



The Business Value of BIM for Construction in Major Global Markets:

How Contractors Around the World Are Driving Innovation With Building Information Modeling

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The Business Value of BIM for Construction in Major Global Markets: How Contractors Around the World Are Driving Innovation With Building Information Modeling SmartMarket Report

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About McGraw Hill Construction

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.

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Introduction

Change is sweeping the globe. Project teams are benefiting from faster communications, smaller, more powerful and mobile computers, robust digital modeling tools and a transformative shift toward integrated project delivery processes, all of which are generating positive outcomes, efficiencies and benefits unimaginable just a few years ago.

Since 2007, McGraw Hill Construction has been closely tracking the business impacts of these technology advances through its SmartMarket Report series, with a particular focus on how Building Information Modeling (BIM) is transforming the design and construction process in Asia, North America and Western Europe. During that period, construction companies have emerged as the leading drivers of BIM innovation and value.

This report analyzes new survey data collected exclusively from construction companies that use BIM in nine of the world's top construction markets to improve productivity, efficiency, quality, safety and their own competitiveness. Among the key findings:

- **Three quarters of the construction companies report a positive Return on Investment (ROI) on their BIM program investment and have clear ideas about how to further improve ROI.**
- **Fewer errors and omissions, less rework and lower construction costs are among the top five BIM benefits cited by contractors.**

- **Over the next two years, contractors expect the percentage of their work that involves BIM will increase by 50% on average.**
- **BIM ROI increases directly with a contractor's level of BIM engagement, represented by its BIM experience, skill level and commitment to doing a high percentage of its work in BIM.**
- **Contractors in all markets are planning significant investments to expand their BIM programs over the next two years, including an increasing focus on internal and external collaborative procedures as well as mobile hardware and BIM software.**

Although BIM implementation has been underway for many years in Canada, France, Germany, UK and the US, the markets that have begun adopting more recently, such as Australia, Brazil, Japan, Korea and New Zealand, are showing tremendous momentum and are outperforming the more established regions in several key categories of the research, such as ROI, commitment to investment, offering innovative new services and expanding the use of BIM to non-building projects like mining and manufacturing.

This is an exciting time in the global construction industry, and BIM is accelerating the pace of positive change for contractors of all types, sizes and locations. We would like to thank our partners for their support that allows us to continue to bring this exciting information to the industry.



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Stephen A. Jones leads McGraw Hill Construction's (MHC) initiatives in BIM and integrated project delivery, as well as developing alliance relationships for technology and content. Active in numerous industry organizations, he frequently speaks at events around the world about the business impact of emerging technologies and trends. Before joining MHC, Jones was a vice president

with Primavera Systems (now Oracle), a leading provider of project management software. Prior to that, he spent 19 years in creative, marketing and management roles with design firms, most recently as a Principal and Board of Directors member with Burt Hill (now Stantec), a large, global architectural and engineering firm. Jones holds an M.B.A. from Wharton and a B.A. from Johns Hopkins.

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.

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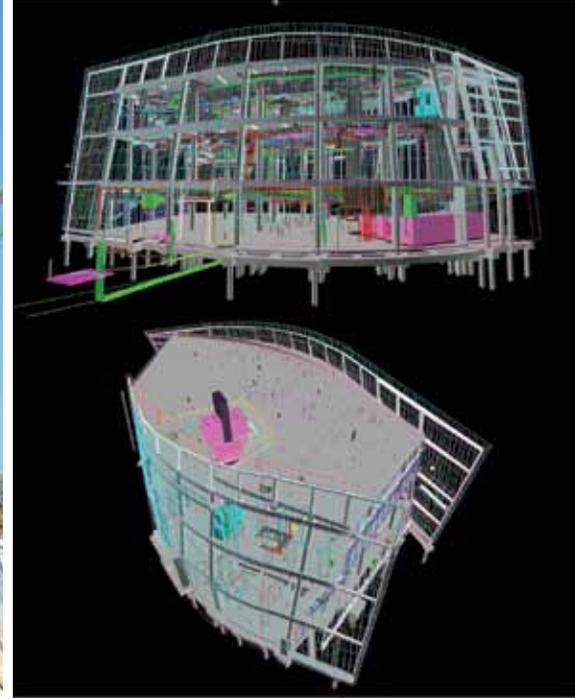
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Front Cover:
Building Information Modeling is used for construction logistics planning and simulation on a high-rise urban structure.

This page:
Building Information Modeling is being used extensively by the design and build team to plan and execute the construction of the National Center for Civil and Human Rights, Atlanta Georgia, USA.



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Executive Summary

While Building Information Modeling (BIM) is rapidly expanding around the globe, there are significant differences between construction companies' experience with and business benefits from BIM in various regions. This

study builds upon McGraw Hill Construction's investigation of BIM in individual markets, including North America, Europe and South Korea, to demonstrate larger trends globally through data from contractors in 10 countries: Australia, Brazil, Canada, France, Germany, Japan, New Zealand, South Korea, UK and US.

BIM Across the Globe

BIM usage is accelerating powerfully, driven by major private and government owners who want to institutionalize its benefits of faster, more certain project delivery, and more reliable quality and cost. BIM mandates by US, UK and other government entities demonstrate how enlightened owners can set specific targets and empower design and construction companies to leverage BIM technologies to meet and exceed those goals, also driving BIM into the broader project ecosystem in the process. Resulting BIM adoption in North America skyrocketed from 28% to 71% between 2007 and 2012, and the UK and other regions are poised for similar dramatic expansions. Adoption by contractors (74%) recently exceeded architects (70%) in North America, and this group is increasingly showing leadership in driving BIM innovation, metrics and value.

