82%
- Increased Ability to Contract New Work: 66%
- Improved Project Quality: 66%

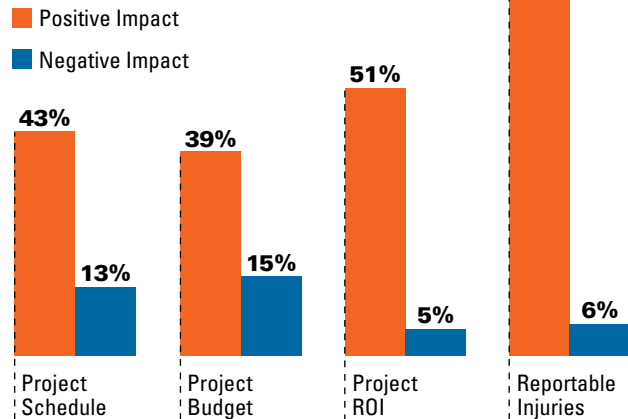
Given the relatively low cost of instituting safety practices, these benefits can help drive companies, especially smaller firms, to justify greater investments in their safety management programs.

Large Firms Are Adopting Safety Policies and Practices More Widely Than Small Firms

Throughout the report, our findings demonstrate that firm size is directly correlated to the level of adoption of safety policies and programs, with large firms leading the industry. Nearly double (92%) the percentage of large firms with 500 or more employees report having a fully inclusive and widely observed safety program than firms with 1 to 49 employees (48%).

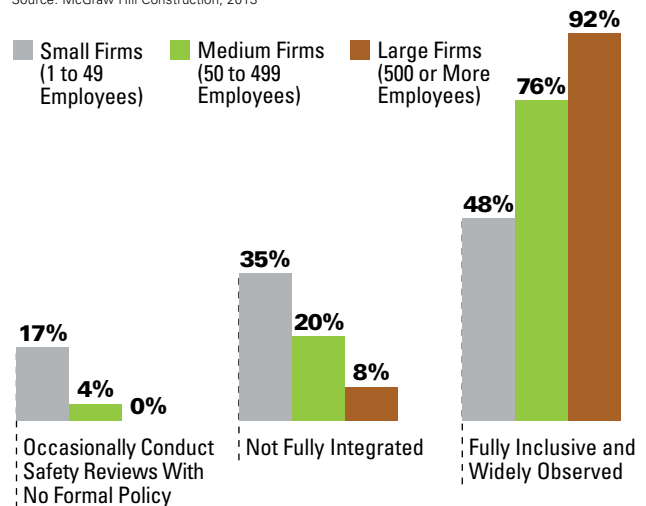
Positive and Negative Impacts of Safety Programs on Projects

Source: McGraw Hill Construction, 2013



Level of Adoption of Safety Practices and Policies

Source: McGraw Hill Construction, 2013



With construction firms averaging approximately 10 employees, these data results demonstrate the need for greater knowledge about safety impacts in the industry to encourage adoption among smaller firms, so they can see that they do not need extensive resources to implement stronger programs. The link between safer jobsites and their benefits, such as avoiding high dollar losses caused by injuries, lower insurance rates and less business disruptions, must be emphasized.

Despite a strong differential in the level of adoption, large and small firms rank many practices at the same level. **The top three practices noted as the most effective for increasing site safety reveal the importance of delivering safety practices directly to the site and beginning the process of incorporating safety as early as possible.**

- Develop Site-Specific Health and Safety Plan (HASP)
- Analyze Potential Site Hazards in Preconstruction
- Appoint/Assign/Authorize Project Safety Personnel

Use of BIM, Mobile Tools and Prefabrication Have Positive Impacts on Safety

BIM AND PREFABRICATION/MODULARIZATION

In addition to the direct impact on safety noted on the charts at right, use of BIM and prefabrication/modularization have broader implications on strong safety practices.

- A higher percentage of firms using BIM and firms employing prefabrication/modularization report using all the safety practices in the study, with most of the differences being statistically significant.
- 83% of BIM users and 73% of prefabrication/modularization users report having a fully inclusive and widely observed safety program.
- A higher percentage of BIM users report achieving nearly all the benefits of safety measures in the survey.

While both BIM and prefabrication offer many opportunities to improve project safety directly, their use also encourages contractor involvement in projects before construction begins, a key factor for improving safety.

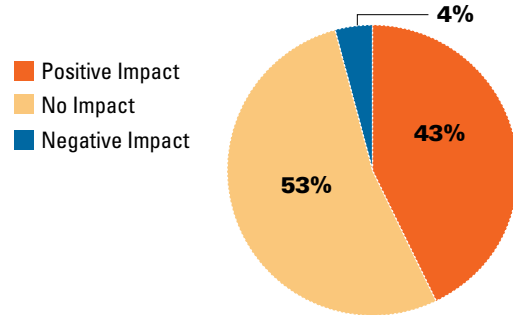
MOBILE TOOLS

A wide range of mobile devices are reported as having a positive impact on safety. The devices that are seen as having the greatest impact on safety:

- Smartphone other than iPhone (82%)
- iPad (81%)
- iPhone (78%)

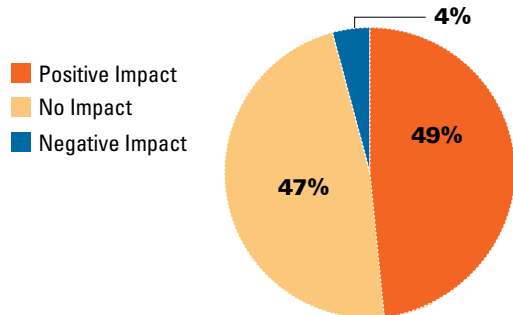
Impact of BIM on Site Safety (According to Respondents That Use BIM)

Source: McGraw Hill Construction, 2013



Impact of Prefabrication/Modularization on Site Safety (According to Respondents That Use Prefabrication/Modularization)

Source: McGraw Hill Construction, 2013



Onsite Safety Training and Education Considered the Most Valuable

Ninety-five percent of firms report using on-the-job training, and 82% consider it to have the greatest value to jobsite workers. This preference is consistent across all firm sizes and types, and it aligns with the importance assigned to delivering training to those on the jobsite that is also reported. Online training is still emerging as a trend in the industry.

Factors Driving Adoption of Safety Practices

Over 70% of contractors report that worker health and well-being (79%), insurance costs (78%) and liability concerns (77%) are the top drivers for investment in their safety programs, demonstrating that businesses are largely motivated by financial incentives, as well as concern for workers, in their investment decisions.

Recommendations

In order to increase the adoption of safety practices in the industry, players from across the industry must engage in promoting the use of a wide range of safety management practices by contractors.

While contractors have the most direct impact on the adoption of safety management practices, increasing project safety does not benefit them alone. The industry as a whole would benefit by being able to attract talent if it had a better safety reputation, and project owners would benefit from projects with less insurance liability, shorter schedules and improved budgets.

Owners

REQUIRE A FULL RANGE OF SAFETY PRACTICES

Nearly two thirds of the contractors surveyed said that stronger owner requirements would encourage them to develop a more extensive safety management program.

REQUIRE EARLIER CONTRACTOR INVOLVEMENT IN PROJECTS

The contractor is the most important, well-informed and influential player in encouraging overall project safety. Therefore, having the contractor, and especially that firm's safety personnel, engaged during the design and preconstruction phases can help avoid some

hazards and mitigate others that are unavoidable. This includes involvement by the major trades, such as mechanical and electrical contractors, as well as subcontractors.

ENCOURAGE USE OF BIM AND PREFABRICATION

Forty-three percent of the contractors surveyed report that BIM use improves project safety, and nearly half of those using BIM cite the ability to identify site hazards before construction begins as a major factor, with clash detection also noted by nearly a quarter. These findings suggest that encouraging BIM use could have a material impact on safety.

In addition, 49% of contractors find that using prefabrication/modularization on projects has a positive impact on safety. While prefabrication is not a universal solution, it is still underutilized in the industry, and interest in these approaches by project owners when appropriate would encourage wider use, thereby potentially improving site safety.

Industry Associations and Organizations

PROVIDE MORE DATA ON THE BUSINESS BENEFITS OF SAFETY

Many of the main obstacles cited by firms, including increased cost and lower productivity, are areas in which investment in safety can improve performance. More hard data on these savings can help firms encourage their senior leadership to invest in greater safety management practices.

APPLY PRESSURE TO THE INSURANCE INDUSTRY TO REDUCE CONTRACTOR INSURANCE RATES BASED ON USE OF A STRONG SAFETY MANAGEMENT PROGRAM

Seventy-eight percent of contractors consider reduced insurance rates a strong incentive to help fund their investments in safety programs. Industry associations and organizations have more collective clout to advocate for change in rate policies.

Contractors

IMPLEMENT SAFETY PRACTICES FROM THE BOTTOM UP

The study results consistently demonstrate that safety practices implemented on the jobsite and engaging jobsite workers are highly effective, a finding that is not surprising but one that contractors need to bear in mind as they expand their safety programs.

TAKE ADVANTAGE OF ONSITE MOBILE TOOLS

Over three quarters of the respondents find that mobile tools with a wide range of uses, like iPads, iPhones and other smartphones, have a positive impact on safety. General contractors in particular would benefit from wider use by all jobsite workers of these tools and taking full advantage of all the ways in which they can help improve safety.

ENCOURAGE GREATER INVESTMENT IN SAFETY BY ENGAGING SENIOR LEADERSHIP

For small firms, the owner needs to recognize the value of safety in order to see greater investment in more safety practices, while engagement by senior leadership in large firms is essential to improve safety programs. ■

Data: Introduction

Safety concerns have always been paramount in the construction industry. Jobsites are complex environments, with workers from multiple trades interacting in challenging physical environments. Recent efforts to improve safety appear to have had some effect: The U.S. Bureau of Labor Statistics (BLS) in September 2012 reported that fatal injuries in the private construction sector had declined for five consecutive years, with fatal injuries down between 2006 and 2011 by 46%.

At the same time, McGraw Hill Construction's Dodge construction starts data demonstrate that 2006 marked a peak for the construction industry, and between 2006 and 2011, construction activity measured by value declined more than 50%, suggesting that declines in fatal accidents may be at least partly attributed to lower rates of overall activity. In addition, the same BLS report also noted that construction still has the second-highest rate of fatal work injuries compared with other industries despite the improvement in performance. **Clearly improving safety remains one of the greatest challenges facing the construction industry today.**

While the issue of improving safety has been an industry need for decades, this is a particularly exciting time to examine how safety management practices are being implemented and are perceived by the industry, as well as the benefits of a safety program. The construction industry is changing in ways that have strong implications for site safety. Some of the key trends that have implications for safety include the use of new and unfamiliar products and technologies to achieve green goals on projects, the use of BIM and collaborative design, the proliferation of mobile tools onsite and the increasing interest in the use of prefabrication. All of these rising trends offer new opportunities to increase safety, as well as unique challenges that may necessitate new approaches to the development and delivery of safety training. The use of increasingly multifunctional mobile tools onsite, for example, offer new ways to bring safety information to jobsite workers, but they need to be deployed effectively in ways that contribute to productivity and enhance communication.

The data in this study demonstrate that the industry has a high awareness of safety management practices, but that the implementation of those practices and of an inclusive and comprehensive safety program varies widely, especially by firm type and size. It also demonstrates how firm type and size factor into the value placed on different means of educating staff about safety.

One key finding that can help spur greater investment in safety training is the productivity and business benefits gained from making investments in a strong safety management program, from improved company reputation to improved project return on investment. Engaging firm leadership in the need for a strong safety program as a critical aspect of a firm's competitiveness can help increase investment in safety.

By providing a clear portrait of existing safety practices that can serve as a benchmark for companies, by demonstrating the gaps in safety adoption, and by exploring the opportunities and challenges represented by important construction industry trends for increasing safety in construction, this report offers all industry players insights into how to continue to improve this vital part of the construction process.

Note About the Data

The data and analysis in this report are based on an online survey conducted with responses from 263 general contractors, specialty contractors, design-build firms, construction managers and engineering firms. For the purpose of analysis, the category of general contractors used in the data includes design-build firms and construction managers, and the category of specialty contractors includes engineering firms.

The data also include comparisons between firms using building information modeling (BIM) and those that do not. A firm is identified as using BIM if they have worked with BIM models created by other firms or authored a BIM model for any of their projects.

For the full methodology, see page 52.

Data: Types of Safety Practices

Types of Practices Used to Promote Safety on Projects

Construction industry firms report using a broad array of safety practices as a part of their safety management programs. Out of the 15 practices included in the survey (see page 52 for the full list of practices), eight are used by 60% or more of respondents, revealing a broad adoption of safety practices in the industry.

General contractors report a significantly wider use of safety practices across the board than specialty contractors. However, the relative ranking for most practices remains the same, suggesting that some practices have greater acceptance in the industry overall than others.

The practices with the smallest differential in adoption between general and specialty contractors are establishing effective safety goals and objectives, and developing a site specific Health and Safety Plan (HASP), although there is still an 11% and a 12% differential, respectively, between these two. Thus, while these see wider agreement across the industry, they also reinforce greater emphasis on a more comprehensive safety program by general contractors.

The difference in use between general contractors and specialty contractors may reflect the role of the general contractor in promoting safety as “controlling employers” on a jobsite. According to OSHA, general contractors need to exercise reasonable care to prevent and detect violations on the site and establish safety programs that protect all workers, including specialty contractors. Another factor that may play a role in the consistently wider adoption of safety practices by general contractors is the availability of greater resources for general contractors, which are generally larger firms than specialty contractors.

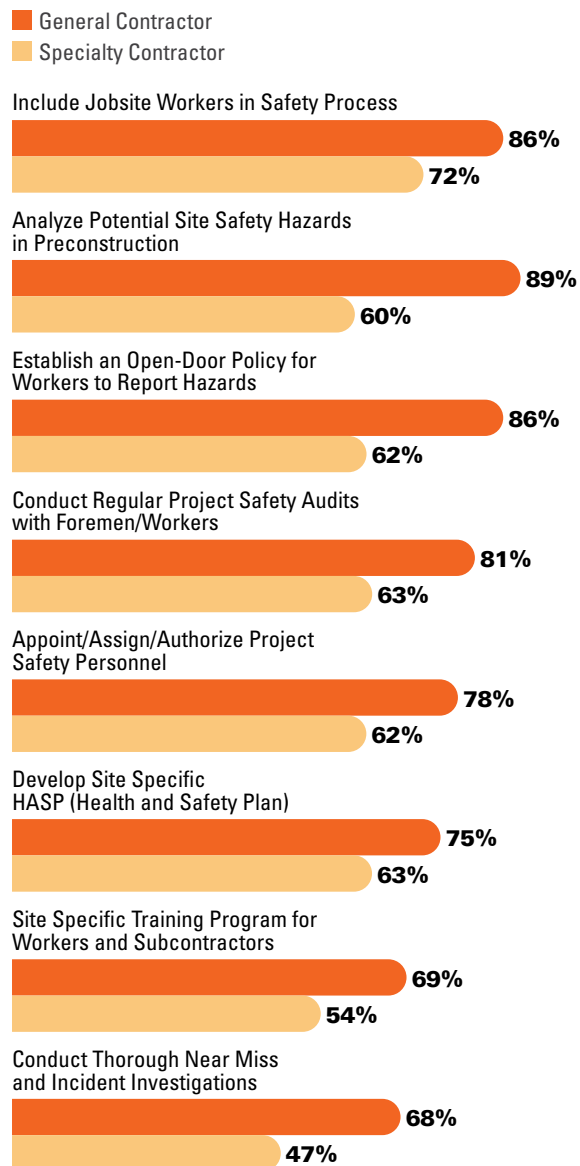
This finding has a direct implication on the greater percentage of general contractors that report seeing positive impacts from their safety programs. (See page 16.)

Promoting a Safety Culture

Several of the top practices emphasize the importance general and specialty contractors place on creating a safety culture throughout their organizations. The most widely used practice is including jobsite workers in the safety process, used by 81% of all the contractor respondents. Over 70% also report establishing an open-door policy for workers to report hazards and having specific personnel assigned to safety. This emphasis reflects industry recognition of the importance of having employees adopt a safety mind-set to make their safety programs effective.

Types of Practices Used on Projects to Promote Safety (by Firm Type)

Source: McGraw Hill Construction, 2013



Site Specific Practices

Respondents also report wide use of site specific safety management practices, demonstrating their understanding of how important it is to have a safety program that recognizes the unique challenges posed by each new site.

Types of Safety Practices

Types of Practices Used to Promote Safety on Projects CONTINUED

- **78% of all respondents report analyzing potential site hazards in preconstruction, the second most widely adopted practice.** Preconstruction planning has been recognized by the industry to significantly impact worker protection and reduce injuries as studies have shown over the past decade.
- **70% report developing a site specific HASP.**
- **63% indicate using a site specific training program for workers and subcontractors.**
- **50% say they use a site specific emergency action plan within the HASP.**

These findings may be influenced by current OSHA requirements and other federal and state regulations regarding response to specific site hazards.

Practices Involving Analysis, Investigation or Measurement

Several practices adopted by a significant percentage involve measurement of safety hazards and/or analysis of safety data that is not related to a specific site.

- **60% conduct thorough near-miss and incident investigations.**
- **54% report using either a job safety analysis (JSA) or job hazard analysis (JHA).** Both of these look at specific jobs within a company to determine potential hazards associated with that job and reduce risks.
- **52% establish measurable safety goals or objectives.**
- **32% track leading safety metrics.**

Variation by Firm Size

When examined by firm size, the data show that, across the board, larger firms report wider use of safety practices than smaller firms. While this corresponds to the firm findings, since specialty contractors are typically smaller than general contractors, the results are even more dramatic by size, with the differential between the largest and smallest firms ranging from 34% to 81%, whereas the largest differential by firm type is 29%. This finding supports the conclusion that some of the difference by firm type may be due to the differences in the average size of the general and specialty contractors.

The most significant differences include the wider use by large firms with 500 or more employees of the following practices:

- **Reporting development of site specific HASPs (92%)**
- **Conducting thorough near-miss and incident investigations (94%)**

- **Establishing effective, site specific training programs for workers and subcontractors (92%)**

Small firms with 1–9 employees report use of these practices at much lower rates, 39%, 24% and 33%, respectively.

The most likely reason for the dramatic difference in adoption of most practices between large and small firms is the availability of resources to devote to safety at larger firms that can invest in dedicated safety personnel and training staff.

Variation by Use of BIM

A significantly higher percentage of firms using BIM software report employing 14 out of 15 of the safety practices measured in the survey. The only safety practice without a statistically significant difference is including jobsite workers in the safety process, and even for that factor, the percentage using BIM employing that practice (86%) is still notably higher than those not using BIM (77%).