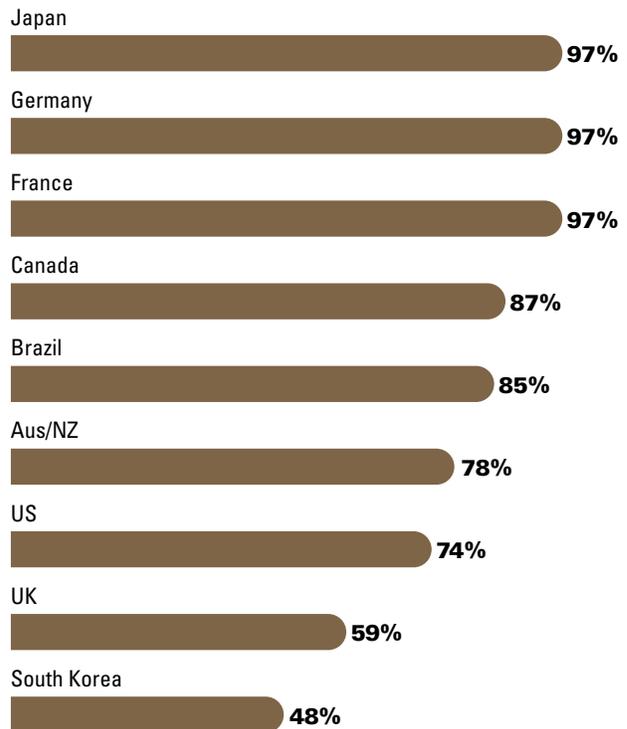
Return on Investment (ROI) for BIM

Three quarters of all contractors surveyed report a positive ROI on their investment in BIM. While there is no standard metric for measuring ROI on BIM (unlike more standard measurements on project ROI), the largest percentage of firms estimate the ROI on their BIM investments to be between 10% and 25%. The findings demonstrate that each region has a unique set of metrics that are considered important and different drivers that construction companies believe will improve their return.

- **Japanese, German and French contractors report the top ROI on BIM investments, with South Korea, the UK and the US trailing all regions.**
- **Financial metrics, such as reduced cost, higher profitability and higher productivity, are generally considered the most important category for measuring ROI on BIM investments, followed by metrics related to the project delivery process, such as fewer RFI's, fewer unplanned changes, higher customer satisfaction and less disruption in project process.**

Contractors Reporting a Positive Return on Investment (ROI) for BIM (By Country)

Source: McGraw Hill Construction, 2013



- **Embracing the collaborative nature of BIM projects, 60% of contractors in all regions expressed the belief that further enhancements of visualization with BIM would probably have the most positive impact on their BIM ROI.**

Looking forward, creating and managing facilities management-enabling models for owners after construction may prove to be one of the most important new service revenue streams and contributors to ROI for contractors.

Contractors Are Enjoying a Wide Variety of Important BIM Benefits

The top project-related benefits that contractors are receiving from BIM are reduced errors and omissions and reduced rework, both of which have immediate positive impact and contribute to strong ROI. Reduced construction cost, reduced project duration and improved safety round out the top five project benefits of BIM.

Contractors cite BIM’s ability to enhance collaboration among key team members as its most important contribution to improving the project delivery process. Better cost control/predictability, and reduced cycle time for workflows and approvals are also acknowledged as important process benefits of BIM.

BIM Engagement Is Key Driver of Greater BIM Benefits

The more deeply that construction companies become engaged with BIM, the greater their ability to receive its benefits and to realize very strong return on their investments in BIM. McGraw Hill Construction developed a BIM Engagement Index to measure the level of engagement for every contractor that participated in this research, based on their experience, skill and the percentage of BIM projects they work on. Analyzing the research findings by respondents’ BIM engagement level demonstrates a clear business benefit to higher levels of engagement:

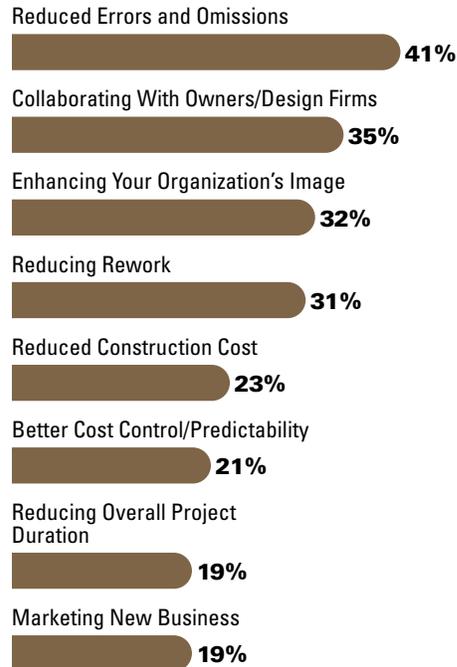
- Half of the contractors at the highest level of BIM engagement are reporting very positive ROI—in excess of 25% on their investment in BIM—compared with 11% of the firms at the lowest level, over a third of whom are still at negative or break-even ROI.
- BIM is significantly reducing costly rework on projects for 40% of the highest BIM engagement contractors, versus only 28% of those at a low engagement level.

Contractors Plan Aggressive Investments in BIM Programs

Contractors around the world are focusing most highly on investing in their internal collaborative processes, BIM training and BIM software in the next two years. Almost two thirds (61%) of contractors at the highest level of BIM engagement are focusing on new/upgraded tablets/mobile devices, which will allow them to bring the value of BIM to the staff in the field. Only about half as many (38%) of the other contractors surveyed are placing a high priority on that category of investment.

Contractors Citing BIM Benefit as Among Top Three for Their Company

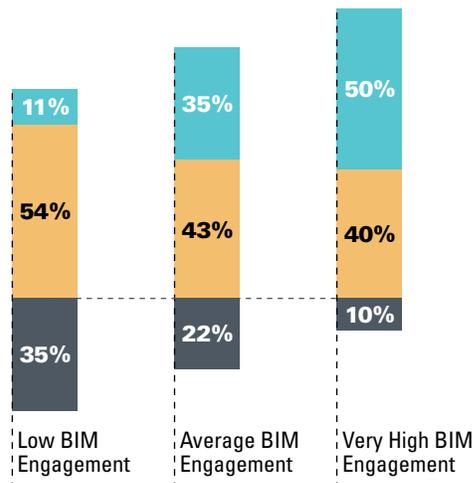
Source: McGraw Hill Construction, 2013



Impact of Contractor’s BIM Engagement Level on ROI

Source: McGraw Hill Construction, 2013

- Very Positive ROI on BIM (Over 25%)
- Moderately Positive ROI on BIM (1% to 25%)
- Negative and Break-Even ROI on BIM



Observations and Recommendations

Observations and Recommendations

Model-based technologies and processes will continue to power the industry's evolution. Contractors need to stay abreast of the key trends that will give shape to the future of the industry.

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS

Performance Metrics

Early-stage BIM users need to compare performance metrics from pre-BIM projects to establish the value of basic BIM benefits such as virtual coordination and to justify their continued BIM investments. More experienced BIM firms should analyze their completed BIM projects to refine the approach to more complex BIM uses on their new projects, such as determining in advance the best ratio of model-driven prefabrication to site-built construction to optimize cost, schedule and site logistics.

Emerging Uses of Modeled Data

Basic modeling and virtual coordination are quickly becoming routine. To remain competitive contractors need to embrace emerging uses for leveraging model data.

- Laser scanning to capture existing conditions and integrate with models
- Augmented reality to blend models with live camera views of reality
- Simulation and analysis to optimize

logistical planning and decision-making

- Hyper-realistic immersive visualization to communicate complex information among multiple parties extremely efficiently, and more effectively engage clients and prospects for a competitive edge

Industrialization of Construction

Model-driven prefabrication and the accelerating use of modular building elements are the leading edge of a tectonic shift in how construction projects will be designed, assembled and maintained.

- Major pre-engineered multi-system assemblies will be available from manufacturers' catalogs, and produced on-demand from highly automated factories designed for mass-customization rather than mass-production, keeping costs low, allowing a variety of aesthetic options, optimizing material usage and reducing waste.
- Work at project sites will focus primarily on assembly of these manufactured elements, with extensive GIS-controlled

robotics enhancing consistency and safety.

Many new businesses will form to serve this market, and existing companies will need to embrace the change, determine where they provide value and stake out their role, or else risk becoming irrelevant.

Redefining the Construction Company

Traditionally, contractors simply built what design professionals drew. As project complexity increased and fluctuating market conditions created more uncertainty, contractors began providing expertise as advisors to the design process for cost, schedule and constructability issues.

Now that contractors' adoption of BIM is surpassing design professionals in major markets such as North America, and formerly separate discipline-specific workflows are integrating into a more holistic and efficient approach to project delivery, construction companies have the opportunity to leverage technology innovations and redefine

their role in the industry, deepening their long-term relationships with owners.

- **Project planning:** Contractors can be valued advisors to owners' capital planning processes, not just implementers.
- **Productization:** Contractors, particularly the trades, have the opportunity to manufacture and service complex assemblies as standardized products, rather than custom-building for each project with no ongoing economy of scale or post-project revenue stream.
- **Model management for owners:** As the entity managing all the digital project information into its final physical form, contractors are ideally situated to organize and manage the information over the long term for owners, creating lifecycle engagement and an entirely new revenue source.

A firm's ability to succeed will depend on its willingness to innovate and embrace the business opportunities that these advancing technologies provide. ■

Data: Introduction

From the initial research conducted by McGraw Hill Construction (MHC) on the use of Building Information Modeling (BIM) in North America, conducted in 2007, the potential of BIM to support a transformation of the processes of design and construction has been evident. Further research in Europe, North America and South Korea over the next few years revealed that BIM was seeing wide industry awareness and adoption. Now in the first study conducted by MHC on some of the most significant construction markets globally, it is clear that BIM is beginning to fulfill its promise to deliver improved ways to pursue construction globally.

This study extends the research previously conducted by MHC by allowing immediate comparisons between several different markets that are both markedly different in terms of their construction activity and in terms of the length of time and degree of implementation of BIM. Some countries, such as the United Kingdom, have government mandates encouraging wider BIM adoption that are having an impact on increasing the degree of interest in BIM at a more rapid pace. However, the findings clearly suggest that the benefits firms see from BIM, in terms of their own businesses, the projects they work on and their ability to collaborate and improve workflow in general, are encouraging adoption globally in all the major markets studied.

One aspect of this global research that differs from previous research conducted by MHC on BIM is that this study focuses solely on contractors. In the studies conducted by MHC in North America, a key indicator of the impact of BIM on the industry was the increased level of engagement by contractors. Given their role in projects, contractors are at the heart of the workflows and processes that see the greatest benefits from BIM, but the majority of contracting firms are also typically small companies that work domestically or regionally. Therefore, they are the ideal type of company to consider when examining the value gained from BIM in individual markets.

The findings in this report demonstrate that, despite regional differences, contractors in all of the markets studied are experiencing strong value from BIM. The research results offer countries just emerging in terms of BIM use data and insights from more mature markets, which they can use to understand the opportunity and value of making further investments into BIM. It also helps those with more experience better understand the competitive advantages of using BIM and the baseline of how users in more nascent BIM markets are advancing.

Note About the Data

The data and analysis in this report are based on an online survey conducted with 727 contractors in ten countries that represent some of the largest construction markets globally: Australia, Brazil, Canada, France, Germany, Japan, New Zealand, South Korea, the United Kingdom (UK) and the United States (US).

All data presented throughout this report in charts and tables that is not specifically identified by region or country reflects the average across all the survey respondents.

In addition to this quantitative study, qualitative research with contractors using BIM was conducted in China and India in order to reveal key trends on BIM activity in these markets, despite the challenges presented in doing a quantitative study in these regions.

See the full methodology on page 60 for more information.

Data: BIM Users

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

Number of Years Contractors Have Been Using BIM

BIM has established traction among contractors in all the major construction markets surveyed for this research, with some markets showing greater maturity than others.

BIM is Reaching Maturity Among Contractors in Europe and North America

The technology for modeling buildings, which is now generally termed BIM, was initially developed in Europe, so it is no wonder that **12% of the contractors using BIM in France, Germany and the UK report that they have been doing so for six or more years.** This is particularly true for the UK, where 19% of BIM general contractors claim more than 10 years' experience. This shows strong growth from McGraw Hill Construction's 2010 research in these three countries¹ where less than a quarter (24%) of contractors were using BIM at all.

Meanwhile **BIM adoption among contractors in North America has grown dramatically in recent years, now topping 70%, according to McGraw Hill Construction's research in 2012.**² This is demonstrated by the finding that more than a third (36%) of the BIM-using contractors in the US and Canada have six or more years of experience, greater than twice the number that were at that level in 2009.

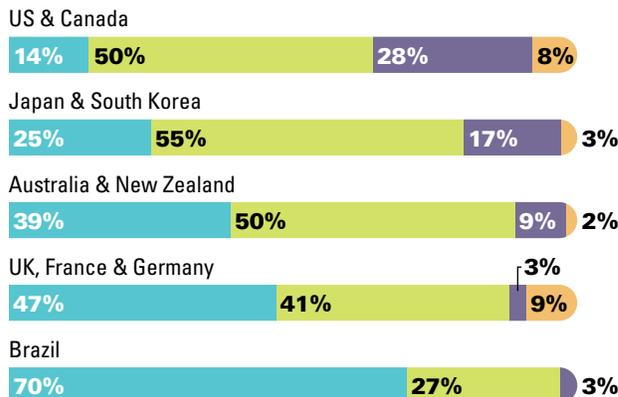
BIM is Becoming Established With Contractors in Other Regions

Japan, South Korea and Australia/New Zealand represent the next tier of maturity, with the majority of their contractor BIM users falling in the three to five years experience tier. This finding reflects the more recent adoption in these regions, but it also shows how rapidly BIM is advancing. For example, South Korean contractors show a 65% BIM adoption rate in McGraw Hill Construction's 2012 research of that region.³ Thus, although this country is relatively new to BIM, there are many contractors participating.