BIM firms are generally larger than firms not using BIM, which clearly influences these results. However, there could be several other factors impacting this result. Certain aspects of BIM may enable use of some safety practices, such as analysis of site hazards. In addition, firms that keep up with important industry trends like BIM may also be more likely to invest in more safety practices, motivated by the desire to be leaders in the industry or to have a competitive advantage.

Variation by Use of Prefabrication/Modularization

A higher percentage of contractors using prefabrication/modularization employ all 15 safety practices than those that are not, with statistically significant differences between non-users and those using prefabrication/modularization on more than 50% of projects for 11 of the 15 practices. In fact, the percentage of prefabrication/modularization users employing any one practice typically rises as the level of their prefabrication/modularization use increases.

As with BIM, this finding is no doubt influenced by a number of factors, including the possible selection of prefabrication/modularization as an approach because of a firm's emphasis on the importance of safety since the industry reports a positive impact of prefabrication and modular construction on project safety (see page 47).

Top Practices to Increase Safety on Projects

Overall, when respondents are asked to choose the single best practice to improve safety, their responses fall into two categories: either they directly address site conditions or they involve incorporating a strong safety process, including assigning personnel and engaging jobsite workers.

Twenty-five percent of respondents report developing a site specific Health and Safety Plan (HASP) to be the most effective in increasing safety on their projects. This finding is not surprising given that site specific HASPs are comprehensive in nature and generally cover OSHA requirements, safety rules and responsibilities, safety training, emergency action plans and other elements that are critical to safety management on a project site.

Some firms also report safety practices that start in the preconstruction stage to be among the most effective in improving the safety of a project down the road. Seventeen percent find analyzing potential site safety hazards and assigning project safety personnel before construction begins to be very effective.

It is notable that, despite higher use of practices by firms using BIM and prefabrication, there are no statistically significant differences in the percentage of these firms' selections of the single best practice.

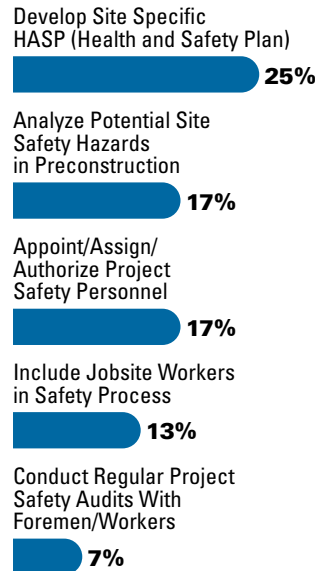
Variation by Firm Type

General contractors and specialty contractors are quite similar when it comes to what practices they consider as the top most effective in improving safety on projects. Both general contractors (26%) and specialty contractors (25%) report developing a HASP as the most effective safety practice.

The second and third most effective safety practices according to both are analyzing potential site safety hazards in preconstruction and appointing project safety personnel, although analyzing site hazards ranks second for general contractors while appointing safety personnel ranks second for specialty contractors. Although the difference in the percentage stating these responses is minor, the greater emphasis by general contractors on analyzing the site in preconstruction corresponds to the role of the general contractor, since they bear greater responsibility for site safety as a whole and are more likely to be involved in the preconstruction phase than some types of specialty contractors.

Top Practices Found Most Effective in Increasing Project Safety

Source: McGraw Hill Construction, 2013



Variation by Firm Size

The data reveal that firm size is not directly correlated to the practices that firms find most effective in increasing safety on projects, with a relatively even distribution of the results according to firm size.

There is one notable difference—15% of small firms report that they find including jobsite workers in the safety management process to be most effective while only 9% of large firms do so. In smaller firms, employees typically take on a wider range of roles, and these results suggest that this trend extends to their involvement with safety management.

Implementing New Safety Practices in the Next Three Years

Forty-two percent of respondents do not plan to change their current safety practices over the next three years. This finding suggests that many contractors believe that they are already doing enough in terms of their safety practices. This is particularly true of firms using BIM, with 51% reporting that they expect to just continue their existing safety practices.

Still, a portion plan to do more to enhance their safety programs over the next three years, albeit at low levels.

Variation by Firm Type

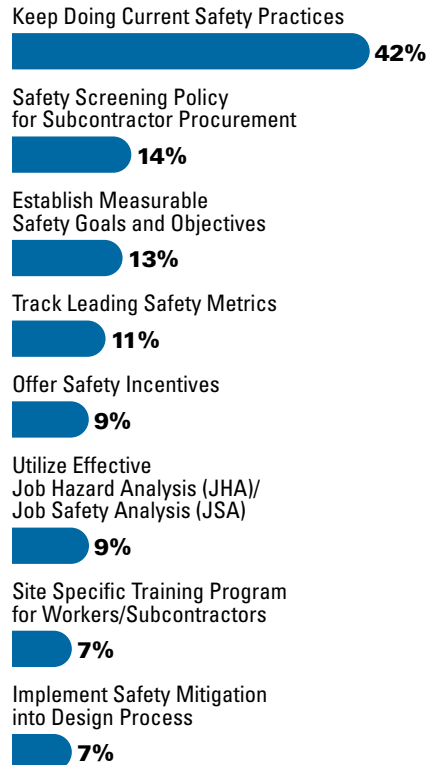
General contractors and specialty contractors are evenly split at 42% when it comes to not changing their current safety practices over the next three years. There are also no statistically significant differences between general and specialty contractors' plans to implement new practices, with three exceptions.

- **Safety Screening Policy for Subcontractor Procurement:** 19% of contractors expect to adopt this compared with only 7% of specialty contractors, an expected result since many specialty trades do not hire subcontractors. Some contractors are even actively engaged in training subcontractors like Sellen Construction's sustainability program and Balfour Beatty's Zero Harm system.
- **Implement Safety Mitigation Into the Design/Engineering Process:** 10% of general contractors are interested in this compared with just 2% of specialty contractors, likely because including general contractors in preconstruction work is more common than the inclusion of most specialty trades.
- **Analyzing Potential Site Safety Hazards:** 8% of specialty contractors plan to use this practice, compared with 1% of general contractors. Since many contractors are already engaged in this practice, this finding suggests that more specialty contractors are becoming part of the preconstruction process and can therefore tackle safety issues at this stage.

On the other hand, both contractors and subcontractors are particularly interested in building metrics that will allow them to gauge the effectiveness of their safety programs.

New Safety Practices Firms Are Planning to Implement in Next Three Years

Source: McGraw Hill Construction, 2013



Variation by Firm Size

Roughly the same percentage of small (46%) and large (45%) firms report that they do not expect to change their current safety practices over the next three years. However, a higher percentage of smaller firms generally plan to implement new safety practices compared with larger firms. With smaller firms generally having fewer safety practices already in place, many clearly recognize the need to invest in their safety programs.

The practices with the greatest differentials demonstrate that small firms are seeking to lay the foundations for a more extensive safety program over the next three years.

- **24% of small firms plan to establish measurable safety goals and objectives, compared with 8% of large firms.**
- **15% plan to establish an effective, site specific training program for workers and subcontractors, compared with 2% of large firms.**

Level of Integration of Safety Policies and Programs

Firm size is directly correlated to the level of integration of safety policies and programs at firms. Ninety-two percent of large firms (500 or more employees) report having fully inclusive and widely observed safety policies in place compared with only 48% of small firms (1 to 49 employees). At the same time, 17% of small firms report having occasionally conducted safety reviews with no formal policies in place, whereas no large firms report doing so.

That larger firms have more fully integrated safety programs than smaller firms is consistent with our previous findings indicating wider use of safety practices among larger firms and supports the notion that larger firms do invest more into safety programs, possibly due to their larger budgets and access to resources.

Variation by Firm Type

General contractors are more likely to have formal policies than specialty contractors, but both report using them in high numbers. Seventy-one percent of general contractors indicate having fully inclusive and widely observed safety policies compared with 63% of specialty contractors. Only 7% of general contractors report not having a formal safety policy compared with 10% of specialty contractors.

VARIATION BY FIRM TYPE BY SIZE

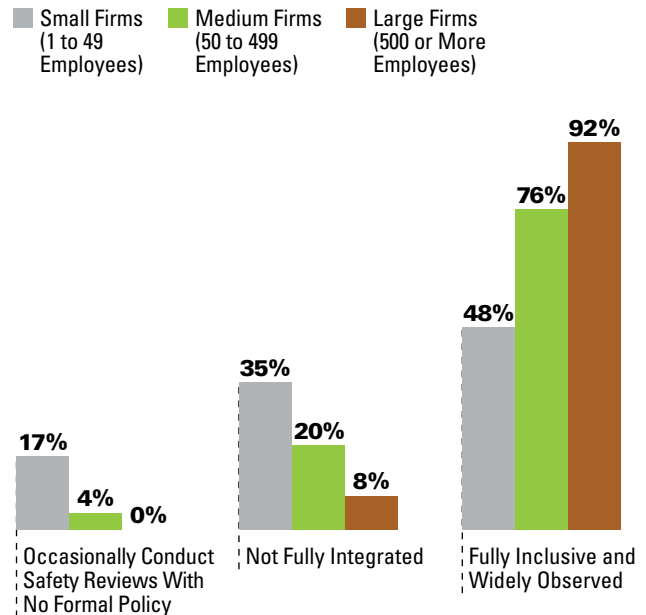
The general trend on firm size holds true when examined by firm type.

- **95% of large general contractors report having fully inclusive and widely observed safety policies compared with small general contractors (50%).**
- **80% of large specialty contractors report having fully inclusive and widely observed safety policies compared with small specialty contractors (46%).**

This finding also demonstrates that firm size is not the only factor that creates the overall differential between general and specialty contractors when it comes to the comprehensiveness of their programs since there is a 15-point difference between large general contractors having such a program and specialty firms having one. However, a higher percentage of medium-size specialty contractors (81%) report having fully inclusive and widely observed safety policies than medium-size general contractors (72%). This suggests the need for further research to determine the full impact of the type of firm on the implementation of an integrated safety program, assessing the impact of variables other than size.

Level of Adoption of Safety Practices and Policies

Source: McGraw Hill Construction, 2013



Variation by Use of BIM

Eighty-three percent of firms using BIM have a fully inclusive and widely observed safety program, compared with 56% of firms not using BIM. This corresponds directly with the significantly higher level of safety practices reported by BIM users (see page 9).

Variation by Use of Prefabrication/Modularization

Seventy-three percent of firms using prefabrication/modularization have a fully inclusive and widely observed safety program, compared with 48% of firms not using prefabrication. In addition, a higher percentage of firms doing greater levels of prefabrication/modularization work report having this kind of program than those doing lower levels, with 79% of firms using prefabrication/modularization on more than half of their projects reporting this advanced level of safety program. As with BIM, firms doing prefabrication/modularization report using many more safety practices, which correlates well with this finding. (See page 9.)

Aspects of a World-Class Safety Program

The selection of ten practices by over 60% of the respondents as a critical part of a world-class safety program clearly demonstrates recognition that a wide range of practices are necessary for strong safety results. A higher percentage of general contractors also select each practice than specialty contractors, and general contractors are more consistent in their evaluation of the importance of these practices than specialty contractors. This finding provides additional support for the conclusion that general contractors typically take a more comprehensive approach to safety than specialty contractors.

On-the-Ground Approach

The two practices selected by the largest percentages of both general and specialty contractors favor a bottom-up, on-the-ground approach to safety: Having strong safety leadership abilities in supervisors and regular jobsite meetings on safety are cited by over 80% of general contractors and over 70% of specialty contractors as important. In fact, strong safety leadership in supervisors is the only practice for which there is no statistically significant difference between general and specialty contractors. HASPs at each jobsite also rank very high for both types of firms.

The high level of agreement in the importance of these practices by both general and specialty contractors demonstrates broad industry recognition of the critical need to take an on-the-ground, project specific approach to safety, whether by working with project supervisors or through site specific practices.

Organizational Involvement

General and specialty contractors also have a relatively consistent response to practices that involve engaging the entire organization. The practices selected by at least 63% of general contractors and 50% of specialty contractors in this category include access to training across the organization, emphasis on communication and regular C-suite meetings about safety.

Practices Involving Investigation or Analysis

The most significant differences between general and specialty contractors are the two practices that investigate or analyze safety practices. Seventy-seven percent of general contractors think safety audits are critical to a world-class program, compared with just

Aspects of a World-Class Safety Program (According to General Contractors and Specialty Contractors)

Source: McGraw Hill Construction, 2013



Types of Safety Practices

Aspects of a World-Class Safety Program

CONTINUED

SAFETY MANAGEMENT IN THE CONSTRUCTION INDUSTRY DATA

51% of specialty contractors, and the same differential of 26% is present between general contractors and specialty contractors that favor thorough incidence and near-miss investigations. This finding suggests that general contractors have a more advanced approach to safety than specialty contractors currently do because investigation and analysis are the hallmarks of a more advanced program.

Variation by Firm Size

A significantly greater percentage of large firms find nearly all the safety practices essential to a world-class safety program than do small firms. Some of the most striking gaps include:

- **Jobsite worker's input in launch/ongoing operation of program: 80% versus 42%**
- **Specific safety goals with metrics to measure performance: 67% versus 18%**
- **Staff position dedicated to safety: 88% versus 51%**
- **Prompt and thorough near-miss investigations: 84% versus 42%**

All of these factors involve greater investment of money or resources, including the time to track metrics and the cost of a dedicated position, which may explain why more large firms consider them essential.

Variation by Use of BIM

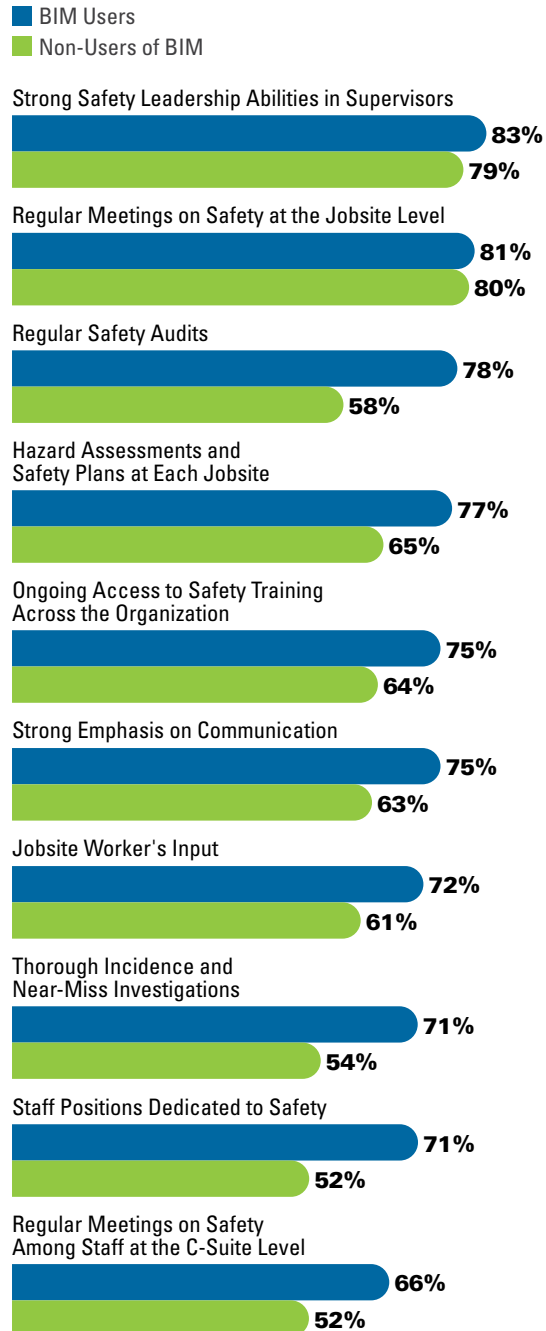
A significantly higher percentage of BIM users select many practices as part of a world-class safety program than non-BIM users, even though there is little difference in the top two factors. As stated above, the on-the-ground approach to safety that these practices represent are recognized as critical across the industry. The elements with the greatest difference are regular safety audits, staff positions dedicated to safety and thorough incidence and near-miss investigations.

The fact that BIM firms are larger may account for the differences, although they also reflect the findings throughout the report of a more comprehensive commitment to safety practices by BIM users compared with non-users.

The BIM results largely align with the opinions of general contractors. This may be because the trades more likely to employ BIM, including mechanical, electrical and structural, involve working with other contractors, which may make them functionally similar to general contractors when it comes to their approach to safety.

Aspects of a World-Class Safety Program (According to BIM Users)

Source: McGraw Hill Construction, 2013



Integration of Safety and Quality Management

Many contractors are finding the integration of risk analysis, quality and safety to be critical as they determine project scheduling and phasing.

When reviewing project results and performance metrics, some firms see a strong correlation between construction quality and construction safety. Through new delivery methods, some of these firms are taking a more integrated approach to these two measures.

Gary Amsinger, vice president for Corporate Safety at McCarthy Building Companies, says that safety professionals recognize quality issues, such as construction defects, as both financial risks and safety risks.

“Doing rework means exposing [workers] to additional hazards,” he says. “You build it once and that’s an exposure. You take it down and that’s an exposure. Then you redo the work and that’s another exposure. There clearly are benefits to doing it right the first time [from a risk perspective].”

Expanding Risk Analysis

That nexus of safety and quality has prompted some companies to change how they view risk.

“We view all of these risk issues holistically,” says Casey Halsey, executive vice president and chief risk officer at JE Dunn Construction. Several years ago, Halsey says the company began to move toward a “very centralized homogenous program of safety and quality” under its risk management department.

With the adoption of more lean construction techniques, the company is further integrating its

risk management with operations functions. While safety and quality were both under its risk management department, they now fall under an integrated services group that includes scheduling, building information modeling and lean construction.

“We’ve moved it back to operations, but raised the level of sophistication of our efforts in order to incorporate those facets all at once,” he says. “You can’t schedule, if you don’t take into account safety and quality. You can’t calculate prefabrication, if you don’t think about safety and quality.”

With that view, the company is pushing for greater use of prefabrication and modularization—methods, notes Halsey, that improve both safety and quality by moving construction to more controlled environments.

Integrating Safety and Quality in Project Planning

Mortenson Construction takes a similar view. Scott West, director of Quality at Mortenson, says that while safety and quality each require specific technical backgrounds, it’s critical to integrate how they are managed, especially when planning a project.

“Our goal is to have the safest and highest quality project, delivered in the most efficient way,” he says.

“No rework and zero injury are the goals, and that requires integrated planning.”

The company’s integrated planning process involves bringing subcontractors into the process early and incorporating quality and safety management into the plan. “We engage all of our trade partners who will perform the work,” he says. “We open the plan and ask them how they would do it.”

West says Mortenson determines the highest safety risks and quality risks and factors those in as the schedule is determined. The team then sets up a phase plan and the activities that support those phases.