Length of Time Contractors Have Been Using BIM (By Region/Country)

Source: McGraw Hill Construction, 2013

■ 1-2 Years ■ 3-5 Years ■ 6-10 Years ■ 11 or More Years



Large Number of Contractors With One or Two Years of Experience

The UK has the highest proportion (24%) of BIM contractors with just one year of experience, probably due to the recently announced government mandate for BIM.

All regions have experienced a recent influx of trade contractors into BIM usage, with 20% of the total reporting only one year of experience, compared with just 9% of general contractors at that initial stage. In South Korea, while 65% of all contractors were engaged with BIM in 2010, that fell to only 20% when looking just at trade contractors.

Variation by Size of Firm

Across all regions surveyed, large contractors have been using BIM longer than small ones.

- **Over a third (34%) of large firms report over five years of experience versus just half as many (16%) small firms.**
- **Almost half (44%) of small organizations have only one to two years of experience compared with only 13% of large companies.**

1. McGraw Hill Construction, *The Business Value of BIM in Europe*, 2010. 2. McGraw Hill Construction, *The Business Value of BIM in North America*, 2012. 3. McGraw Hill Construction, *The Business Value of BIM in Korea*, 2012.

BIM Implementation

The level of BIM implementation refers to the percentage of a contractor's projects that involve BIM. McGraw Hill Construction has been using a consistent scale for BIM implementation in research studies since 2009.

- **Light Implementation Level: Less than 15% of projects using BIM**
- **Medium: 15% to 29%**
- **Heavy: 30% to 59%**
- **Very Heavy: 60% or more**

Relationship Between BIM Implementation Level and Years of BIM Experience

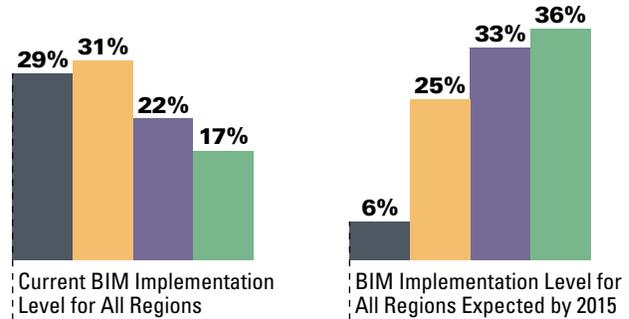
McGraw Hill Construction research consistently shows that as experience advances, users typically deepen their level of BIM implementation. This trend is demonstrated among contractors in this research as well.

- **Across all regions surveyed, the majority (60%) of contractors currently operate at light or medium BIM implementation (i.e., 30% or fewer of their projects).** This is expected to shift dramatically in the next two years, by which time more than two thirds expect to be heavy or very heavy BIM implementers (i.e., more than 30% of their projects).
- **While only a fraction (10%) of the contractors with one to two years of experience are operating at high or very high BIM implementation levels, this percentage skyrockets to almost two thirds (64%) by the time they reach five or more years of experience.**

Contractors' Current and Future Expected BIM Implementation Levels

Source: McGraw Hill Construction, 2013

- Users at Low BIM Implementation (Less Than 15% of Projects)
- Users at Moderate BIM Implementation (15%–30% of Projects)
- Users at High BIM Implementation (31%–60% of Projects)
- Users at Very High BIM Implementation (More Than 60% of Projects)



Differences Among Contractors at High and Very High BIM Implementation Levels

The percentage of contractors from all regions surveyed that are engaging with BIM on more than 30% of their work is projected to increase sharply from an average of 39% to over two thirds (69%) in two years.

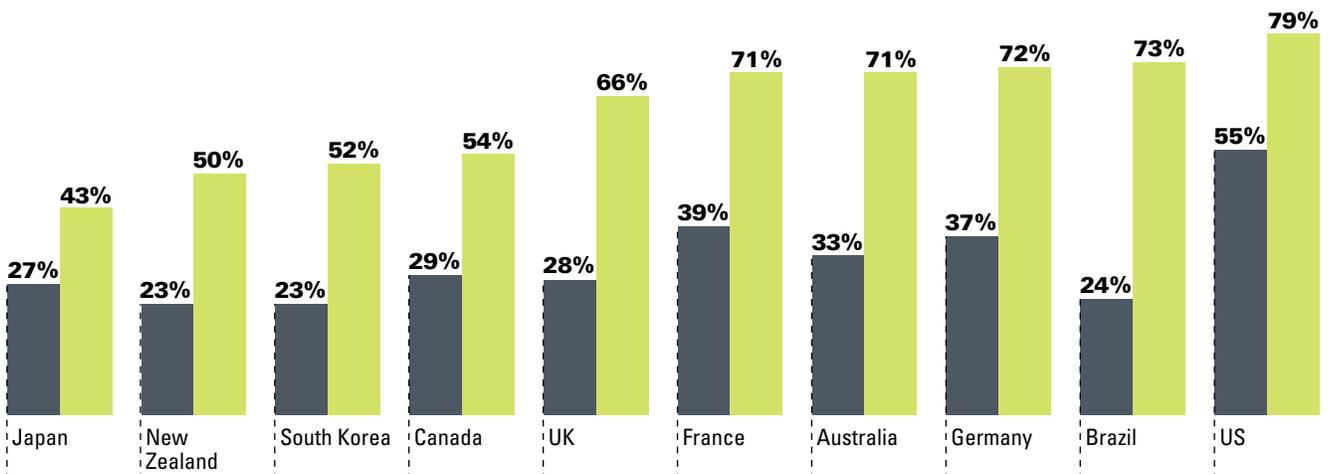
There are interesting differences among the results related to this forecasted increase in BIM implementation.

- At 55%, US contractors already lead the rest of the regions surveyed for high and very high implementation, so their increase to 79% is relatively modest as a percentage, compared with Brazilian contractors who will reach almost the same level (73%), but from starting points of just 24%, representing more than a threefold increase.
- Although general contractors and trades are roughly equal in their current percentages of high and very high level BIM implementers (39% and 38% respectively), the general contractors are predicting reaching 70% in two years, while trades are more modest at 64%.

Percentage of Contractors at High/Very High BIM Implementation Levels (By Country)

Source: McGraw Hill Construction, 2013

■ 2013 ■ 2015



BIM Expertise

Although there is no globally accepted standard by which to rate BIM expertise, in each of its BIM surveys since 2009, McGraw Hill Construction has asked respondents to classify themselves by one of four levels: beginner, moderate, advanced or expert. Although subjective, this self-assessment of skill level into a few broad categories provides a useful way to filter results and understand variances in user perceptions and experiences.

As would be expected, there is a broad variety in the findings about relative levels of BIM expertise in this research.

- While contractors in North America lead for the combined percentage of advanced and expert BIM users (53% in the US and 44% in Canada), Japan shows a similarly high percentage of experts (17%), as does France with advanced users (35%).
- The highest percentage of beginners is in the UK (37%), likely reflecting the recent surge of BIM users in response to the recently announced government mandate for BIM.
- Almost half of contractors from medium and large companies (47% and 49%, respectively) claim advanced or expert BIM skills, compared with just over a quarter of contractors from small companies (29%).

One area of continuity among the findings on BIM expertise is between general and trade contractors, where each has about the same combined percentage of advanced and expert BIM users (42% and 44%, respectively).

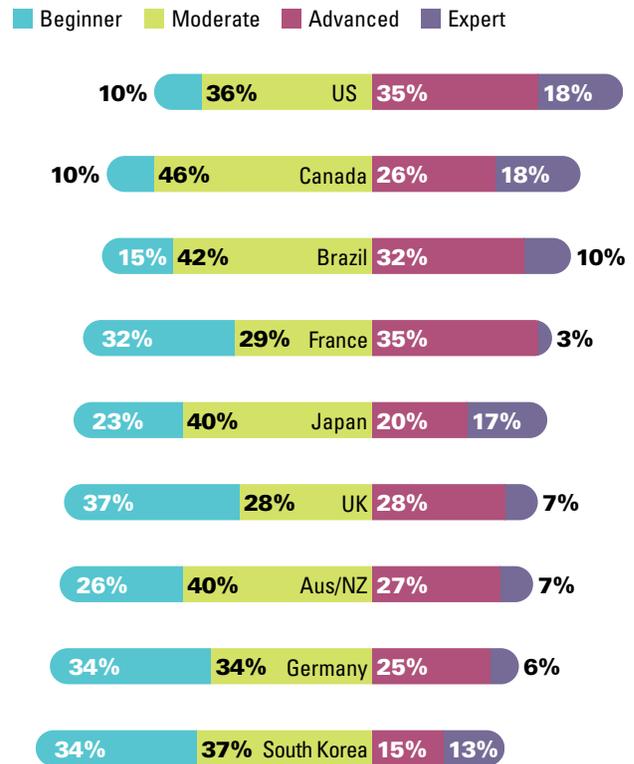
BIM Expertise Correlates Directly With Experience and BIM Implementation

Skill grows directly with experience, demonstrated by the finding that while only 10% of contractors with one to two years of experience are advanced or expert BIM users, the percentage grows to over a third (37%) among three- to four-year users and to almost three quarters (71%) by the time a contractor has five or more years of BIM experience.

BIM expertise also correlates directly with level of BIM implementation. Only 10% of contractors at a low implementation level (less than 15% of projects involve BIM) report having advanced or expert BIM skill, versus those with high and very high BIM implementation (71% and 84%, respectively).

Percentage of Contractors at Various BIM Expertise Levels (By Country)

Source: McGraw-Hill Construction, 2013



Contractors' Perception of BIM Proficiency Among Trades

The success of a BIM project for a general contractor often relies heavily on the BIM proficiency of the trade contractors that are part of the project team.

Steel and Mechanical Contractors Lead the Industry Globally

The steel fabricators/erectors stand out as the leaders for BIM proficiency, with 56% of all general contractors surveyed rating their proficiency as high or very high.

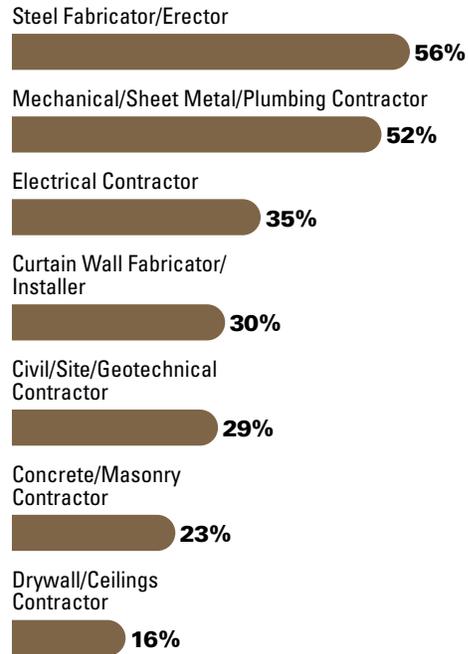
The perception by general contractors of the level of BIM skills among steel contractors increases directly with the general contractors' size, years of BIM experience, level of BIM implementation and their own BIM skill level, as the following percentages of firms perceiving steel contractors to have a high/very high proficiency on BIM reveals:

- 65% of large general contractors versus 44% of small companies
- 68% of contractors with five or more years' experience versus only 40% of those with 1–2 years
- 71% that are operating at a very high level of BIM implementation (over 60% of projects involve BIM), compared with 45% of general contractors at low implementation (under 15% of projects involve BIM)
- 71% of general contractors with expert levels of BIM skill as opposed to just 41% of beginner level users

Following in close second (52%) to the steel contractors in terms of recognition of their BIM proficiency are the mechanical/sheet metal/plumbing contractors. Again, recognition of their BIM skills also increases directly based on general contractors' size and BIM maturity. It stands to reason that as more general contractors expand their BIM programs, these two categories of specialty contractor will rise in esteem and value for their BIM capabilities.

Percentage of General Contractors Rating Trade Contractors' BIM Skills as High/Very High

Source: McGraw Hill Construction, 2013



Regional BIM Proficiency Ratings for Categories of Trade Contractors

The matrix shows the full range of responses for the percentage of general contractors by country that included each type of trade contractor among its top three most proficient with BIM.

Among all regions, French and German general contractors have the highest opinion of the BIM skills of the trade contractors they work with. The fact that BIM began in Western Europe is probably an important factor influencing this finding because the companies have had a longer time to work together to cultivate their BIM skills and processes.