“Each activity is typically owned by a trade partner,” he adds. “When we’re in that phased planning set time frame, we’ll bring our trade partners on board, and we begin full planning sessions to outline how each activity interacts with the other. In defining a phase and the activities that support it, we go deeper into the safety hazards and ask each trade how they would deal with the hazards and how they get to that first-time quality. We want them to buy into that interaction. Once we get the phase and what activities will be performed, then we drill down into an activity plan. That’s where we sit down one-on-one with our trade partners and we’ll go really deep into the hazards associated with the activity. That’s the unique way that this is being integrated by bringing in the subcontractors as part of the process.” ■

Data: Impact of Safety Practices/ Programs on Business

SAFETY MANAGEMENT IN THE CONSTRUCTION INDUSTRY DATA

Impact of Safety Practices on the Success of Projects

Improved reputation is the positive impact of adopting safety practices reported by the highest percentage of respondents, even higher than reduction of injuries. This result is striking because it demonstrates that firms recognize the business value of safety. An improved reputation in the industry is likely the result of many of the other benefits of a good safety program—including reduced injury rates, reduced costs as a result of reduced risk, less rework, more on-time completion of projects, improved employee morale and enhanced productivity.

Safety Culture

The next two most commonly reported positive impacts demonstrate the importance firms place on having a strong safety culture. Having open door policies that encourage workers to report unsafe conditions and provide safety-related feedback and a reduction in reportable injury rates are both viewed by over 70% of the respondents as having a positive impact on safety. This result is not surprising since both of these are key outcomes that firms across the industry expect from their pursuit of safety practices.

Business Impacts

A significant percentage of respondents report their firms' safety practices as having positive business outcomes—two thirds find that they have an increased ability to contract new work and improve project quality due to their safety practices. This finding is critical because it demonstrates how many firms view their safety practices as providing them with a competitive advantage.

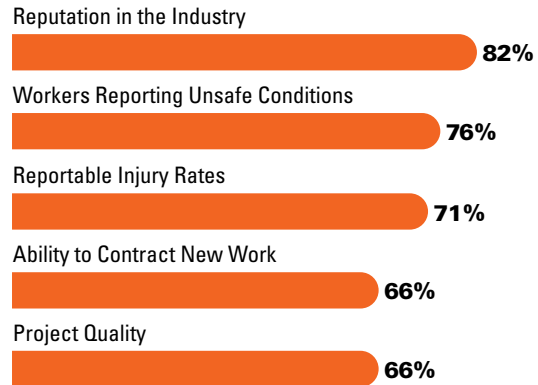
Over half of the respondents also find that safety has a positive overall impact on ROI. This is also important, especially given the fact that less than half find specific improvements to project schedule (43%) and project budget (39%). Clearly the other benefits they achieve carry enough weight for them to find value in safety.

However, it is important to note that only a small percentage report that safety practices have a negative impact on project budget (15%) or project schedule (13%), and even fewer see negative impacts on project ROI (5%). For most, safety practices are either neutral or beneficial for these direct business impacts.

The notable percentage of respondents that do not yet perceive these benefits, though, suggest that the positive business impacts of safety management still have

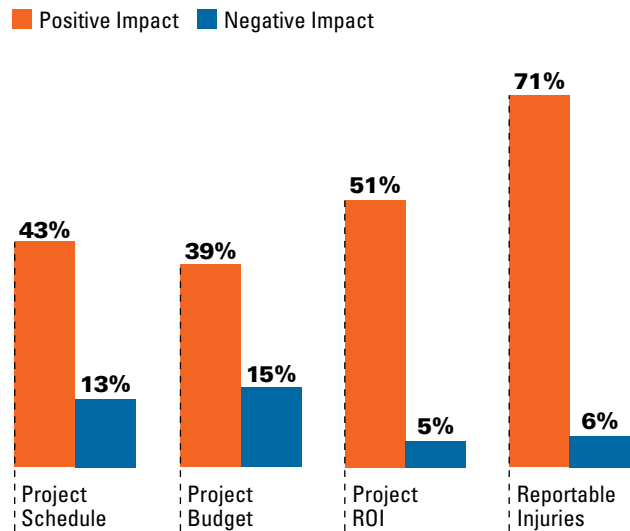
Positive Impacts of Using Safety Practices (Reported by At Least 50% of Respondents)

Source: McGraw Hill Construction, 2013



Positive and Negative Productivity Impacts of Safety Programs on Projects

Source: McGraw Hill Construction, 2013



to be made known across the industry. **The connection must be made between safer jobsites and their benefits: avoiding high dollar losses caused by injuries, reduced overhead cost of insurance payments and hidden costs such as employee replacement costs and OSHA citations.** According to the Business Roundtable, the ratio of cost savings to program costs for implementing a safety management program is estimated to be between five-to-one and nine-to-one for the construction industry.

Impact of Safety Practices/Programs on Business

Impact of Safety Practices on the Success of Projects CONTINUED

Other Safety Impacts

Despite the strong influence of safety on firm reputation, only 46% report that safety practices help them to retain staff and 37% find that safety practices help them attract new staff. However, these numbers must be viewed in light of the sustained high levels of unemployment in the construction industry, which have no doubt impacted the ability of staff to select firms based on their safety records. A sustained recovery could have longer-term implication for the firm's reputation in this area.

Variation by Firm Type

For two measures of safety impact, a significantly higher percentage of general contractors report seeing positive benefits from their safety programs than specialty contractors.

■ Project Schedule

- General Contractors: 56%
- Specialty Contractors: 42%

■ Project ROI

- General Contractors: 49%
- Specialty Contractors: 33%

In addition, there is also a general trend for a higher percentage of general contractors to report positive impacts compared with specialty contractors, even if the differences are not statistically significant, for factors such as improved reputation in the industry (84% versus 78%); willingness of workers to report unsafe working conditions (77% versus 74%); improved injury rates (74% versus 68%); ability to contract new work (69% versus 63%); and improved project quality (68% versus 63%).

This finding is clearly influenced by the wider adoption of most safety practices by general contractors than by specialty contractors (see page 8 for more information).

Variation by Firm Size

For the most part, there is a significant difference between respondents from small firms and large firms on what impact safety practices have on the success of their projects. A significantly higher percentage of large firms compared with small firms report safety having a positive impact in the following areas:

- Reportable injury rates (88% versus 36%)
- Reputation in the industry (92% versus 57%)
- Ability to contract new work (84% versus 33%)
- Project ROI (67% versus 21%)

In addition, large firms report positive impacts on project schedule (55%) and project budget (47%)—a higher percentage than small firms (36% and 24%, respectively).

Given that small firms are less likely to report having fully inclusive, widely observed safety programs (see page 12), this finding also demonstrates that greater investment in safety yields stronger returns. To see better outcomes, small firms may need to consider long-term benefits when considering their safety investments.

Variation by Use of BIM

A significantly higher percentage of BIM users report that they experience nearly all of the positive impacts measured in the survey on their projects from their safety program than non-BIM users, including the top five impacts reported by respondents as a whole. The only benefit not reported by a statistically larger percentage of BIM users is staff retention, though a notable 11% more BIM users than non-users report this benefit.

The study demonstrates that firms using BIM have a larger commitment to safety, employing more practices (see page 9) and having a more fully integrated safety program (see page 12) than non-BIM users. Given these findings, it is not surprising that they would report greater benefits from their safety adoption.

Variation by Use of Prefabrication/Modularization

Despite generally wider adoption of safety practices by firms that use prefabrication/modularization compared with those that do not, there are just three benefits of a safety program reported by a significantly higher percentage of prefabrication/modularization users:

- Positive impact on project schedule: 48% of prefabrication users, compared with 23% of non-users
- Positive impact on willingness of jobsite workers to report incidents: 79% of prefabrication users, compared with 60% of non-users
- Positive impact on reputation: 83% of prefabrication users, compared with 73% of non-users

Since prefabrication and modularization improve project schedule as well as safety, it is not surprising that users attribute some of their schedule savings to their safety programs. Also, the association of safety and these practices may help firms that use prefabrication/modularization to gain an improved reputation in the industry. With less clutter and activity onsite, jobsite workers may also be able to note more potential hazards.

Impact of Safety Practices on Project Schedule

Among the firms that note an improvement in project schedule due to their safety practices, 50% have experienced a decrease in their project schedule by one week or more, with 19% reporting a decrease of two weeks or more. This level of schedule improvement can have a significant impact on a contractor's bottom line, as well as on their reputation with clients, since schedule is typically a key measure by which a client gauges the effectiveness of a construction firm.

There is very little variation by firm type, with general contractors and specialty contractors reporting roughly the same level of schedule decreases. Schedule is a critical factor for both types of firms, with the completion of specific trades onsite critical to coordinating a project as a whole. However, with some trades onsite on individual projects for much shorter periods of time than the general contractor, the lack of statistical differences on reductions of a week or more demonstrates that specialty contractors are benefiting strongly from their safety practices.

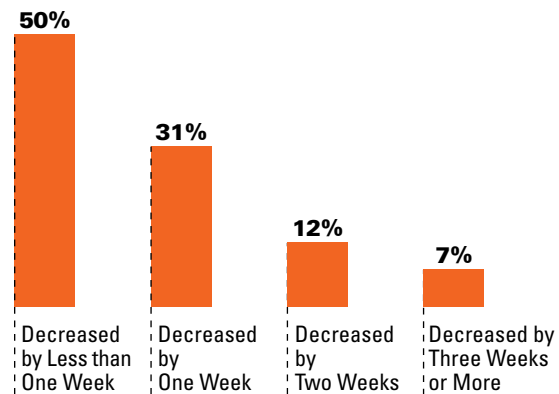
Variation by Firm Size

A higher percentage of very small firms (67%) report that safety practices decrease their project schedules by less than one week compared with the largest firms (43%). Correspondingly, a much higher percentage of the largest firms (43%) cite decreases in their projects by one week compared to very small firms (13%).

Small firms are far more likely to be involved in shorter-term projects than large firms, so when measured purely in amount of time saved, it is to be expected that they would report far less savings. However, more research is necessary to see if small firms experience equivalent schedule savings as large firms if measured by percentage of total project schedule.

Impact of Safety Practices on Project Schedule (According to Those That Reported Positive Impacts on Schedule)

Source: McGraw Hill Construction, 2013



Impact of Safety Practices on Project Budget

Nearly half (49%) of the respondents that indicate positive impacts on their budgets report a decrease of 1% to 5% in their project budget as a result of their safety programs. While these savings may appear relatively conservative, in the construction industry, saving even 1% of the project budget can be quite impactful. Net earnings margins for contractors averaged 3.2% in 2011, according to the Construction Financial Management Association, and the cost of safety programs is also typically a negligible percentage of total project budget. Therefore, a large percentage seeing savings between 1% and 5% is actually a strong return on safety investments.

Robust safety programs, which lead to injury-free projects, reduce or eliminate the need to pay workers compensation and also result in lower insurance rates. These are all key factors that lead to decreases in project budgets over the long run.

Variation by Firm Type

While there is no statistically significant difference by firm type, there is a general trend for a higher percentage of specialty contractors to report greater budget savings due to safety practices than general contractors.

■ **Budget Decrease of more than 20%**

- General Contractors: 3%
- Specialty Contractors: 6%

■ **Budget Decrease of 6% to 10%**

- General Contractors: 12%
- Specialty Contractors: 26%

On the other hand, a notably higher number of general contractors compared with specialty contractors report a decrease by less than 1% (32% versus 17%).

Specialty contractors may have a better opportunity to train for specific, trade-related safety issues, allowing them to see a larger impact on their overall budget.

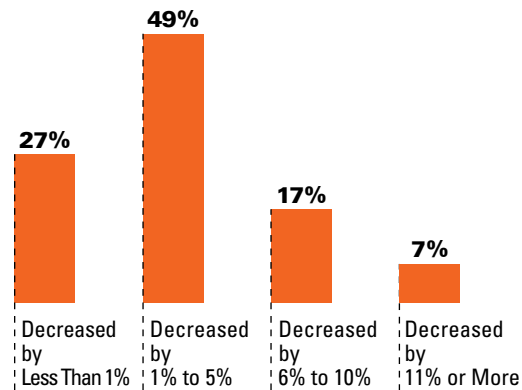
Variation by Firm Size

A higher percentage of very small firms (those with less than 10 employees) report that safety practices have either a strong impact on their budgets or very little impact on their budgets compared with very large firms (with more than 500 employees).

Impact of Safety Practices on Project Budget

(According to Those That Reported Positive Impacts on Budget)

Source: McGraw Hill Construction, 2013



■ **Budget Decreases of more than 20%**

- Very Small Firms: 13%
- Very Large Firms: 4%

■ **Budget Decreases of less than 1%**

- Very Small Firms: 38%
- Very Large Firms: 21%

For small firms, absorbing the extra costs of safety practices into their smaller budgets may mute the benefits in some cases. However, just one example of strong savings could have a more major impact on a small firm's budget than a similar savings by a large firm, resulting in greater overall impact.

Impact of Safety Practices on Project ROI

Fifty-three percent of the respondents who report increases in ROI as a result of safety practices find that they achieve ROI increases of 1% to 5%. Twenty percent of respondents see even higher returns of 6% or more. As with project budget decreases, even small increases in ROI are significant, especially given the relatively low cost of implementing most safety practices.

Some of the factors that contribute to these ROI increases include increased reputation, increased ability to contract new work and increased project quality. The financial return on these benefits exceeds the cost of investing in safety.

Variation by Firm Type

No significant difference exists between general contractors and specialty contractors on the impacts of safety practices on project ROI, but **there is a trend for specialty contractors to see greater ROI increases compared with general contractors**—58% of specialty contractors compared with 49% of general contractors report an increase by 1% to 5%, whereas 30% of general contractors versus 23% of specialty contractors cite an increase in project ROI by less than 1%.

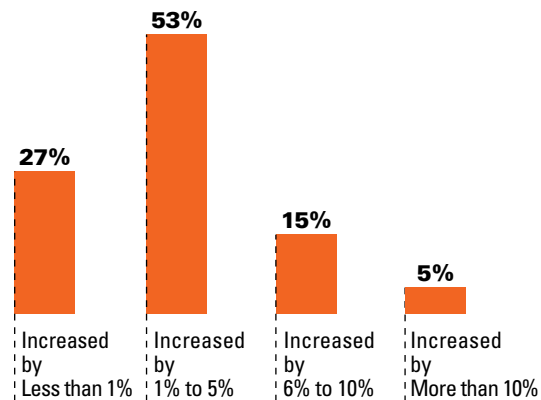
Specialty contractors may see bigger business impacts from their safety investments than general contractors because of their position in the hiring chain. While a safety record may impact a contractor's likelihood of being employed, greater sensitivity to safety issues among contractors compared with other players, like owners, may make a good safety record more important for specialty contractor firms, which are hired primarily by general contractors.

Variation by Firm Size

While the sample size prevents the differences from being statistically significant, **there is a clear trend for larger contractors to see stronger ROI improvements than small firms.** Forty-three percent of small firms report ROI increases of less than 1%, compared with 15% increases reported large firms, and 24% of large firms cite a 6% to 10% increase, but no small firms report increases at that level. This finding demonstrates that, as the number of employees in a firm increases, the return on investing in their safety increases as well.

Impact of Safety Practices on Project ROI (According to Those That Reported Positive Impacts on ROI)

Source: McGraw Hill Construction, 2013



Impact of Safety Practices on Injury Rates

Not only do a large percentage of contractors report that the use of safety practices result in reduced injury rates (see page 16), but a much higher percentage also report medium to high levels of reduction, compared with the other impact measures. In fact, nearly half (45%) report a decrease in injury rates of more than 10%.

One factor that may be driving these high results is the close attention that firms may give to this measure because of its impact on their experience modification ratings (EMRs). EMRs are a widely used measure of safety performance that is employed to adjust the cost of workers compensation insurance premiums. A low EMR translates to lower insurance rates.

Some firms have adopted zero tolerance policies to any safety violations to help ensure a low injury rate. However, there is debate in the industry about whether zero tolerance programs may actually reduce the willingness of workers to report infractions or other safety concerns. Clearly, though, firms are highly concerned about taking steps to reduce injury rates.

Variation by Firm Type

While no significant differences are observed, a higher percentage of general contractors (25%) report seeing injury rates decrease by more than 20% than specialty contractors (20%). Conversely, a higher percentage of specialty contractors than general contractors (13% versus 8%) report a decrease in injury rates by less than 1%. Since this finding parallels the findings by firm size, (see below) the same factors are probably at play in this difference.

Variation by Firm Size

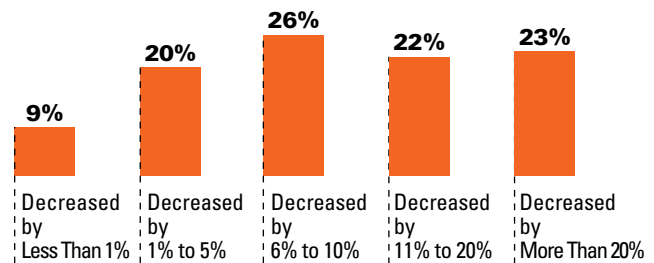
Large firms are more likely than small firms to see a greater reduction in injury rates. A higher percentage of small firms versus large firms report a decrease by less than 1% (42% versus 4%) and decrease by 1% to 5% (42% versus 27%) as a result of their safety practices. In addition, while 31% of large firms report decreases of 6% to 10% and 18% report a decrease by more than 20%, no small firms report decreases in either of these categories.

One factor that may have an impact on this finding is that large firms may be more likely to be involved in large and highly complex projects than small firms. Project complexity can have an impact on the potential for injury, and sound safety practices that address the problems these create may therefore have a broader impact.

Impact of Safety Practices on Project Injury Rates

(According to Those That Reported Positive Impacts on Injury Rates)

Source: McGraw Hill Construction, 2013



Using Leading Metrics

to Improve Safety Management

Many companies use leading indicators in performance metrics, helping to alert them to issues and guide them about how to react.

Lagging indicators of safety performance, such as Total Recordable Incident Rates, and Days Away and Restricted or Transferred Rates, are well established in the construction industry. But in an effort to take a more proactive approach to safety, many contractors also track leading indicators to see how they can best deploy resources and mitigate risk.

Experts admit that it's not an exact science. While major lagging indicators are based on quantifiable statistics—such as the number of injuries on a job—leading indicators often aren't so easily defined—such as rating a company's safety culture.

Developing Leading Indicators

Safety consultant Emmitt Nelson of the Zero Injury Institute has developed metrics for more than two decades. Based on work started by the Construction Industry Institute in the 1990s, Nelson created a system that measures 131 leading indicators, which he uses as performance metrics for clients. His process includes surveying project personnel, ranging from top executives to the trade workers in the field.

"If my survey shows that company leadership says [the team] is doing something [relative to training], but only a few of the trades say they are doing it, that's an indicator of a lack of safety knowledge," he says. "Safety knowledge correlates with safety results. If you want results, you have to focus on the execution gap."

Steve Smithgall, corporate senior vice president for Safety, Health and Environment at Balfour Beatty Construction, says leading indicators are a prime focus of the company's safety performance metrics. With more than 1,000 active projects in the U.S. at any one time, the company has standardized its safety audit system to capture and analyze data across the entire country.

"We look for common issues," he says. "We're not just counting accidents—we're counting all observations. If we see 500 observations of unsafe use of ladders, that's a leading indicator that we need a stand down at our jobsites to do ladder safety training."

Data on ladder safety led to changes at Turner Construction. The company studied its data from 2005 to 2009 and identified the costs of incidents related to ladder injuries. "The results were staggering," adds Cindy DePrater, vice president of Environmental Health and Safety.

Following the two-year study, Turner developed its Ladders Last program, which emphasizes using means other than ladders on jobsites, such as platforms or lifts. Although the initiative has the potential to raise construction costs up front, DePrater says the company sees the payback.

"The metrics at the end showed improvement in lost time, falls and recordable incidents," she says. "We also found that by providing [workers] with better equipment or a lift, they were more productive and we saw better quality."

Armed with that knowledge,

DePrater says the company now tracks the program's performance as a leading indicator. "If you don't continue to measure, you can't understand your improvements from baseline," she adds.

Safety Database

Rich Baldwin, director of Health, Safety and Environment at PCL Construction, says the company sees leading indicators as a way to drive down incident rates. As such, the company has invested in its Safety Management Center, a database that he says captures "every facet of data you can imagine related to health, safety and environment."

"We not only gather incident information—including injuries, near misses and first aids—but we capture the leading indicators as well," he says. "We measure the superintendent's accomplishment of periodic inspections; we measure attendance at field safety meetings; and we measure our action plans. When we discover a trend in our incidents, we develop action plans and track those through the SMC."

In some cases, those findings have driven purchasing decisions. Due to data about hand injuries, the company committed to spend "five to 10 times as much" on better work gloves. Data on eye injuries also lead to use of "spoggles," a hybrid of safety glasses and goggles. ■

Data: Influence Factors

SAFETY MANAGEMENT IN THE CONSTRUCTION INDUSTRY DATA

Factors Driving the Adoption of Current Safety Management Practices

Respondents report a high number of factors driving the adoption of their current safety practices. At least 50% report 10 different factors, with the most influential driver being concern about worker health and well-being (79%). This factor is also of particular importance to BIM users, with 89% of BIM users reporting this driver compared with 72% of non-users.

Other top drivers stem from concerns over project cost and schedule, including insurance costs (78%), liability concerns (77%) and avoiding business disruption (65%). Higher injury rates can certainly be a cause of expensive liability payments and higher insurance rates, as well as OSHA citations and work stoppages.

For users of BIM and prefabrication/modularization, positive expectations about the impact of safety practices also are key drivers, with a significantly higher percentage reporting the following drivers:

- **Positive Return on Investment**
 - 49% of BIM users versus 30% non-users
 - 44% of prefabrication users versus 17% of non-users
- **Leadership in Overall Safety Culture**
 - 72% of BIM users versus 36% non-users
 - 58% of prefabrication users versus 23% of non-users

Expectation of achieving these positive impacts may contribute to the high level of safety investment at firms using BIM and prefabrication/modularization.

Variation by Firm Type

General contractors and specialty contractors respond similarly on what factors are most influential in driving the adoption of current safety practices, with the exception of two factors:

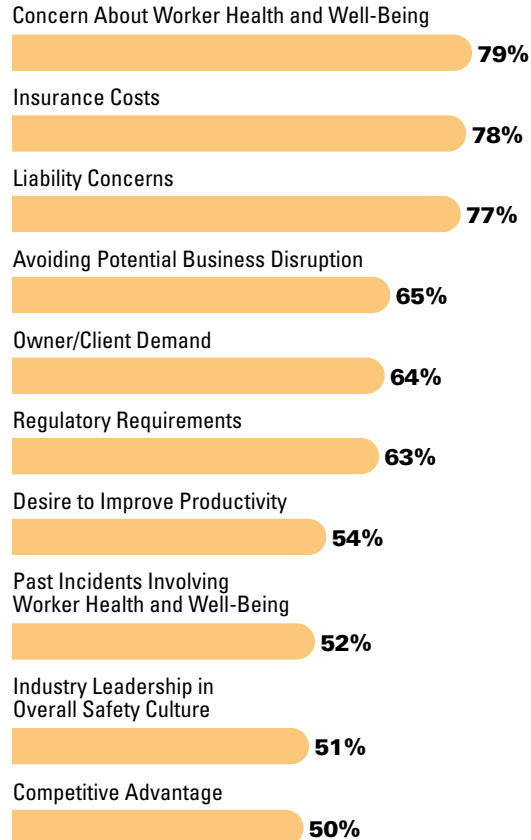
- **83% of general contractors report concern for worker well-being as highly influential compared with 73% of specialty contractors.**
- **44% of general contractors also cite evidence of a positive ROI as highly influential compared with 30% of specialty contractors.** Given the fact that a higher percentage of general contractors experience positive ROI on their safety investments than specialty contractors (see page 16), it is not surprising that this is also a bigger factor for encouraging general contractors to make safety investments.

Variation by Firm Size

A couple of significant differences are observed based on firm size. While 82% of large firms (500 or more

Factors That Influenced Firms to Adopt Safety Management Practices

Source: McGraw Hill Construction, 2013



employees) see leadership in overall safety culture as a highly influential driver of current safety practices, only 21% of small firms (1–9) think so. This result is not surprising since larger firms are more likely to be motivated by the desire to improve their reputation as leaders in industry trends.

Also, 71% of large firms report competitive advantage as highly influential versus 30% of small firms. Given the fact that small firms experience lower ROI and fewer advantages from their current safety investments (see pages 16 and 20), they are probably less likely to see safety investments as providing them with a strong competitive advantage.

Factors Encouraging Future Investment in More Extensive Safety Management Practices

Respondents report reduced insurance rates (78%) and greater client requirements (68%) as the top two factors influencing their firms to invest in more extensive safety management practices and procedures in the future.

Reduced insurance rates play a significant role in bringing project costs down, and clients that recognize the advantages of a good safety program are likely to seek contractors that actively and successfully control their risks through comprehensive safety programs.

Fifty-four percent of respondents cite availability of data on the financial impact of improving safety as a factor encouraging adoption of safety practices, demonstrating that a large share of the industry still needs to see proof of the benefits of a good safety program before they will commit additional resources.

Variation by Firm Type

No significant differences exist between general contractors and specialty contractors on reasons to improve their current safety program, with the exception of one factor, which did not make the top five factors in the chart because it was reported by less than 50% of respondents overall. **Wider adoption of risk analysis is reported by significantly more general contractors (50%) than specialty contractors (33%).** Since this finding aligns with the finding on firm size below, the reasons behind it may be more related to size than to firm type.

Variation by Firm Size

Sixty-three percent of large firms report wider adoption of risk analysis as a highly influential reason to invest in more safety management practices, compared with only 33% of small firms. Large companies can typically invest in more intensive processes like risk analysis than small firms and may also be able to devote staff to this function.

Variation by Use of BIM

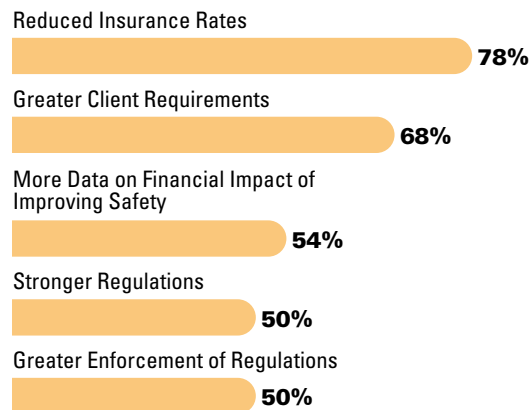
Two factors are reported by a significantly higher percentage of BIM users than non-users as being influential in their willingness to invest in their safety programs.

Greater client demand is noted by 75% of BIM users as a key driver for future investment compared with 62% of non-users. Since BIM users have already clearly invested in adopting many safety practices, they may need the added impetus of client demand to do more.

Wider adoption of risk analysis and mitigation is reported by 57% of BIM users as influential compared with 33% of non-users. BIM users may be more

Factors Encouraging Wider Adoption of Safety Management Practices in the Future (According to 50% or More of Respondents)

Source: McGraw Hill Construction, 2013



influenced by emerging trends like risk analysis than other, less forward-thinking firms, and BIM may provide better tools to determine project risks.

Variation by Use of Prefabrication/Modularization

Fifty-five percent of prefabrication/modularization users report that stronger regulations and mandates would influence them, compared with 29% of non-users. As with BIM users, the investment in safety practices by prefabrication users is already quite high, so it makes sense that many would feel compelled to add to their program only by necessity.

Fifty-nine percent of prefabrication/modularization users also would invest in safety if they had more data on its positive impacts, compared with 38% of non-users. Considering the emphasis on business benefits that leads firms to use prefabrication, according to McGraw Hill Construction's 2011 *Prefabrication and Modularization SmartMarket Report*, it is not surprising that business benefits would also encourage greater safety investments.

Factors Discouraging Investment in More Extensive Safety Management Practices

Three of the top four factors that discourage investment in safety reflect ongoing concerns that safety will have negative impacts on a firm’s business, including concerns about increased cost, lower productivity and reduced competitiveness. However, these concerns are in direct contradiction to the positive benefits reported in this study.

These findings suggest that the business case for safety still needs to be made to a substantial portion of the industry. The findings in this study clearly demonstrate that most firms see their investments in safety leading to a positive impact on project budget and schedule, as well as on their ability to compete (see page 16). More awareness on the true costs of accidents and how much they really impact the productivity and the bottom line of businesses is needed.

The other top concern is a lack of organizational commitment. As the findings about the positions within companies with the greatest influence on safety investments makes clear, the initial commitment to safety needs to be driven by company leadership and the owners of the firms (see page 26). This is an interesting contrast to the implementation of safety, which benefits from a ground-up approach (see page 13).

Close to a quarter (24%) of respondents also indicate lack of knowledge of advanced safety practices, suggesting a need for more education and training in the industry.

No significant differences are observed between general contractors and specialty contractors, firms that use BIM and those that do not or firms that use prefabrication/modularization and those that do not on any of the factors discouraging investment. This suggests that most of these concerns span the industry as a whole.

Variation by Firm Size

Thirty-eight percent of large firms report lack of organizational commitment as a factor discouraging investment in more extensive safety management practices, compared with 27% of small firms. This factor is the only significant difference by firm size, and it may suggest that influencing the leadership of large firms about safety investments may be even more necessary than in small firms to see wider adoption of practices by this group.

Factors Discouraging Investment in Safety Practices

Source: McGraw Hill Construction, 2013



Top Influential People Impacting Improvement of Safety Management Practices

Respondents report owners (37%) and company leadership (29%) as most influential in driving safety improvements at their firms. Taken together, 66% see senior leadership as the top ranked safety driver. This finding illustrates that effective implementation of safety practices and programs requires strong conviction on the part of leaders; therefore, it is critical that they are convinced of the business benefits.

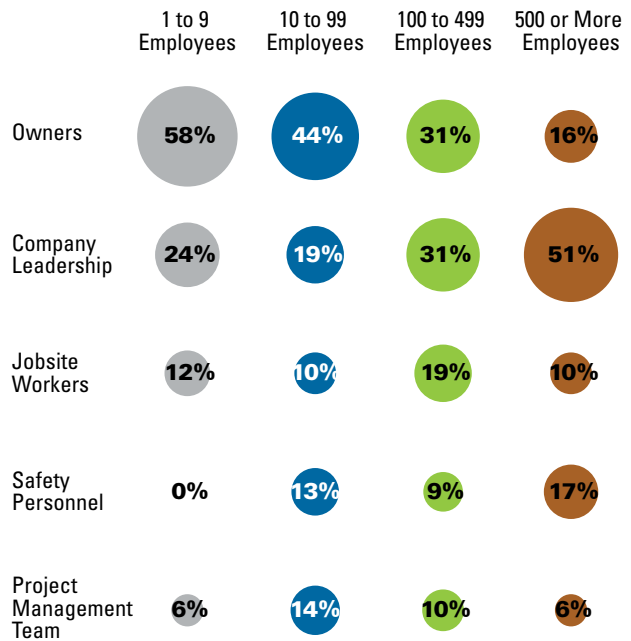
The most significant factor that determines the degree of influence that different roles in firms have on improving safety programs is the size of the firm. For large firms, company leadership is most influential, while smaller firms are more influenced by owners. Small firms may be more likely to have an owner actively guiding decisions as opposed to large firms, which are more likely to have a more significant layer of company leadership.

The impact of firm size is probably the driver for other differentials by firm type or BIM use. General contractors and firms that use BIM also are more influenced by company leadership than specialty contractors and non-BIM users, but this is probably because general contractors and BIM-using firms tend to be larger.

For the largest firms, those with 500 or more employees, safety personnel are also critical, ranking second at 17%, even higher than owners. Large firms may have senior positions devoted to safety, giving them a larger voice.

Most Influential Position Within Company for Improving Safety (By Firm Size)

Source: McGraw Hill Construction, 2013



Interview: Thought Leader



Charles A. Bacon, III
Chairman & CEO, Limbach Facility Services

Charlie Bacon is a founding member of the Incident and Injury-Free CEO's Forum and has been recognized for his leadership and commitment to improving the industry's safety performance, including being named as one of ENR's Top 25 Newsmakers of 2013.

Injury claims at Limbach have been substantially down for the past eight years. How were you able to achieve this?

BACON: Prior to joining Limbach, while I was on the executive team for safety at Bovis, we launched a program called Incident and Injury Free (IIF) after we experienced six fatalities around the world. The program was incredibly successful. When I joined Limbach as CEO in 2004, we had a fatality here two weeks before I arrived. The experience made me realize, as we had done at Bovis, that a whole different approach had to be taken on how to get the mind-set of working safely and not have any accidents. So I made the decision to employ the IIF approach at Limbach. Since then we have dramatically changed our profile, and we are one of the safest contractors in the U.S. today. I'm not only proud of what we've done at Limbach, but I'm also very proud of the IIF program.

Could you briefly describe the main aspects of the Incident and Injury Free (IIF) approach to safety and how it differs from others? How does it benefit the industry?

BACON: The big emphasis in IIF is on the behavioral part. It is not a carrot-and-stick approach, but is more about reinforcement of the behavior you want out of the individual. IIF really stresses the importance of personal ownership. The program involves bringing the tradesmen in

and doing a detailed orientation. But one of the biggest differences, and one of the most powerful aspects of the program, involves them writing a letter to their family, which is presented to them after they have died due to an injury on the job. This emotional experience really hits home.

In addition, the program conducts detailed training of foremen, also called supervisory training. It emphasizes giving positive reinforcement when somebody does something well in contrast to yelling at them for doing something wrong. Overall, the program drums into each employee to care about what they're doing, to care about the others that they work with and to care about the company they work for. Essentially it is about creating a real culture of safety.

How were you able to implement the IIF program? What are the critical steps that need to be taken if other firms want to adopt the IIF approach to safety?

BACON: First, you need to consider what other things are going on at your firm, other strategic initiatives you may have. Then if you choose to do this, this has to be led by the CEO, not by anybody else. If it isn't led by the CEO, it won't work because this is cultural. I believe the only way you can change a culture within a business is when it is driven and driven hard by the CEO.

Second, you will need to bring in a consultant. When I want to do some work on some matter that's really

outside of our tree of knowledge, I do look to bring in the best and the brightest I can find on particular subjects to help us move it along. I think with this, because it's more psychological in getting people to think differently about safety, you can't really do that internally at the start. I really think the CEO needs to have an external coach to help them through the journey of change management.

The training and development starts with the executive team, and then you continue to cascade that down through the organization to the tradesmen where they are involved in a day- or two-day long orientation. So it's a huge investment of time and money because you're tying people up.

What other ways has a robust safety program impacted your business?

BACON: With safety becoming a part of the culture at Limbach, we've seen the quality of our workmanship go up, our productivity has improved, and rework is now almost nonexistent. We have not seen any sort of general liability claim in several years.

Our margins have also improved dramatically. Most things are driven by economics, and people really do kind of get around numbers because we are in business. It's terrible to bring up safety in numbers, but the fact of the matter is, if you work safely, you will make more money. ■

Data: Communication and Education

Impact of Safety Training and Orientation on Construction Firm Employees

SAFETY MANAGEMENT IN THE CONSTRUCTION INDUSTRY DATA

Safety training and orientation has a major impact on safety management procedures for key personnel on construction projects.

This training is especially powerful for those most directly involved in day-to-day construction activities. Respondents reported that the training was considered influential for the vast majority of foreman/supervisors (85%) and jobsite workers (81%). Among these two groups, the training was deemed highly influential by 64% for foreman/supervisors and 61% for jobsite workers, demonstrating the strong value recognized across the industry for applying appropriate training. This supports the previous finding that a world-class safety program works from the ground up.

The impact of this training is also substantial for the project management team (77%) and company leadership (63%). Again, this demonstrates that, in addition to encouraging a safety mind-set on the ground, engaging the leadership in the importance of safety practices is also important.

While the percentage that consider safety training and orientation for estimators is much lower than the rest (31%), it is still notable given the limited role an estimator can play in implementing safety practices. Given the increasing importance of introducing a safety mind-set in preconstruction, it may be interesting to see if the impact of training and orientation for estimators grows over time.

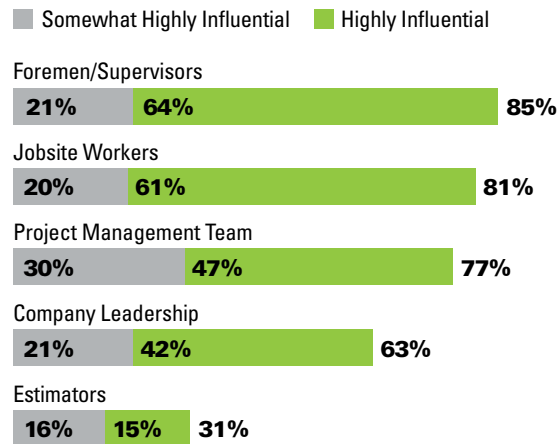
There were no significant differences when reporting by firm size, considering either the smallest firms (1–9 employees) or the largest firms (over 500 employees). These trends were also consistent across different types of firms, with no statistically significant difference between general contractor or specialty contractor firms, and between BIM users and non-users.