- Electrical contractors rate more highly in France (77%) and Germany (68%) than any of the other regions, where the average is just 30%, and they earn an even higher rating in France and Germany than the universally popular steel and mechanical trades.
- Each category of trade contractor earns at least a 50% top designation from French and German general contractors, which compares very favorably to the average of 32% for all trades in all other regions combined.

Brazil, South Korea and UK show the lowest levels of overall satisfaction with the BIM proficiency of trade contractors. This probably directly relates to the fact that these three regions have the most BIM users with low experience, skills and implementation.

- UK (24%), South Korea (19%) and Brazil (18%) have the highest percentages of contractors with just one year of experience, as opposed to an average of 9% for the other regions combined.
- UK (37%) and South Korea (34%) have the highest percentages of contractors at the beginner level of BIM expertise, versus an average of 20% for the other regions combined.
- South Korea (56%), UK (44%) and Brazil (35%) have the highest numbers of contractors that are at a low level of BIM implementation (doing less than 15% of their projects in BIM), as compared with the average for all other regions of 21%.

Percentage of General Contractors That Selected Individual Trades Among the Top Three for BIM Proficiency (By Country)

Source: McGraw Hill Construction, 2013

	France	Germany	Japan	Aus/NZ	Canada	US	Brazil	UK	South Korea
Steel Fabricator/Erector	66%	61%	70%	51%	48%	62%	37%	62%	41%
Mechanical/Sheet Metal/Plumbing Contractor	63%	61%	50%	57%	38%	66%	24%	24%	24%
Electrical Contractor	77%	68%	60%	36%	35%	35%	16%	18%	10%
Curtain Wall Fabricator/Installer	50%	58%	43%	27%	31%	21%	32%	21%	35%
Civil/Site/Geotechnical Contractor	80%	52%	57%	46%	38%	12%	39%	21%	7%
Concrete/Masonry Contractor	60%	50%	50%	35%	8%	13%	21%	13%	11%
Drywall/Ceilings Contractor	50%	58%	33%	13%	19%	7%	12%	8%	12%

BIM Engagement Index

Each contractor is engaged with BIM in a unique way. McGraw Hill Construction has developed a BIM Engagement Index to quantify engagement with a numerical score for each respondent that participated in this research. The score is derived from the following data:

- Experience: The number of years the contractor has been using BIM
- Expertise: The level each contractor selected as best representing their skill with BIM
- Implementation: The percentage of the contractor's current projects that involve BIM

These responses are weighted to reflect the increasing level of engagement that is represented by more experience, skill and/or implementation. And each of the three criteria is weighted against the others to reflect its relative degree of importance for BIM engagement, with expertise being the most valuable, followed by experience, then implementation level.

- The lowest possible score for each of the three criteria is one point.
- Very heavy implementation (more than 60% of projects involve BIM) earns eight points.
- More than five years' BIM experience earns nine points.
- Expert BIM skill level earns 10 points.

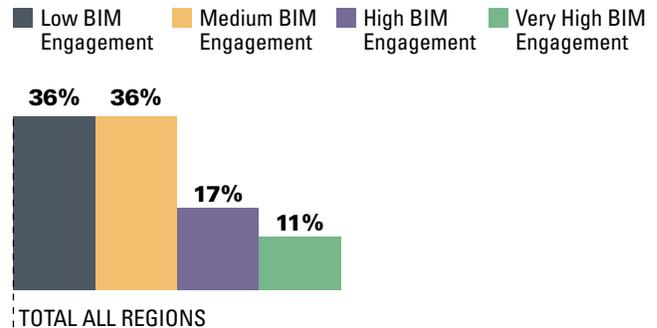
Using this scoring system, each contractor's BIM Engagement Index falls somewhere in a range from three points to 27 points.

To provide a way to analyze a large group of contractors in a region and be able to compare regions, McGraw Hill Construction divided the overall range into four standard levels, from light BIM engagement (firms with generally low experience and skill, who are not doing very many BIM projects), through medium and high levels, to very high BIM engagement (companies with a great deal of experience and expertise who are executing more than 60% of their projects with BIM). Each contractor's BIM Engagement Index score falls into one of these four standard levels.

McGraw Hill Construction intends to track the progress of users and regions through its continuing research over the years as BIM expands and users become more deeply engaged. This benchmarking system for evaluating BIM engagement provides useful targets, expectations and goals for users and entire regions as they advance.

Average Percentage of Contractors in Each BIM Engagement Level

Source: McGraw Hill Construction, 2013



BIM Engagement Level for All Contractors in All Regions

Combining results from all regions that participated in this research, **over one third (36%) of the BIM-using contractors are currently in the low BIM engagement group, while a small number (11%) are at a very high BIM engagement level.** This distribution is appropriate for this point in time of the advancing maturity of BIM across the world, and provides a reasonable framework for tracking future expansion and growth.

Comparing BIM Engagement by Region

The percentage of users in a given region that populate each of the various levels is a useful way to compare regions in terms of their overall degree of BIM engagement.

- The UK shows a very large percentage of low engagement users (54%) due to the recently announced government BIM mandates, but also has a relatively large population (28%) at high and very high engagement levels.
- Due to both the length of time that BIM has been actively deployed there and the rapid pace of its growth, the US has both the fewest low-level users (21%) and the largest numbers at high and very high levels (22% each).

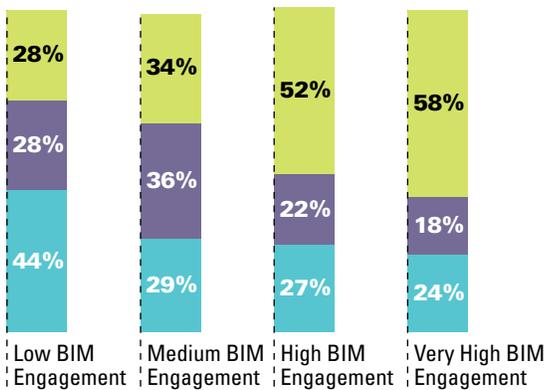
Impact of Contractor Size on BIM Engagement

Consistent with other findings that larger contractors have more BIM experience, more advanced skills and deeper levels of implementation, there is a direct relation between size and overall BIM engagement.