Variation by Use of Prefabrication/Modularization

Eighty-nine percent of firms employing prefabrication or modularization find that safety training and orientation is quite influential for foremen and supervisors, compared with 71% of non-users. The percentage that report this influence also increases slightly as the percentage of their projects that include prefabrication or modularization increases. This may be due to the important role that foremen and supervisors play in the safe installation of prefabricated building elements or modular building components.

Influence of Safety Training By Role at Contracting Firm

Source: McGraw Hill Construction, 2013



Entities That Conduct Safety Training for Jobsite Workers

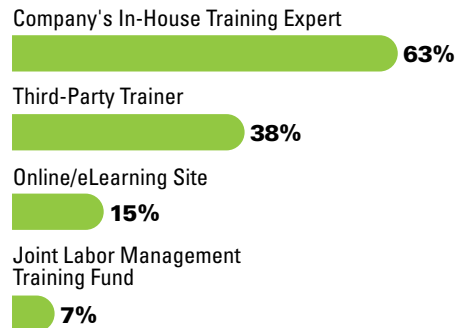
Firm size is a significant factor in the choice of how safety training is conducted by firms. A significantly higher number of large firms (90%) opt to use training capabilities developed in-house compared to only 30% of small firms. A higher percentage of firms using BIM also report using in-house training, which may be a reflection of the tendency of BIM users to be larger firms.

In addition, 47% of small- to medium-size firms with 50 to 99 employees report using a third-party trainer, compared with 25% of larger firms. A third-party trainer allows firms to avoid expensive specialization of staff and also helps to make sure that training covers the latest safety practices. Large firms can invest cost-effectively in training by devoting staff to this function, while for most small firms, it is probably less expensive to outsource training.

Twenty percent of firms using BIM do online training compared with 10% of non-users. BIM users are more likely to be comfortable in an electronic format, which may contribute to this difference.

Entities That Conduct Safety Training for Jobsite Workers

Source: McGraw Hill Construction, 2013



General contractors and specialty contractors share the same preferences on who conducts safety training and orientation for jobsite workers, as do firms using prefabrication/modularization and firms that don't.

Safety Training Conducted Online

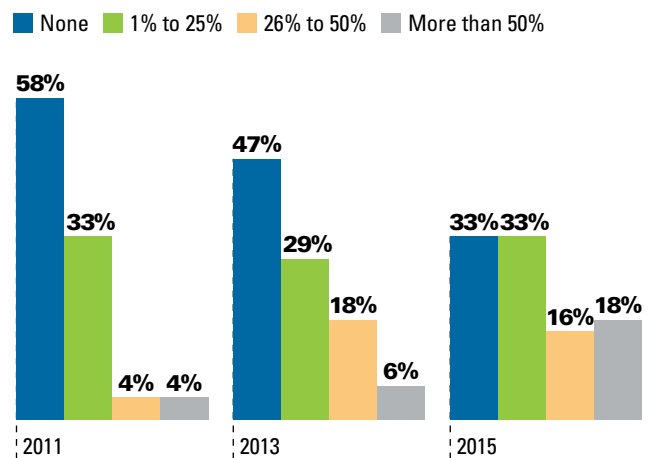
Online safety training is gaining acceptance in the construction industry. In 2011, less than half the contractors surveyed were using online training, but by 2015, two thirds expect to do some of their safety training online. However, the transition is gradual, with most firms using online for less than half of their overall safety training.

Not surprisingly, tech-savvy firms using BIM are adopting online training much quicker. Sixty-four percent were already using online training by 2011, and 83% expect to be using it by 2015. Also large firms employ online training more than smaller ones, with adoption by the smallest firms going from 36% in 2011 to 55% in 2015, but adoption by the largest firms advancing from 71% in 2011 to 92% by 2015.

Online training offers firms the opportunity to provide safety training more broadly and more regularly to their employees with less disruption. With the increased use of mobile tools (see page 43), it also allows firms to bring safety training directly to the jobsite.

Percentage of Safety Training/Orientation Conducted Online (Past, Current and Future)

Source: McGraw Hill Construction, 2013



Requiring OSHA 10 and OSHA 30 Training

OSHA 30 training for supervisors and foremen is more prevalent than OSHA 10 training for all jobsite workers. Respondents report that over two thirds of all firms (70%) require OSHA 30, while 53% require OSHA 10.

The size of the firm is directly correlated to requiring OSHA 30 training, with the largest firms being most likely to require OSHA 30 (86%), and the smallest firms least likely (42%). This finding suggests that since the largest firms typically incur more risk and liability than smaller firms, they are more likely to make investments in basic OSHA 30 and OSHA 10 training as critical elements of their business strategy. Moreover, larger firms simply may have more funds to invest than their smaller counterparts.

Though a higher percentage of general contractors require OSHA 30 and OSHA 10 training than specialty contractors, the differences are not statistically significant. As with the large firm versus small firm discussion above, general contractors may have more funds to invest than do specialty contractors.

Variation by Use of BIM

Sixty-one percent of firms that use BIM require OSHA 10 training, and 82% require OSHA 30 training, compared with non-users at 47% and 60%, respectively. This may be correlated to the fact that firms using BIM tend to be larger than non-users, but it also corresponds to the general trend evident throughout the data of BIM firms demonstrating a more comprehensive approach to safety than non-BIM firms.

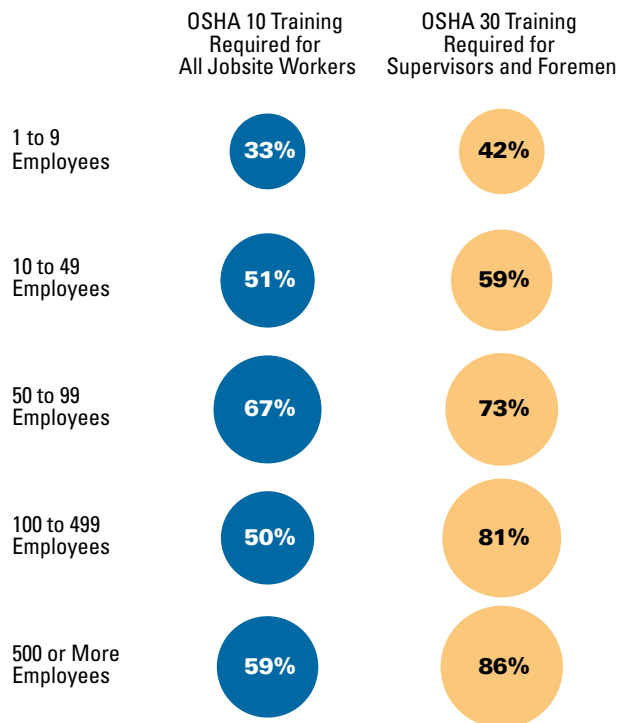
Variation by Use of Prefabrication/ Modularization

A higher percentage of firms using prefabrication or modularization on their projects also require OSHA 10 and OSHA 30 training. Fifty-eight percent of prefabrication/modularization users require OSHA 10, compared with 33% of non-users, and 74% require OSHA 30, compared with 50% of non-users. In addition, as the share of projects involving prefabrication or modularization increases, so does the percentage of firms that require OSHA 30 training.

This difference is also typical of a larger commitment to safety practices demonstrated by firms using prefabrication or modularization. The steady increase in OSHA 30 training also corresponds to the greater emphasis of firms doing prefabrication/modularization on training for their project foremen and supervisors (see page 32).

OSHA 10 and OSHA 30 Training Requirements (by Size of Firm)

Source: McGraw Hill Construction, 2013



Types of Safety Training and Orientation for Jobsite Workers

Level of Use of Training/Orientation

While different training modes are widely used by most firms, there are also notable differences.

- 95% of respondents use on-the-job training.
- 89% use classroom training.
- 86% use authorized jobsite workers.
- 76% use online learning.

Though there are lower levels of use for online safety training programs by construction firms compared to other types of training, it is still widely used by respondents. Its use is likely to increase in the future, particularly given that it is a relatively inexpensive alternative to traditional learning methods.

These trends are the same when examined by type of firm. Specialty firms are slightly more likely to use authorized jobsite workers than general contractors, but the differences are not significant.

Value of Training/Orientation

While different types of safety training and orientation are offered to jobsite workers, on-the-job training is considered to have the greatest value (82%).

This preference for on-the-job training is consistent across all firms, regardless of size or type. This may allow the most direct way to address specific hazards. In addition, since on-the-job training uses the specific tools, equipment and materials of the jobsite, it is often less expensive than other forms of training conducted away from the normal workplace.

Classroom and authorized jobsite workers are equally valued (52%), while online learning is considered to have great value by just 26%.

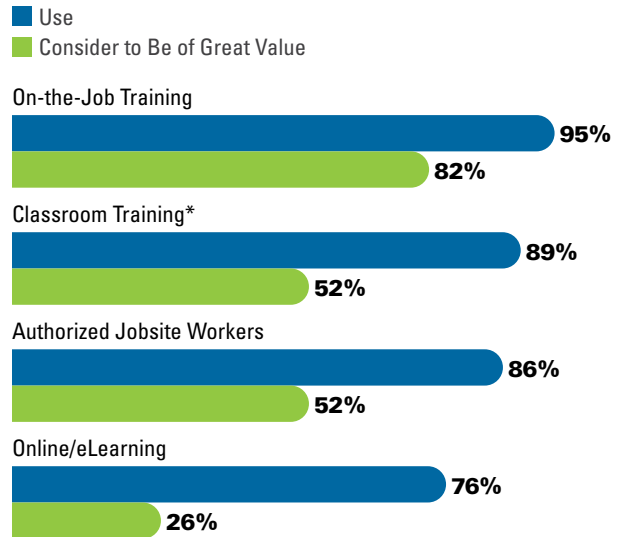
Variation by Firm Size

Classroom training is also the only mode of training with a statistically significant difference in use and value between very large and very small firms.

- **Very Large Firms (500 or more Employees)**
 - Used by 98%
 - Considered Highly Valuable by 69%
- **Very Small Firms (Less than 10 Employees)**
 - Used by 76%
 - Considered Highly Valuable by 27%

Level of Use and Value of Modes of Training for Jobsite Workers

Source: McGraw Hill Construction, 2013



*Note the Distribution by Firm Size per Analysis at Left

Smaller firms are much more likely to outsource training. Therefore, they may have much higher expectations of what is required to justify their investment, which could explain why they are far less likely to consider this training valuable.

Variation by Use of BIM

Sixty-four percent of firms that use BIM consider authorized site worker training to be of great value, compared with 43% of non-users. BIM offers the opportunity to conduct better training onsite (see page 42 for firms using this practice) and therefore helps to enable authorized site work training.

Types of Safety Training and Orientation for Foremen and Supervisors

As with jobsite workers, on-the-job training is reported to have the greatest value to foremen (82%) among training modes. This is consistent across firms of all sizes, and it is consistent for general and specialty contractors alike. This finding aligns with other findings throughout the study that demonstrate that firms place more emphasis on site specific grounded safety practices.

Classroom training is accorded high value by 55% of respondents and is especially favored by large firms that can make the investments for offsite training. While this may appear in contrast to the emphasis on internal training capabilities for larger firms, offsite classroom training may in fact still be conducted by internal staff. This training is favored by 75% of firms with more than 500 employees and 62% of firms with between 100–499 employees.

Online training is considered a great value by only 26% of respondents and is not used at all by 24% of respondents. The smallest firms (1–9 employees) value online training the highest (36%), though differences with larger firms are not statistically significant.

Variation by Firm Type

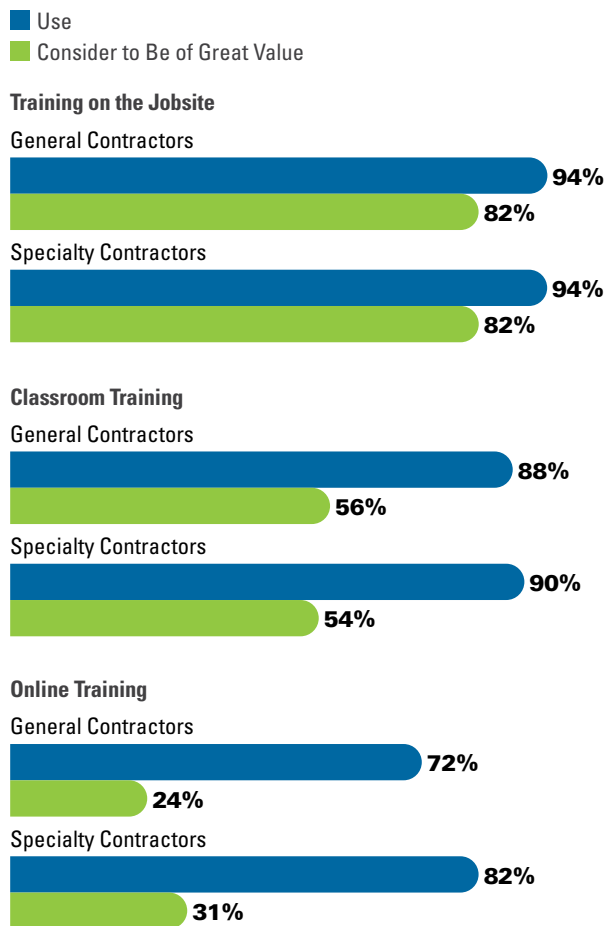
General contractors and specialty contractors share the same preferences for training mode, with 82% of respondents believing on-the-job training to be of great value. The only significant differences between the two types of firms is that specialty contractors are more likely than general contractors to feel that there is no value in classroom training (9% versus 3%). The slightly higher reticence of specialty contractors to use classroom training may reflect a desire to keep costs low and primarily focus on on-the-job training with minimal capital investments.

Variation by Use of BIM

While a greater percentage of firms that do not use BIM consider classroom training to be moderately valuable (24%) than those that do (21%), that differential is far less than the greater percentage of firms using BIM that consider classroom training to be of great value (69%) versus non-users (44%). These firms may deal with more technology issues, making classroom training more valuable.

Level of Use and Value of Modes of Training for Foremen and Supervisors (By Type of Firm)

Source: McGraw Hill Construction, 2013



Variation by Use of Prefabrication/Modularization

Eighty-five percent of firms using prefabrication or modularization consider on-the-job training for foremen and supervisors valuable, compared with 71% of non-users. Onsite training may help foremen and supervisors better deal with any hazards created by the assembly of prefabricated components or modular buildings.

Importance of Safety Training for Jobsite Workers

Site orientation (78%) and supervisor training (77%) are considered to be of greatest value for jobsite workers. OSHA 10-hour training (63%) and OSHA 30-hour training (44%) are also perceived to be of great value, although to a lesser extent. While respondents feel that OSHA 10-hour training is of greater value than OSHA 30-hour training, as noted above, more firms require OSHA 30 for their supervisors than OSHA 10 for all jobsite workers (70% versus 53%). (See page 30.) This may be due to the expectation that supervisors can most directly impact jobsite safety.

Most firms consider all of these four types of training to be valuable. The smallest firms of 1 to 9 employees, however, are most likely to place no value on these training alternatives, ranging from 6% to 15%. Presumably, these firms are most likely to grapple with cost considerations when offering such training to their few employees.

Firm type is not correlated with the value placed on different training programs to jobsite workers.

Variation by Use of BIM

Eighty-six percent of firms using BIM consider site orientation to be of great value for jobsite workers, compared with 71% of non-users. Even though the differential is largely found in a higher percentage of those who consider site orientation of moderate value, overall, it is clear that firms doing BIM put great value on site orientation. BIM projects are often complex, and site orientation may be critical to help minimize hazards.

In addition, 73% of BIM users consider OSHA 10 training to be of great value, compared with 54% of non-users. This suggests the importance placed on training jobsite workers at BIM firms since OSHA 10 is typically provided to jobsite workers.

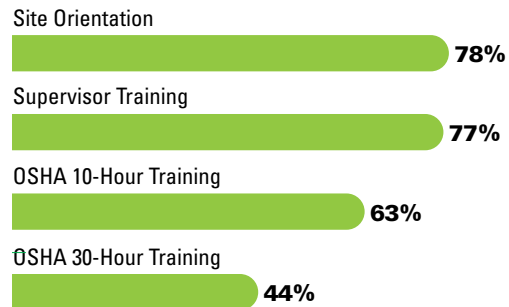
Variation by Use of Prefabrication/Modularization

Firms using prefabrication or modularization place great value on OSHA training in general, with 68% that consider OSHA 10 and 48% that consider OSHA 30 to be of great value, compared with 42% and 27% of non-users, respectively. The greater emphasis placed on OSHA 30 corresponds to other findings that demonstrate that firms doing prefabrication or modularization place a particular emphasis on training for foremen and supervisors, no doubt due to the challenges of assembling prefabricated components or modular buildings onsite.

Value of Types of Safety Training for Jobsite Workers

(By Percentage Who Consider It to Be of Great Value)

Source: McGraw Hill Construction, 2013



Value of Safety Training for Senior Management

Creating a culture of safety is a very high priority in the training provided to senior management. Safety culture effects on performance (67%) and safety leadership training (60%) are seen as having the highest value. Safety professional training (42%) is also seen as having great value, albeit to a lesser extent. These trends were consistent across all sizes of firms.

General contractors felt that safety culture effects on performance have a greater value than do specialty contractors (73% versus 58%). This corresponds to many previous findings about the higher adoption rate of safety practices, as well as the higher reported performance impacts by general contractors. (See pages 8 and 17.) General contractors typically have project lead responsibilities, including safety concerns, to a greater degree than specialty contractors, which could impact their emphasis on how safety impacts performance. In all other cases, there were no significant differences by firm type.

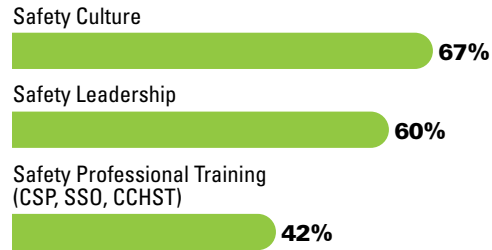
Variation by Use of BIM

Eighty percent of firms using BIM place great value on training for senior management on safety culture's effects on performance, compared with 58% of firms not using BIM. The high level of practice adoption and integration of a safety program by BIM firms demonstrates their commitment to a safety culture, and therefore, it is not surprising to find that they value training that demonstrates the effectiveness of this approach to their senior leadership.

Value of Types of Safety Training for Senior Management

(By Percentage Who Consider It to Be of Great Value)

Source: McGraw Hill Construction, 2013



Frequency of Formal Safety Training for Jobsite Workers

The largest firms offer formal safety training to their jobsite workers more frequently than smaller firms. The largest firms typically assume greater risk and liability than smaller firms and thus have a significant interest in repeatedly emphasizing safety issues to their workers. As with some of the other issues discussed in other sections of the report, it may also be a budget issue, with larger firms able to devote greater resources to training and other non-project specific tasks.

The difference in the frequency of safety training as a factor of firm size is striking.

- Slightly more than half (51%) of the largest firms report holding safety training once a quarter or more.
- By contrast, only 18% of the smallest firms (1-9 employees) offer training that frequently.

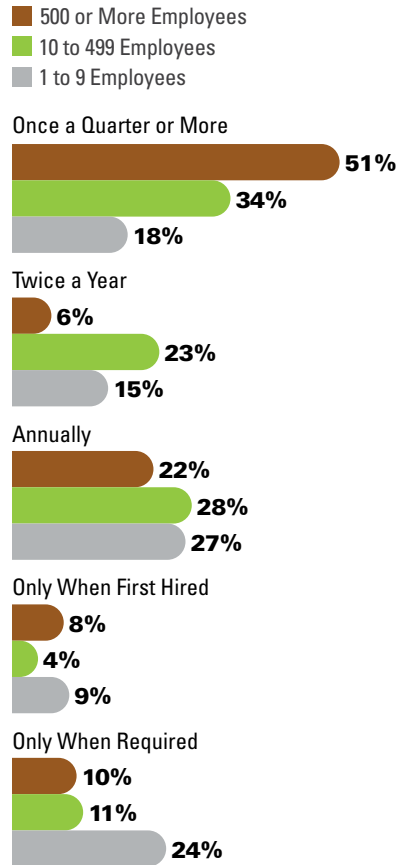
A significantly higher percentage of firms using BIM also offer training once a quarter or more, compared with non-users, which is likely due to BIM firms typically being larger than non-BIM firms.

Slightly over a quarter of firms offer training annually (26%). This pattern holds true for all sizes of firms. Yet, many of the smallest firms hold training only when they are required by specific site demands (24%). Larger firms are less likely to offer their safety training as a function of specific site need.

The frequency of formal safety training is not correlated to firm type. There are no significant differences between general contractors and specialty contractors.

Frequency of Formal Safety Training for Jobsite Workers

Source: McGraw Hill Construction, 2013



Safety Training in the Construction Industry

In concert with industry-wide efforts to improve safety statistics on jobsites, many construction firms aim not only to train workers on how to avoid unsafe practices, but also to instill in them why they should avoid those practices in the first place.

In recent years, behavioral training has emerged as a critical piece of many safety programs. Beyond offering required training and voluntary programs, such as OSHA's 10-hour and 30-hour courses, safety professionals are digging deeper into the problem to focus on changing the culture of safety.

Making Workers Act as Safety Observers

Safety enforcement has traditionally fallen on one or more individuals on a construction site, often viewed by workers as the "safety police." David Stueckler, president and CEO of Linbeck, says his company hopes to eliminate that stereotype by pulling more people into the process. Stueckler says behavior-based training is the centerpiece of Linbeck's safety program, engaging workers and management at every level.

Linbeck seeks to have everyone on a jobsite act as a safety observer. During orientation process, every worker is taught how to conduct a safety observation and report the findings. Workers are expected to regularly report safety observations—good and bad—of their peers.

The initiative serves a dual purpose. In addition to getting more eyes focused on safety, it prompts workers to think about safe behaviors, internalize those lessons and recognize their own behaviors.

As part of the program, a steering committee consisting of both Linbeck project managers and trade

contractors is established at each jobsite to oversee safety observations. "It builds a culture that recognizes that we're all in this together," Stueckler says.

Through the program, the company is able to better monitor its safety performance. In addition to analyzing worker behavior, Linbeck also tracks the level of participation in the program to see if additional training is required to engage more workers in the process.

Stueckler credits behavioral training for helping the company achieve an exemplary safety record. In January 2013, the company reached 1 million man-hours without an accident during an 18-month stretch. Despite its safety results, Stueckler says consistent training is key to changing culture on a grand scale.

"Changing culture is tough," he says. "We are constantly training. When we're on a job, we get new subs who haven't been exposed to the program or subs we've worked with who have new employees. So you always have to stay on top of it."

Although training workers in the field is a central component of changing safety culture, contractors remain focused on behavioral training at all levels. Balfour Beatty Construction created a leadership training program through Duke University to ensure its safety message is received by executives and senior staff.

Engaging the Trades

Casey Halsey, executive vice

president and chief risk officer at JE Dunn, agrees that all-inclusive behavioral training is critical to achieving good safety results. "For a long time, contractors just looked at their own people, but you can't do that and expect change," he says. "We have to look at the subcontractors and get them involved."

As part of that process, JE Dunn instituted an inventive program that rewards its employees and subcontractors for being "proactive about safety." Rather than basing incentives on lagging indicators, workers are recognized for identifying near misses, attending training sessions, contributing safety ideas or simply attending meetings regularly. Halsey notes that the program focuses on rewarding behaviors that lead to safe sites, rather than just the results.

Combining Safety With Other Initiatives

Turner Construction held a nationwide "Safety Stand-Down" at its sites on September 4, 2012, for the presentation "Lean and Safe: Material Management for a Safer Work Environment." Among the messages of the program is reduction of waste on jobsite, which reduces safety hazards. The message fits with Turner's "Nothing Hits the Ground," which encourages use of rolling carts, racks, dollies and pallet jacks in order to reduce the risk of strains, sprains and repetitive motion injuries associated with material handling. ■

Most Effective Means of Communicating About Safety With Employees

The top two most effective means of communicating about safety to employees, selected by a far larger percentage than any other choices, are **toolbox talks (brief safety meetings onsite at the beginning of the day or shift) and training**. Clearly, direct forms of communication are considered far more effective than indirect means like emails and notes with paychecks. Direct contact reinforces the importance of safety communication and allows workers to ask questions and avoid misinformation.

Variation by Firm Type

Although there is no statistically significant difference between the percentage that select these options between general and specialty contractors, toolbox talks rank first in the selection by general contractors, and training ranks first in the selection by specialty contractors. This implies that there is a slightly greater emphasis on communication on the site among workers for the general contractors, while the specialty contractors find that specific training is more important.

Variation by Use of Prefabrication/Modularization

A similar pattern can be found among firms that do prefabrication or modularization. While again there are no statistically significant differences, the top choice for firms doing no prefabrication/modularization or that do prefabrication/modularization on 25% or fewer of their projects is toolbox talks. On the other hand, the highest percentage of firms doing prefabrication/modularization on more than 25% of their projects select training as the most effective means. For firms doing a significant percentage of prefabrication or modularization, making sure workers are properly trained to assemble prefabricated components or modular buildings onsite may be as or more critical to their impact on safety than more general safety communications.

Most Effective Means of Communicating About Safety With Employees

Source: McGraw Hill Construction, 2013



Top Sources of Health and Safety Information

The top source of health and safety information reported by respondents varies strongly by size of firm.

- **Largest Firms (500 or more employees):** Rely most on their peers, followed closely by information online
- **Large Firms (100 to 499 employees):** Nearly evenly divided between online sources, regulatory agencies and associations, training, trade or professional associations and peers as their top sources of health and safety information, with only a five-point differential among them
- **Medium-Size Firms (10 to 99 employees):** Largely favor online and trade or professional associations as the top sources of information.
- **Small Firms (Less than 10 employees):** Have the largest percentage of all the groups seeking their information from online sources, with regulatory agencies and associations also important to a significant percentage.

Firm size directly impacts the access to many of these resources. For example, workers at very large firms have a wide range of peers from whom to get information, and those at large firms may find that they have more access to training and trade associations than those at firms with less than 10 employees.

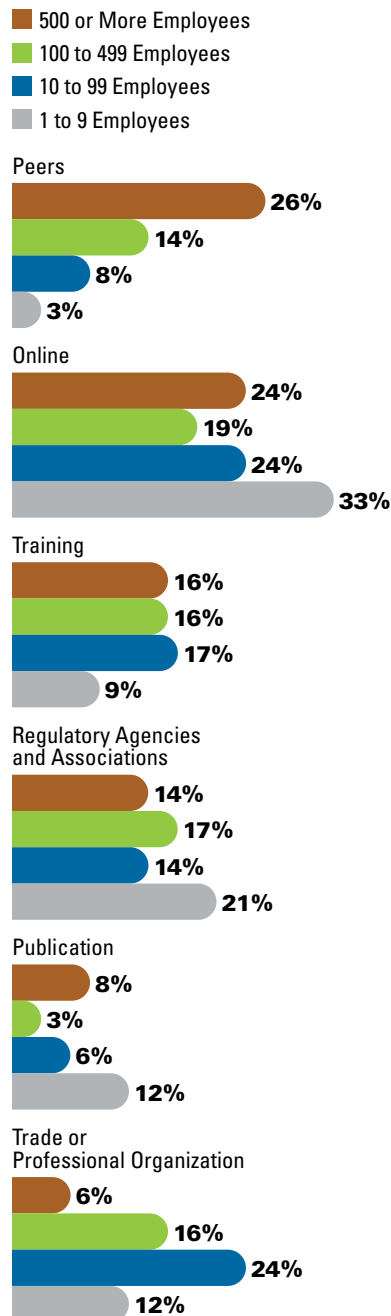
Variation by Firm Type

There are no statistically significant differences between the percentage of respondents at general and specialty contractors that select any one item, but there are some notable gaps in the percentage selecting a top choice. Twenty-eight percent of general contractors find online information to be their top choice, 10 percentage points more than specialty firms and 11 percentage points more than the next most popular choice for general contractors, which is a trade or professional association at 17%.

On the other hand, specialty contractors align closely with the distribution of large firms with 100 to 499 employees, with only a 3 percentage point spread between the top four choices: training (20%), online (18%), regulatory agencies and associations (18%) and trade or professional associations (17%). This finding is surprising since specialty contractors tend to be smaller than general contractors. The greater emphasis on a variety of sources may reflect their need to focus more intensively on the safety factors that impact their specific trade.

Top Sources of Health and Safety Information (By Size of Firm)

Source: McGraw Hill Construction, 2013



Data: Technology and Safety Management

Impact of Building Information Modeling (BIM) on Site Safety

Use of BIM by Respondents

Forty-three percent of the survey respondents report using BIM on at least some of their projects, either working from models created by others or authoring models themselves. Although there are no statistically significant differences in the percentage using BIM between general and specialty contractors, there is a notable trend for general contractors to have slightly higher levels of adoption.

- 48% of general contractors use BIM, compared with 36% of specialty contractors.
- 73% of general contractors using BIM are using it to author models, compared with 65% of specialty contractors.

Firms doing prefabrication/modularization report higher levels of BIM use than firms that do not.

- 25% of those not doing any prefabrication/modularization on their projects use BIM.
- 45% of those using prefabrication/modularization on half of their projects or less use BIM.
- 57% of those using prefabrication/modularization on more than half of their projects use BIM.

This result corresponds to the way in which BIM models can enable the use of prefabrication and modularization on projects.

Impact of BIM on Safety

A large percentage (43%) of the firms that use BIM report that BIM use has a positive impact on site safety, with almost no respondents reporting negative impacts.

There is no significant difference between the findings of general and specialty contractors, nor is there a significant difference based on firm size.

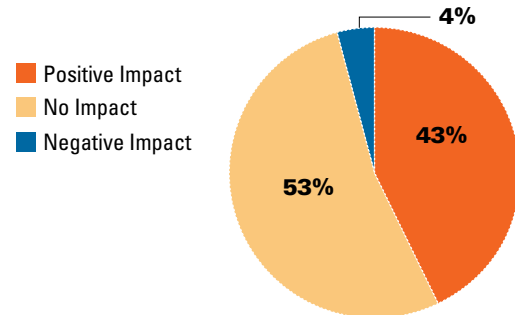
Many of the benefits of BIM have a direct impact on safety, including clash detection, detecting jobsite hazards in preconstruction, more effective scheduling of work on the jobsite and use of prefabrication.

For more information on how BIM use can impact safety, see page 42.

Impact of BIM on Site Safety

(According to Respondents Who Use BIM)

Source: McGraw Hill Construction, 2013



VARIATION BY USE OF PREFABRICATION/MODULARIZATION

Forty-six percent of firms using prefabrication/modularization on their projects report that BIM improves site safety, compared to 25% of firms that do not use these methods. This finding is not surprising since BIM enables the use of prefabrication and modularization, and there is strong evidence of the ways in which use of these approaches improves safety. (See page 47 for more information on the impact of prefabrication and modularization on safety.) This finding does demonstrate, though, a strong link that supports the conclusion that one way that BIM can help enable safety on projects is by making it easier to employ prefabrication and modularization.

Top BIM Functions for Improving Safety

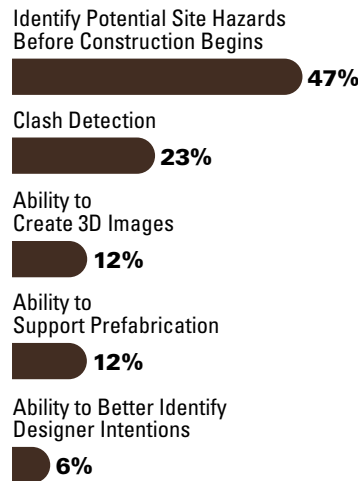
Among the BIM users who believe that use of BIM improves safety, nearly half (47%) find that the identification of potential site hazards before construction begins is the most effective BIM function for improving safety. This result corresponds to findings that demonstrate that safety practices directly related to the jobsite are the most highly valued by contractors in general.

Another important BIM function for improving safety according to contractors is the use of BIM for clash detection. Finding clashes in advance rather than onsite prevents potentially dangerous situations with workers from different trades seeking to do work in one area from arising.

The use of 3D images and prefabrication are also noted by some respondents as the most important choices, but only a few consider understanding the designer's intent a critical way to promote safety.

Top BIM Function for Improving Safety

Source: McGraw Hill Construction, 2013



Use of Building Information Modeling (BIM) in Construction

When McGraw Hill Construction began doing research on BIM in 2007, it was still an emerging trend, with industry-wide adoption at 28%. In *The Business Value of BIM in North America: Multi-Year Trend Analysis and User Ratings (2007–2012) SmartMarket Report*, MHC found that 71% of architects, engineers, contractors and owners are now using BIM on at least some of their projects.

One of the key findings in the latest study is that contractors are now leading all firm types in the adoption of BIM, demonstrating its value to improving the construction process.

The safety study now reveals that use of BIM is linked with strong safety practices. BIM may be influential in encouraging safety because many of its functions have a direct and positive impact on project safety.

Model-driven prefabrication is one example of a BIM-enabled process that has strong safety implications. *The Prefabrication and Modularization SmartMarket Report* in 2011 noted that over one third of contractors using prefabrication find that it increases project safety.

According to the 2012 *BIM SmartMarket Report*, model-driven prefabrication is most commonly used for mechanical, plumbing and fire-suppression systems. Not having to assemble complicated mechanical systems onsite, often in awkward locations involving height or limited space, reduces the risk of constructing these systems.

In addition, the 2012 *BIM SmartMarket Report* reveals that constructability analysis is widely used by contractors that employ BIM. This can be

used to determine hazards in advance and take appropriate action to mitigate them. Another widely employed tool that is also perceived by contractors to be a highly valuable part of the preconstruction process is spatial coordination, which can also be used to identify hazards and determine mitigation strategies.

4D models, which link 3D models to a project schedule, are recognized as valuable by the industry, but they are still also perceived as difficult to implement, which has limited their use thus far. As tools improve, being better able to manage the number of workers onsite through tools like these will also make jobsites safer. See page 42 for more information on this and other emerging BIM tools that will impact safety.

Stages in BIM Process at Which Safety Personnel Get Involved

The top two stages in the BIM process at which safety personnel get involved according to the respondents are just prior to construction start and throughout the construction process. Safety is primarily the purview of contractors, and while there is a clear trend for earlier contractor involvement on projects, the majority of projects still involve engaging the contractor just prior to construction.

However, it is notable that 26% of general contractors do report involvement of safety personnel at design inception, a significantly higher percentage than the 8% of specialty contractors that report the same. In addition, while the differences are not statistically significant, a higher percentage of general contractors consistently report safety personnel involvement after structural members are designed (22%, compared with 11% of specialty contractors) and after mechanical systems are designed (14% compared with 8%). This does reflect the shift occurring in the industry to include contractors in project design. As this shift occurs, it will be increasingly important for safety personnel to get involved since the earlier safety measures are considered, the more effective they can be.

For over 20% of the contractors using BIM, safety personnel never get involved in the BIM process. This suggests that more education is needed in the industry to recognize fully BIM's potential to contribute to site safety.

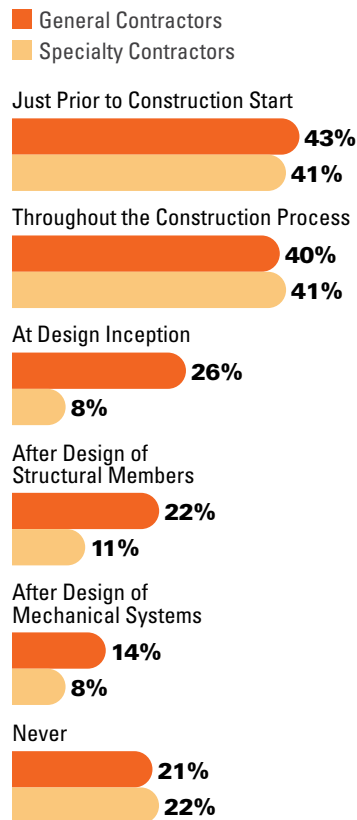
Variation by Use of Prefabrication/Modularization

As with the general contractors, firms using prefabrication/modularization are more likely to engage safety personnel in the design stages than firms that do not use these systems.

- **At Design Inception**
 - Firms Using Prefabrication/Modularization: 22%
 - Firms Not Using Prefabrication/Modularization: 8%
- **After Structural Members Are Designed**
 - Firms Using Prefabrication/Modularization: 20%
 - Firms Not Using Prefabrication/Modularization: 8%
- **After Mechanical Systems Are Designed**
 - Firms Using Prefabrication/Modularization: 13%
 - Firms Not Using Prefabrication/Modularization: 8%

Stage in the BIM Process at Which Construction Safety Professionals Get Involved

Source: McGraw Hill Construction, 2013



While there are a higher percentage of general contractors doing prefabrication or modularization than subcontractors, the differential is not significant enough to account for this trend. Typically, contractors doing prefabrication/modularization are engaged earlier in design since the time involved to create prefabricated components or modular buildings must be factored into the project schedule. Therefore, it is not surprising that their safety personnel are engaged earlier in the process as well.

Emerging Ways to Use BIM to Enhance Safety

Numerous architectural, engineering and contractor firms, academics and organizations around the world are exploring innovative ways of leveraging 4D BIM to visualize construction sequences and processes at a high level of detail with the goal of improving construction safety.