BIM Engagement Level (According to Firm Size)

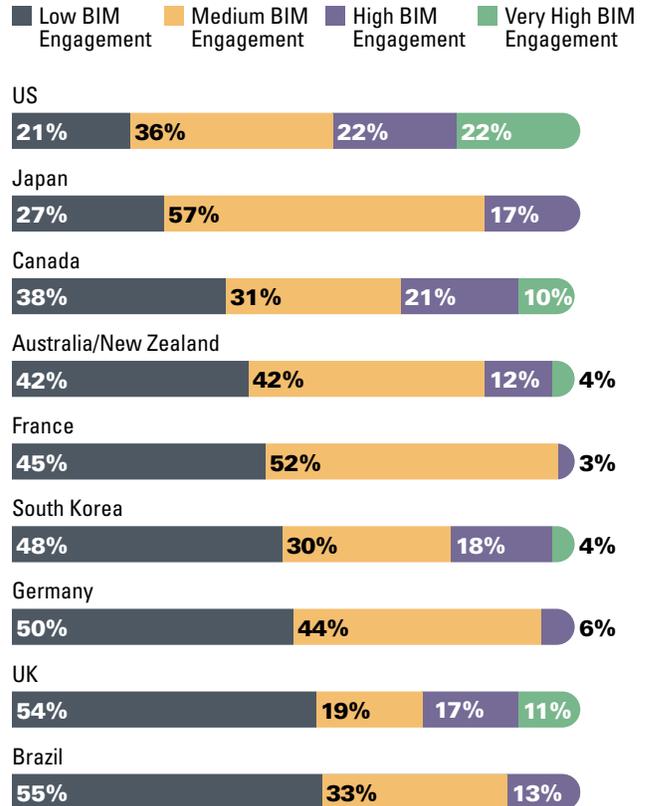
Source: McGraw Hill Construction, 2013

- Large Contractors
- Medium Contractors
- Small Contractors



Percentage of Contractors in Each BIM Engagement Level (By Country)

Source: McGraw Hill Construction, 2013



Impact of BIM Expertise on Team Formation

As more companies engage with BIM, the value of having other team members with BIM experience becomes increasingly important. However, companies currently are taking different approaches to using BIM expertise as a selection factor in the team formation process.

About a third (30%) of the contractors surveyed make a practice of requiring BIM on their projects.

- **This is more common among medium (37%) and large (33%) contractors, compared with only 16% of small companies that may not feel they have the influence to demand BIM.**
- **BIM is also much more frequently mandated by contractors with high and very high BIM implementation levels (48% and 51%, respectively), and expert (59%) and advanced (43%) BIM skills.**

Over half (53%) report that they encourage BIM expertise but do not yet require it. In addition, only 17% say that BIM expertise does not affect their decisions, a group which includes:

- 25% of small companies
- 27% of contractors with just one to two years of experience
- 34% of beginner skill level contractors
- Over a third (37%) of all contractors that are at a light BIM implementation level (doing less than 15% of their work with BIM)

These findings suggest that as BIM becomes more established in many regions, all contractors will increase the degree to which they require BIM capability on their project teams.

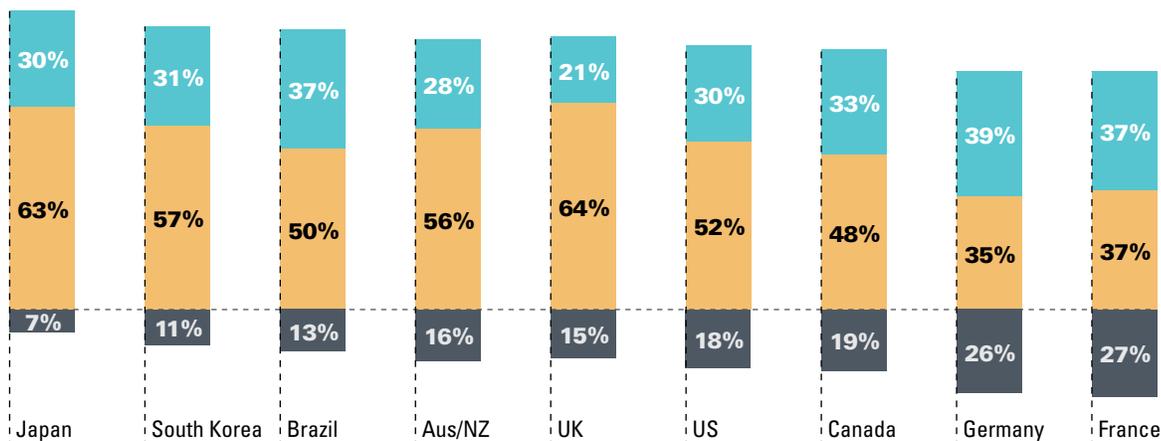
Variation by Country/Region

Japanese (7%) and South Korean (11%) contractors lead in reporting the smallest percentage of BIM-using contractors that do not consider BIM expertise in their team-formation process. **With over a third of contractors requiring it, Germany (39%), France (37%) and Brazil (37%) show the greatest commitment to BIM as a vital factor in team formation.**

Contractors' Approach to Requiring BIM Expertise as a Factor in Team Formation (By Country/Region)

Source: McGraw Hill Construction, 2013

- We require companies be experienced in BIM.
- We encourage BIM expertise, but do not require it.
- BIM expertise does not affect our decisions.



BIM Influence Grows Via Government Mandates

As BIM adoption continues to grow around the world, governments are promoting its ability to eliminate waste on public projects and even mandating its use as a part of construction sector reform, cost-saving efforts and climate-change mitigation strategies.

United Kingdom (UK)

Under Francis Maude, Minister for the Cabinet Office, the UK government is implementing a construction strategy that states BIM will be a key part of the government's procurement of public buildings and, by 2016, model-based BIM will be mandatory on all public sector projects, including delivery of all project and asset information, documentation and data. The UK government has also developed a BIM Task Group to support and assist both government clients and supply-chain contractors in transitioning their work practices to BIM and electronic delivery.

The overarching goal of this strategy is to reduce capital costs and carbon dioxide creation from the construction and operation of the built environment by 20%. The idea is that using BIM will unlock project efficiencies through enabled processes such as early clash detection and building component prefabrication and allow for better sustainable building design and operation.

"We have a managed program that helps the government departments be consistent about how they ask for information from BIM processes. We also have a set of activities to help the supply chain meet demands from the client side," says Adam Matthews, head of European development for the UK BIM Task Group. "We work both sides of the equation. It's very much a support role we provide to government departments, then on

the supply side we help with the foundation activities, we put in place standards, training support and guidance."