McGraw Hill Construction now reports that BIM adoption in North America is at 71%.

Wide adoption has encouraged innovative BIM tools and approaches that have strong implications for improving construction safety.

3-D Visualization and Analysis

In "Enhancing Safety throughout Construction using BIM/VDC," Carla Lopez del Puerto and Caroline M. Clevenger at Colorado State University state that "3-D visualization and analyses are situated to play a critical role in enhancing construction site safety." They describe how building simulations throughout the construction process help firms identify potential safety and health hazards. They explain, "For example, temporary scaffolding systems can be modeled to avoid clashes.... If the hazards are identified during the design phase, elimination and substitution of hazards may be inexpensive and simple to implement."

Integrating Safety Into Project Design

Jeremiah Bowles, the National BIM Manager for the engineering firm Black and Veatch, is passionate about the power of BIM to enhance safety. His approach focuses on integrating construction safety elements such as fall protection, lift/crane access, temporary access (ladders scaffolding), confined space access and

temporary/movable structures planning (forms, bracing, benching) into the initial design. Then he builds the project virtually in BIM creating simulations such as hoisting and rigging or scaffold logistics to test the effectiveness before going to the field.

Bowles feels that "safety is no accident. Using BIM to find synergy between productivity and safety is essential and can be improved through virtual job hazard analysis, simulation and maintenance safety reviews."

Innovative Safety Training Using BIM

Balfour Beatty, a global contractor, has a unique safety program called "BIM for Zero Harm." In an interesting twist on conventional safety training, they use BIM to show subcontractors what the wrong way to do things looks like and the consequences of doing things the wrong way.

"Learning how to do something safely gives you only one side of the story," explains technology specialist Chris Manzione. "BIM models allow us to take safety training a step further. We can compare safe and unsafe practices side-by-side, which gives trainees a better understanding of the activities—without exposing them to danger on a real site."

4-D BIM

At Georgia Tech, professors Jochen Teizer and Chuck Eastman are developing rule-checking software that

applies OSHA requirements to 4-D BIM models to identify temporary conditions such as stairs without railings and pour breaks in slabs.

Eastman says, "We catch slab edges without wall barriers, openings in walls that have a non-safe sill and holes in slabs that people or things can fall through." In a second step, the application will identify the corrective action. "These are parameterized" Eastman explains, "to allow company-level responses such as different types of barrier fence, coverings of slab holes or guard rails in wall openings." Based on the company rules, their application automatically generates the corrective action in the model and inserts it into the schedule for implementation. As a testament to its potential, in September 2012 their technology won the first BIM & Safety Competition, sponsored by the International Council for Research and Innovation in Building and Construction.

The Future of BIM and Safety

It seems that the safety applications for 4-D BIM are as varied as the span of activities related to construction projects. "The more complex the task, the more powerful the effect BIM models can have," says Charlie Bird, loss prevention director of Balfour Beatty. "So far, we've used these models to explain safer methods for site excavations, trenching, benching and access, but the applications are nearly endless." ■

Use of Mobile Devices on the Jobsite

Level of Use

Mobile devices have become a common feature on jobsites, integrated in the workflow of a project. Eighty-eight percent of respondents currently use mobile tools on their projects, up from 76% in 2011. However, there is a slight reduction in the firms that intend to use them onsite in the future, down to 84%, suggesting that this adoption has reached a saturation point for current devices.

Seventy-one percent of the respondents using mobile devices do so on more than 75% of their jobsites. General contractors tend to use mobile devices more frequently than specialty contractors, with 14% more general contractors reporting use of mobile devices at that level.

Interestingly, firm size is not a factor in the level of use, with no statistically significant differences reported between small and large firms.

Types of Devices Used Over Time

Currently smartphones are the most widely used technology on jobsites. While this was true two years ago as well, the level of use has increased. The same pattern holds for GPS devices, also widely used on sites.

The devices that are expected to grow in use over the next two years are tablets and netbooks. This clearly demonstrates a desire for more capabilities and power in the device. The larger screens may also be appealing for review of project documents. There may be expectation that prices will also continue to fall for these technologies.

VARIATION BY FIRM TYPE

A significantly higher percentage of general contractors use mobile technologies compared with specialty contractors, 92% versus 82%, respectively. General contractors are also using them on a higher percentage of their projects, with 76% reporting that they use them on 75% or more of their projects versus 62% of specialty contractors.

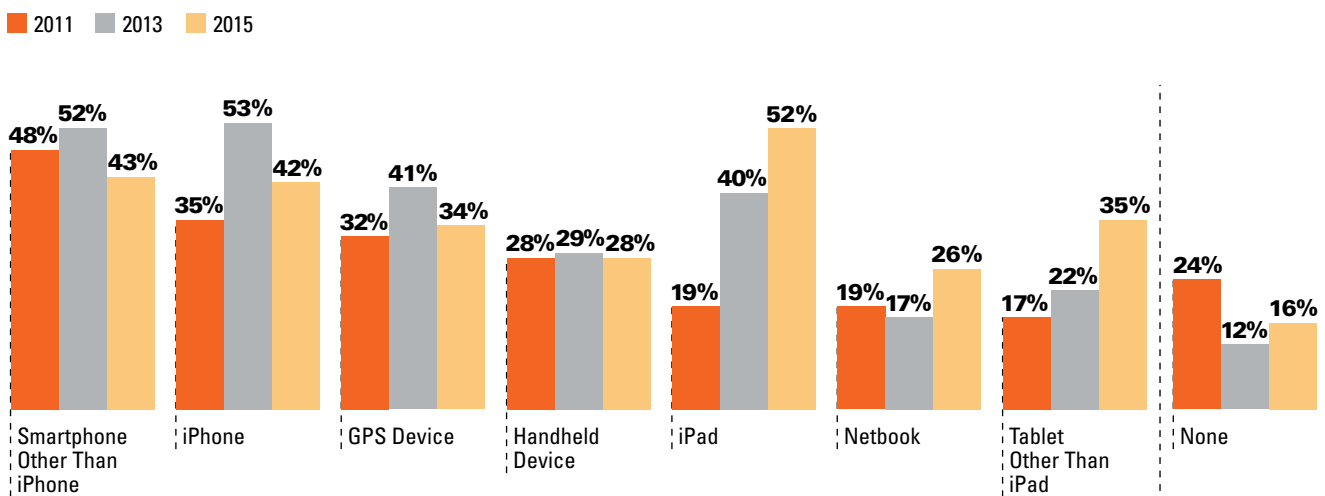
The only form of technology for which there is a statistically significant difference is iPads, with a higher percentage of general contractors (45%) currently report their use than specialty contractors (32%). However, there is a trend toward more general contractors using more expensive technologies, including iPhones and netbooks as well. That trend also appears to hold for the next two years, with a significantly higher percentage of general contractors expecting to be using iPads and netbooks than specialty contractors. Clearly, specialty contractors are more cost-sensitive in their technology investments.

VARIATION BY FIRM SIZE

There is no statistically significant difference in the level of use of mobile technologies by firm size. The differences in the types of technologies are also less evident than by firm type. While larger firms appear to be more willing to invest in the iPhone and iPad, there is not an equivalent tendency for more of them to use netbooks, either now or in two years, which suggests that they are less likely to be making technology decisions based primarily on cost considerations.

Types of Mobile Devices Used Over Time (By Percentage of Respondent)

Source: McGraw Hill Construction, 2013



Mobile Device Tools Most Commonly Used on Jobsites

Cameras are the most commonly used mobile device tool by far, in use by 89% of all respondents using a mobile device. Camera use has critical safety implications since they can document worksite conditions from preconstruction throughout the construction phase of the project and help safety personnel identify potential hazards.

Project document sharing and GPS applications are the next most common tools, each used by half of the respondents. Electronic document sharing can not only save time, but it can help increase safety by making it less likely for out-of-date documents to still be in circulation.

VARIATION BY FIRM TYPE

General contractors appear to use mobile tools for more safety-related purposes than specialty contractors since the only two tools used by significantly higher percentage of general contractors are both safety related: safety inspection checklists (36% of general contractors versus 20% of specialty contractors) and accessing safety and health websites (31% versus 15%). This finding supports conclusions made previously in this report that general contractors have a more intensive and comprehensive approach to safety than specialty contractors.

VARIATION BY FIRM SIZE

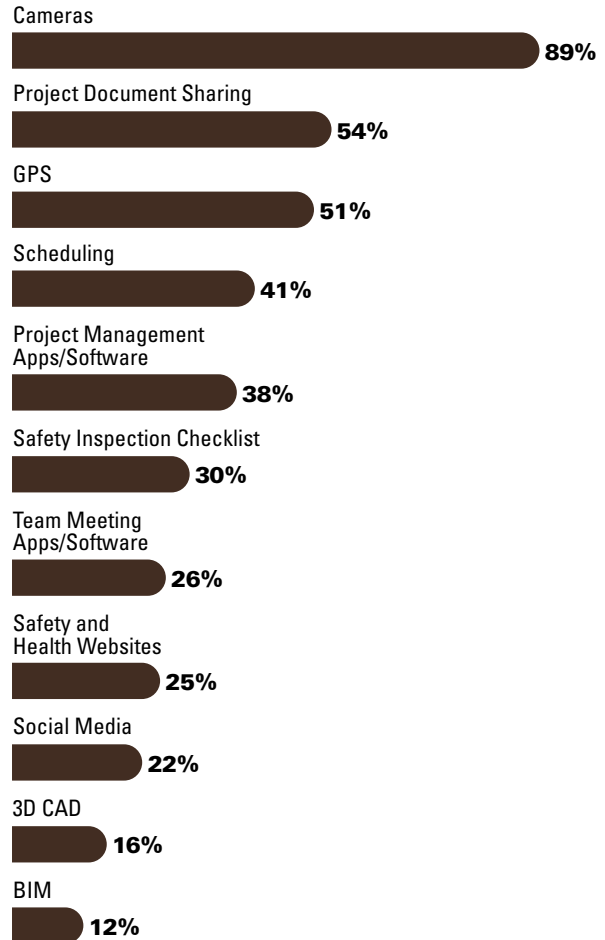
Use by large firms with 500 or more employees of two tools is 38 percentage points higher than use by small firms with less than 10 employees: safety inspection checklists (used by 52% of large firms) and BIM software (used by 42% of large firms). There is also a 37 point increase in large firms reporting use of project document sharing (60% of large firms). Other significantly higher percentages of large firms using tools include project management and safety and health websites. Small firms may have budget constraints the limit the use of specific tools or the employees that have access to them.

Variation by Use of BIM

While BIM users are using mobile devices on jobsites at about the same level as non-users, BIM users do take advantage of more tools on mobile devices than non-users. A significantly larger percentage report using, not just BIM software, but project management, safety inspection checklist, team meeting and project document sharing software and apps, as well as 3D CAD and safety websites. BIM users would be expected to be very

Tools Used on Mobile Devices on Job Sites (By Percentage of Respondents Using the Tools)

Source: McGraw Hill Construction, 2013



technologically savvy, so it is not surprising to see them maximize use of their devices onsite.

Variation by Use of Prefabrication/Modularization

A significantly larger percentage of prefabrication/modularization users employ project management, safety inspection checklist and team meeting software and apps, as well as 3D CAD.

Staff Using Mobile Devices

The staff most typically using mobile devices depends largely on the type of firm. For general contractors, site superintendents and senior management are reported by the largest percentage as the users of mobile devices onsite, and the percentage reporting them is nearly 30 percentage points higher than the next position. Less than one quarter of the general contractors report that jobsite workers are using mobile devices.

On the other hand, the highest percentage of specialty contractors identify their foremen as the largest users of mobile devices onsite. And while a large percentage still report use by superintendents and senior management, the gap between them and those reporting use by jobsite workers is considerably less.

This may be a reflection of the roles of the employee answering the surveys. Respondents who work for specialty contractors are more likely to have positions that work more directly with field staff, and they would therefore be more aware of the devices used in the field. However, if that issue does not fully account for this difference, these findings have implications about the use of mobile devices to improve safety onsite. Given the clear emphasis on the strongest safety programs being implemented through the entire organization, especially the staff in the field, it is clear that the use of mobile devices to increase safety is limited when the access to these devices is limited, especially among general contractors and smaller firms.

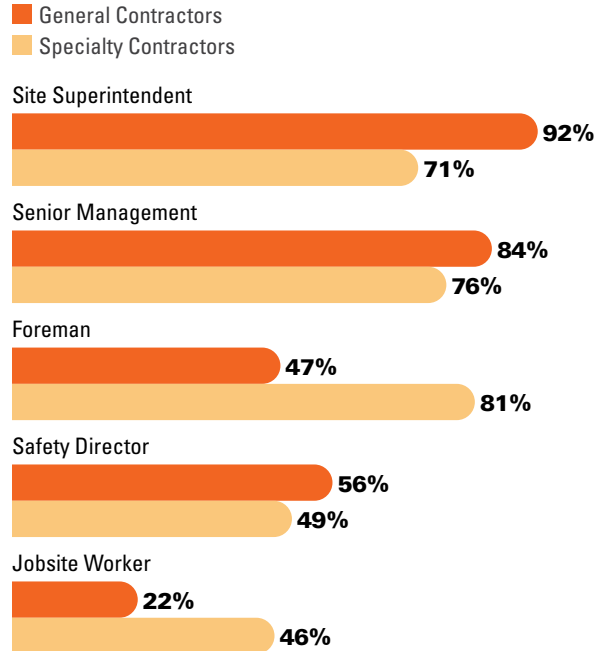
Variation by Use of BIM

Ninety percent of BIM users report that site superintendents use mobile devices, compared with 80% of non-users. There are advantages to giving site supervisors access to the BIM models rather than just using drawings produced from the models on the site, which may explain the higher usage.

In addition, 71% of BIM users report that safety directors use mobile devices onsite, compared with 40% of non-users. This dramatic difference is in line with the stronger safety practices across the board demonstrated by BIM users throughout this report.

Staff Using Mobile Devices (by Type of Firm)

Source: McGraw Hill Construction, 2013



Variation by Use of Prefabrication/Modularization

Like the BIM users, users of prefabrication and modularization have a demonstrated commitment to strong safety practices, and they also report a higher percentage of safety directors using mobile devices onsite (55%) compared with non-users (30%).

However, the only other statistically significant difference reported by users of prefabrication and modularization is greater use of mobile devices by senior management onsite. Eighty percent of prefabrication/modularization users report this, compared with 65% of non-users. Further research is needed to determine why senior management is more likely to be using devices onsite for firms that employ prefabrication and modularization.

Impact of Mobile Devices on Safety

A wide range of mobile devices is reported as having a positive impact on safety, with over half of the respondents indicating positive impacts for all of the devices and more than 75% for several of them. In addition, the percentage reporting a negative impact is under 5% for all the devices except one, tablets other than iPads, and even that was still a nominal 7%. There is clearly agreement across the industry that using mobile devices helps make projects safer.

The devices that are seen as having the greatest impact on safety include smartphones, iPhones and iPads. It is likely that iPhones, smartphones and iPads are considered highly effective because they can host many different tools, from cameras to schedulers to safety training videos and instructions. Surprisingly, tablets other than iPads are selected by a much lower percentage of respondents as having a positive impact on safety, with an over 20 point differential between those finding iPads to have a positive impact and those finding the same impact from other tablets. This is most likely due to broader familiarity and use of the iPad compared with other tablets. Apple's dominant share of the current tablet market may be influencing this result.

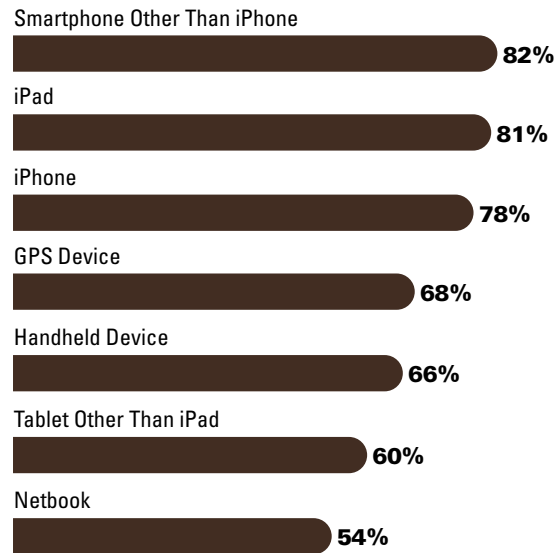
Variation by Firm Type

There are no statistically significant differences between the percentage of general contractors and specialty contractors that find that mobile devices have a positive impact on safety. However, specialty contractors trend higher in the percentage that note a positive impact from these devices for all options except one, smartphones other than iPhones.

Many factors could contribute to this finding. One possible finding that could correlate with this result is the higher percentage of specialty contractors reporting mobile tool use by foreman and site workers, compared with general contractors. (See page 45.) Getting these devices in the hands of people onsite may contribute directly to their impact on safety.

Impact of Mobile Devices on Safety

Source: McGraw Hill Construction, 2013



Variation by Firm Size

A significantly higher percentage of firms with 100 or more employees find smartphones other than iPhones to have a positive impact on safety than firms with fewer employees, with approximately 75% of the smaller firms reporting that smartphones have a positive impact compared with 95% of firms with 100 to 499 employees and 83% of firms with over 500 employees. This is the only statistically significant difference by firm size. It may explain why smartphones other than iPhones are the only devices a smaller percentage of specialty contractors find to have a positive impact than the percentage of general contractors since specialty contractors tend to be smaller firms.

Data: Building Processes and Safety Management

Impact of the Use of Prefabrication and Modularization on Safety

Prefabrication and modularization have a positive impact on safety, according to half (50%) of the 82% of respondents to this survey who report using prefabrication/modularization on projects. Only 4% of the contractors using prefabrication/modularization find that it has a negative impact, a negligible amount.

The findings by type and size of firm described below strongly suggest that firms with more experience with prefabrication and modularization can better capitalize on the safety benefits of using these building methods.

Variation by Type of Firm

More general contractors (86%) than specialty contractors (75%) report using prefabrication or modularization on projects, although that difference virtually disappears when just examining firms using prefabrication or modularization on more than 50% of their projects, which is reported by a little over 20% of general and specialty contractors alike. This demonstrates that, while overall use of prefabrication and modularization is higher among general contractors, there is a tendency for a small but significant percentage of specialty contractors to work primarily with prefabricated building elements or modular components.

Fifty-four percent of general contractors using prefabrication/modularization think that it has a positive impact on safety, compared to 43% of specialty contractors.

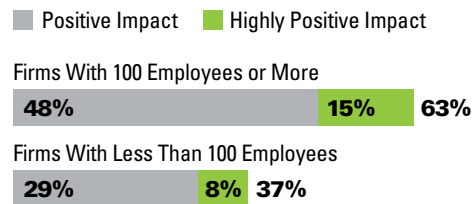
Variation by Size of Firm

Ninety-two percent of firms with 100 or more employees use prefabrication/modularization, compared to 74% of firms with less than 100 employees.

As with the firm type, wider use correlates with stronger safety impacts. Sixty-four percent of large firms with 100 employees or more using prefabrication/modularization think it has a positive impact on safety, compared with 37% of firms with less than 100 employees.

Firms That Find That Prefabrication/Modularization Has a Positive Impact on Safety (by Size of Firm)

Source: McGraw Hill Construction, 2013



Aspects of the Use of Prefabrication and Modularization That Contribute to Project Safety

There are significant differences in the elements of prefabrication and modularization that the highest percentage of general contractors consider to have a positive impact on safety, compared with the elements selected by specialty contractors.

The highest percentage of general contractors (78%) consider the ability to do complex assemblies either on the ground or offsite as an aspect of prefabrication/modularization that increases project safety. Given the role of a general contractor onsite, it makes sense that general contractors would consider eliminating the construction of a complex assembly in difficult-to-reach spaces onsite, which could involve intensive coordination with different trades, an important contribution to site safety.

The highest percentage of specialty contractors (69%) consider site safety improved by the ability to have fewer workers onsite contributing to different aspects of the building by using prefabrication and modularization. Working next to other trades is necessarily a hazard, and even the best coordinated job may involve challenges presented by other workers, so it is not surprising that specialty contractors value this aspect of prefabrication/modularization. In addition, it is worth noting that while it ranks second for general contractors rather than first, this factor is selected by the same percentage of general contractors as specialty contractors, demonstrating wide industry recognition of its value.

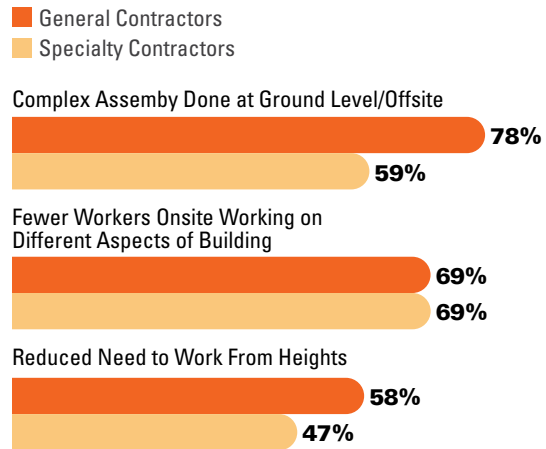
Variation by Firm Size

Despite strong differentials in terms of the use of prefabrication and modularization and the estimation about how they impact project safety between large and small firms (see page 47), there is no statistically significant difference in the percentage of firms recognizing the impact of aspects of using prefabrication and modularization on project safety.

This finding, combined with the previous differential in the estimation of positive impact on safety, suggests that contractors may be aware of how prefabrication and modularization can help improve safety, but the types of firms that typically do less underestimate the impact of these differences.

Aspects of the Use of Prefabrication/Modularization That Contribute to Project Safety

Source: McGraw Hill Construction, 2013



Variation by Firms Using BIM

One widely recognized use of BIM is to help design complicated assemblies. Therefore, it is not surprising that 84% of BIM users recognize the value that prefabrication and modularization bring to site safety by allowing complicated assemblies to be done on the ground or offsite, compared with 54% of those not using BIM.

Renewed Interest in Prefabrication and Modularization in Construction

Safety is an important benefit of using prefabrication and modularization in construction, but it is only one of the many benefits driving a renaissance in this construction process. However, the increased use of these techniques offers an opportunity to see project site safety improve.

Prefabrication and modular buildings are not new to the construction industry, and it may seem strange to consider such an established approach as a trend. However, the use of these practices has recently benefited from a series of factors. These factors include improved processes and materials that have increased their use on sophisticated and complex buildings, use of building information modeling (BIM) that facilitates their use, and trends like lean construction and green building for which they offer unique solutions. This growth in use has strong implications for improved project site safety.

Increased Use of Prefabrication and Modularization

McGraw Hill Construction's 2011 *Prefabrication and Modularization SmartMarket Report* demonstrates that use of prefabrication and modularization is on the rise in the construction industry. While the study reported that 85% of the respondents use some form of prefabrication or modularization on their projects, it also revealed that most firms were using them on a relatively low percentage of their projects, with only about one third reporting use on more than 50% of their projects. Within the next couple of years, though, 45% of the firms reported that they expected to use prefabrication or modularization on more than 50% of their projects. They also identified the main sectors

for growth, with healthcare, higher education and manufacturing buildings offering the strongest opportunity for prefabrication/modularization use in the future.

Factors Driving Growth

One key factor driving growth is the benefits firms report achieving on their projects involving prefabrication or modularization. About two thirds report seeing reductions in project schedules and budgets due to their use of these practices, with over one third finding that the decrease in project schedule amounted to four weeks or more.

For the contractors that use prefabrication/modularization, nearly all (92%) report that improved productivity was a critical factor driving use, closely followed by competitive advantage (85%). The other major factor influencing them was their experience that prefabrication and modularization generate greater return on investment (ROI) at 70%.

Over half of the contractors (56%) also reported that safety was an important driver in their use of prefabrication/modularization, nearly 20% more than the architects and engineers surveyed. Contractors recognize that safety is directly related to improved productivity factors like schedule and budget. However, it is often during the design stages that the decision to use prefabrication is made. Since design firms will never have safety concerns as highly prioritized as contractors,

this demonstrates that more collaborative design processes, with contractors involved earlier in the design process, could help increase the influence of safety benefits on the decision to use these methods.

Ability to Improve Safety

Respondents in this current safety study were asked about three main ways in which prefabrication/modularization can improve safety: the ability to do complex assemblies at ground level or off site, the ability to have fewer workers on site working on different aspects of the building at the same time and the reduced need to do work at a great height. All of these were widely recognized by respondents as beneficial. (See page 48.)

However, this is not a comprehensive list of the ways that prefabrication and modularization can improve site safety. The Modular Building Institute also reports the benefits of workers not being exposed to the elements and the ability to better monitor safety practices in a factory, which also are factors that make prefabrication/modularization use safer.

However, despite the overall trend for improved safety, installation of large prefabricated or modular components can present unique challenges. Proper training on site is still essential. However, it is clear that the rise in prefabrication and modularization has strong implications for overall improvements in site safety, especially for the sectors in which their use continues to grow. ■

Specific Safety Training for Green Technologies, Practices or Products

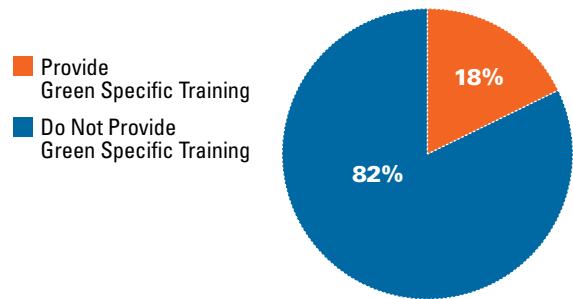
Eighteen percent of the firms responding to the survey report that they provide their employees with specific safety training on green technologies, processes and products. Since green training is recognized as an emerging area, this figure is intended to provide a baseline as safety emerges as an important topic in green building.

There appear to be trends by firm type and size in this early data. While the differences are not statistically significant, 27% of firms with 100 employees or more have delivered this training, compared with 12% of smaller firms, and 24% of specialty contractors report delivering this training versus 14% of general contractors. Since specialty contractors tend to be smaller than general contractors, this finding suggests that there may be more specialized green technologies and products in some specific trades than in general onsite.

The percentage of BIM users (28%) and prefabrication/modularization users (21%), on the other hand, who deliver specific green training is significantly higher than the percentage of those who do not use BIM or prefabrication/modularization, 10% and 6%, respectively.

Firms Providing Specific Safety Training for Green Technologies, Processes and Products

Source: McGraw Hill Construction, 2013



Green Projects and Safety

In the 2013 Dodge Construction Green Outlook, McGraw Hill Construction reports that green represented 44% of all commercial and institutional construction in the United States by value, a \$60 billion market. Green market share is also forecasted to grow, with 55% of U.S. commercial and institutional construction by value expected to be green by 2016.

The rapid rise of green building in the construction industry in the last eight years has led to a strong wave of innovation in products and approaches to achieve green results to serve this increasingly large and competitive market. However, some recent studies have suggested that innovation in green building must be expanded to include safety training and practices that respond effectively to this

growth in green.

In 2009, a study published in the ASCE's *Journal of Construction Engineering and Management* found that projects certified under the Leadership in Energy and Environmental Design (LEED) system had an average recordable injury rate that was 48% higher than the injury rates in conventional building projects.

In 2012, a study published in the same journal used a series of case studies to determine the LEED credits that have an impact on safety during construction, and 16 credits out of 55 were identified. These included a diverse range of credits such as ones dealing with heat-island effect, optimization of energy performance, use of onsite renewable energy, construction waste management, and

daylighting. Some credits, such as the use of low-emitting materials, were found to reduce risks.

However, the study authors also state that the majority of LEED credits, even those using new or different materials or technologies, were not linked to an increase or decrease in construction risk.

One goal of the study, by looking at the specific credits that increase risk, was to help the industry determine appropriate mitigation strategies. Factors such as exposing workers to unfamiliar environments or new risks could be mitigated with appropriate, specific training geared toward these elements. Many of the hazards identified may also become less prominent as green becomes an established part of the industry.

Interview: Thought Leader



Yancy Wright
Director, Sellen Sustainability

A recognized leader in company-wide sustainable operations, Yancy Wright's dedication to evolve all the construction industry through green workforce training has resulted in the training of thousands of trades people.

Is green building more dangerous than traditional construction?

WRIGHT: It really depends on whether or not you are a safe contractor because if you're a safe contractor, you're most likely going to build a safe green building. If you are an unsafe contractor, then there's a high potential that the green building could be unsafe.

Could you elaborate on the role green could play in exaggerating the differences between a safe and unsafe contractor?

WRIGHT: For people building new green building systems, there are a lot of unknowns, and there are situations where new trades will be experiencing new or different conditions. And so, there is a higher potential risk. When I said a safe contractor should have no issue with building a good green building, it means that they're going through the standard process of any new or unique situation and doing an activity hazard analysis that helps them understand exactly what those new conditions are and helps them inform all the trades interacting with that new system to prevent any incidents or accidents from occurring.

Are there ways in which building green can make projects safer?

WRIGHT: The most direct one is indoor air quality management. If you can reduce the known carcinogens...you've absolutely got a safer building. Also associated

with indoor air quality management is [good] housekeeping: being able to simply keep a project cleaner, minimize the amount of particulates in the air, reduce the number of trip hazards, reduce the number of respiratory issues.

[We have also seen simple factors make jobsites safer, such as] higher percentages of glazing and skylights. On the one hand, these can be a potential hazard if you are working around the roof, but on the other hand, it reduces a bunch of hazards because you can often eliminate half or more of the temporary lighting [which reduces] the potential for electrocution and trip hazards.

How does green training need to be different?

WRIGHT: The most important audience to start with is the safety professionals...get them to understand why green buildings are being done and how all these new systems can provide potentially different situations.

What makes it [focusing training on safety professionals] more beneficial [is] the overlap between roles... when companies have standards throughout the company for sustainability... For a company that chooses to practice company-wide sustainability, it makes sense to combine the roles and responsibilities of an onsite safety coordinator and an indoor air quality management coordinator, a waste recycling management coordinator, a stormwater management coordinator, or a construction activity

pollution prevention coordinator.

[All these roles] could be one person doing that job if they are cross-trained. And the benefit is that they are looking not only to meet environmental mandates, but also ensuring that there is a higher level of safety.

Do you see any differences in the training that needs to be delivered to general contractors versus specialty trades?

WRIGHT: Yes. That said, I think some of the best trainings that I've been doing are when it is a composite group of trades. I love to mix it up, so that all the trades—including the general contractor—get to see the overlaps and sharing of information that needs to happen.

The point of [training] a composite group is that green building systems are a lot more integrated. [In the case of this integration, some unions] haven't really established who is responsible for the work.... If it is that new to them, and there'll be multiple trades that need to work [together] to get that end result, then it is better to instruct a composite group of trades.

The most important piece of training, in my opinion, is...helping everyone understand why is [green building] important, why [it] is being done, how does it impact their kids and future generations because if you make it an emotional driver, then they'll care more about the end result of that system working and be more passionate about the work that they are doing. ■

Methodology:

Safety in Construction Study Research

McGraw Hill Construction conducted the 2013 Safety Management in the Construction Industry study to assess the use of specific safety practices and their impact on project safety and outcomes. The research in this report was conducted through an Internet survey of industry professionals between December 13th and December 19th, 2012. The McGraw Hill Construction Contractor Panel was used to reach general and specialty contractors throughout the U.S. This panel contains a representative sample of construction contractors across the U.S. The panelists are identified by many categories, including size, region, types of projects undertaken and specialty. To gain an industry-wide perspective, no specific contractor group was excluded from the study.

The survey had 263 complete responses who identified themselves as follows:

- **129 general contractors (49%)**
- **98 specialty contractors (37%)**
- **16 design-build firms (6%)**
- **16 construction management firms (6%)**
- **4 engineering firms (2%)**

Design-build and construction management firms were coded as general contractors, and engineering firms were coded as specialty contractors.

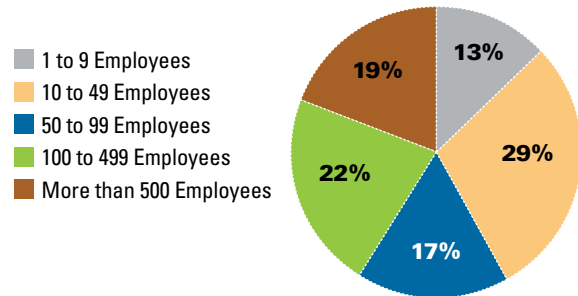
Respondents are working on projects across the commercial, institutional and manufacturing sectors.

There were 15 safety practices that were used to form the basis of the study in assessing a strong safety management program. The full list is at right, showing the overall percentage that report using that practice. A full analysis of the top eight practices, including a split between responses by general contractor and specialty contractor, can be found on page 8.

The use of a sample to represent a true population is based on the firm foundation of statistics. The sampling size and technique used in this study conform to accepted industry research standards expected to produce results with a high degree of confidence and low margin of error. The total sample size (263) benchmarks at a 95% confidence interval with a margin of error of 6% for dichotomous inquiries. ■

Size of Respondents' Firms by Number of Employees

Source: McGraw Hill Construction, 2013



Construction Safety Practices Used by Respondents

Source: McGraw Hill Construction, 2013

Include Jobsite Workers in Safety Process	81%
Analyze Potential Site Safety Hazards in Preconstruction	78%
Establish an Open-Door Policy for Workers to Report Hazards	77%
Conduct Regular Project Safety Audits With Foremen/Workers	74%
Appoint/Assign/Authorize Project Safety Personnel	72%
Develop Site Specific HASP (Health and Safety Plan)	70%
Site Specific Training Program for Workers and Subcontractors	63%
Conduct Thorough Near-Miss and Incident Investigations	60%
Utilize Effective Job Safety Analysis (JSA)/ Job Hazard Analysis (JHA)	54%
Establish Measurable Safety Goals and Objectives	52%
Have a Site Specific Emergency Action Plan Within the HASP	50%
Use an Effective Safety Screening Policy/ Subcontractor Procurement Program	39%
Track Leading Safety Metrics	32%
Offer Safety Incentives	27%
Implement Safety Mitigation Into the Design Process	27%

Resources

Organizations, websites and publications that can help you get smarter about safety in construction.



McGraw Hill Construction

Main Website: construction.com

Dodge: construction.com/dodge

Research & Analytics:

construction.com/dodge/

dodge-market-research.asp

GreenSource: greensourcemag.com

Architectural Record: archrecord.com

Engineering News-Record: enr.com

Sweets: sweets.com

SmartMarket Reports:

construction.com/market_research

ACKNOWLEDGEMENTS:

The authors wish to thank our corporate sponsors Click Safety and the Center for Construction Research and Training (CPWR) for helping us bring this information to the market. Specifically, we would like to acknowledge Brian Tonry, Matt Bower, Hans Helgeson, Ron Bruce and Tracy M. Curl at ClickSafety and Pete Stafford and Patricia Quinn at CPWR for their support. Additional thanks to the United Rentals team.

We would also like to thank our association partner the National Institute for Building Sciences (NIBS) for their support. Additionally, we thank Charlie Bacon at Limbach Facility Services and Yancy Wright at Sellen Sustainability for sharing their insights. Finally, we would like to thank all the firms that provided information about their experiences with safety management for this report.



ClickSafety

www.clicksafety.com

Any logo appearing in this McGraw Hill Construction Safety Smart Market Report does not constitute an endorsement by, or affiliation with, ClickSafety.com, Inc. Any trademarks, logos, and service marks ("Marks") appearing in this report are the sole property of the applicable owner and no use of such Marks is permitted without consent of the owner.



THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

The Center for Construction Research and Training

www.cpw.com

www.elcosh.org

www.cpwrcolutions.org

This publication was supported by CPWR through NIOSH cooperative agreement OH009762. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CPWR or NIOSH. CPWR does not endorse any of the other funding partners associated with this project.



United Rentals

www.unitedrentals.com

Premier Partners

ClickSafety: clicksafety.com

CPWR (The Center for Construction

Research and Training): cpwr.com

United Rentals: unitedrentals.com

Association Partner

National Institute of Building Sciences: nibs.org

Federal Government Agencies & Programs

National Institute of Occupational Safety

and Health: acdc.gov/NIOSH

National Institute of Standards and Technology: nist.gov

Occupational Safety and Health Administration: osha.gov

OSHA Data Initiative: data.gov

Other Resources

The American Institute of Architects: aia.org

American Subcontractors Association: asa.org

Associated Builders & Contractors: abc.org

Associated General Contractors of America: agc.org

American Society of Civil Engineers: asce.org

American Society of Safety Engineers: asse.org

BIMForum: bimforum.org

Construction Industry Institute: construction-institute.org

Construction Users Roundtable: curt.org

Construction Safety Council: buildsafe.org

International Code Council: iccsafe.org

Mechanical Contractors Association of America: mcaa.org

Modular Building Institute: modular.org

Modular Home Building Council: modularcouncil.org

National Electrical Contractors Association: neca.org

National Systems Contractors Association: nsca.org

Sheet Metal & Air Conditioning Contractors'

National Association: smacna.org

■ Design and Construction Intelligence

SmartMarket Report

www.construction.com

McGraw Hill Construction SmartMarket Reports™

Get smart about the latest industry trends.

For more information on these reports and others, visit
www.construction.com/market_research