The BIM Task Group is halfway through a five-year rollout to bring all publicly funded projects up to what the Task Group defines as Level 2 BIM. In the UK maturity ramp, Level 2 is defined as "file-based collaboration and library management." This includes a series of domain-specific models—such as architectural, structural, and mechanical, electrical and plumbing [MEP] services 3D models—all within a single environment where structured data can be shared. The information sharing environment being used by the BIM Task Group is a version of the Construction Operations Building Exchange (COBie) called COBie UK 2012. COBie is a data-exchange format created by Bill East of the US Army Corps of Engineers. COBie helps capture and record important project data at the point of origin, including equipment lists, product data sheets, warranties, spare parts lists and preventive maintenance schedules.

The BSI (British Standards Institute) has created an information sharing standard called PAS 1192:2. It's a publicly available specification created in consultation with industry and government institutions that delineates a workable definition of Level 2 technology compliance in terms of building project information sharing. PAS 1192:2 is not a standard that mandates hardware or software.

It, rather, defines key exchange points between client and supply chain at different stages of a building project and how to exchange information when those points are reached. It sets a clear framework for information management by identifying deliverables to be produced (such as a BIM Execution Plan, a 3D building information model and others), when they are to be produced, what information sources they draw from and what they can be used for. PAS 1192:2 also defines best practices for these project deliverables. It lists more than 20 items that should form its Employers Information Requirement at a minimum. Design software, other tools and work-process decisions are left up to the individual project teams but are required to be defined at a project's outset in documents such as the BIM Execution Plan.

The Task Group is currently working on developing PAS 1192:3, a standard for ongoing operational use of model information for facilities and asset management. The BIM Task Group, now three years into its five-year program, is starting to see adoption of BIM practices by government clients. A number of departments in the UK government, including the Ministry of Justice and the Highways Agency, are engaged and starting early adopter projects. Many of the UK's professional institutions and federations are playing a role in Level 2 uptake. The Royal

Institute of Chartered Surveyors (RICS) has released a series of BIM manager's training courses that align closely to the BIM Task Group's 2012 learning outcomes document. The Royal Institute of British Architects (RIBA) is also playing a role in Level 2 adoption. RIBA's 2013 Plan of Work document aligns eight stages of work in a building project to data exchange points outlined in PAS 1192:2.

Singapore

Singapore has implemented the world's first BIM-based rapid building permitting system. The Building and Construction Authority (BCA) led a multi-agency effort in 2008 that implemented "e-submission," the world's first model-based submission system. E-submission streamlines the process for regulatory submission. Project teams only need to submit one building information model, which contains all of the information needed to meet the requirements of Singapore's regulatory agencies. In 2010, nine regulatory agencies accepted architectural 3D models for approval through e-submission. In 2011, MEP and structural BIM models were accepted via e-submission. More than 200 projects have been approved via e-submission to date.

Scandinavia

In Norway, the civil state client Statsbygg mandated BIM use for the lifecycle of their buildings. By 2010, all of Statsbygg projects were using the industry foundation class file format (IFC/IFD-based BIM). IFC is a platform neutral, open, object-based file format developed by the BuildingSMART Alliance to facilitate interoperability in the AEC industries.

BuildingSMART is an international non-profit organization that aims to improve the exchange of information between software applications.

In Finland, the state property services agency, Senate Properties, has required the use of BIM for its projects since 2007. Many public property and government clients also require BIM for their projects in Denmark and Sweden. The high rate of adoption of ArchiCAD as a BIM design tool and the high use of IFC for file and information sharing has led to rapid adoption of BIM practices in the Scandinavian design and construction industries.

Norway, along with the UK, recently hosted a meeting of public owners from 13 European nations in Brussels last October to explore ways of working together in support of public estate policy goals and improving the competitiveness of the EU construction sector.

US BIM Initiatives

In the US, the General Services Administration, the agency that manages all federal buildings, has been requiring BIM through its National 3D-4D-BIM program through the Office of the Chief Architect of its Public Buildings Service. The National BIM Standard (NBIMS 2.0) from the BuildingSMART Alliance is continuing to evolve with version 3.0 expected to be released in early 2014. While NBIMS is not a mandate or required standard, it does enjoy the backing of many major software vendors and several of the bigger design firms and construction companies.

"There are more best practices out there than standard practices," says Deke Smith, FAIA, program director at the Washington,

DC-based National Institute of Building Sciences, a non-profit, non-governmental organization that includes BuildingSMART as one of its member councils. "It doesn't make any sense to have all the firms developing their own best practices."

NBIMS 2.0 is based on sharing information via IFC, an open-file format. Smith says that improvements made to the file format, itself, by BuildingSMART will allow IFC to be used for information sharing on any BIM project.

"IFC always worked," Smith says. "It was the software implementation of it that did not work too well. Now we have validated that it does, indeed, work... there is an IFC certification 2.0 administered by BuildingSMART that confirms that it can work for this level of information exchange."

As with the UK BIM mandate, NBIMS also allows information sharing via COBie. The version of COBie that will be in version 3 of NBIMS is the same version being used by the UK BIM Task Group. It was actually added in NBIMS 2.26. Smith says that once the UK BIM Task Group started using it, more software vendors came around and said "Okay, it's worth it to us to invest in writing the software for this."

"We want all vendors to be able to write software to support the NBIMS," Smith explains. "The success we have had so far with COBie is going to help us. It's a very good example of how information can flow from design through construction with the intent of delivering that to the facility manager. As that grows and people become more comfortable with sharing information, we believe adoption will grow." ■

Data: BIM Benefits, ROI and Investments

BIM Benefits

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

Top BIM Benefits

The business benefits of BIM will drive its continued global expansion and the increasing depth of BIM engagement for each contractor. Since 2009 McGraw Hill Construction has been tracking the degree to which BIM users are receiving specific benefits as a way to predict the resulting increase in implementation and provide reasonable expectations for users in the early stages of their engagement.

CONTRACTORS' TOP THREE BIM BENEFITS

For purposes of this research, contractors were asked to select three benefits from a list of 15 that they would rate as a top benefit.

Across all regions that participated in this research, BIM's impact on reducing errors and omissions ranked as the top benefit. Eliminating errors and omissions also enhances other high-scoring downstream benefits such as reducing rework, construction cost and overall project duration. So as BIM engagement increases, the entire project delivery cycle is improved.

Leveraging BIM to improve collaboration with owners and design firms also scored very highly with over a third (35%) of contractors. This finding highlights the increasing trend toward greater integration among all team members, one of the most important trends from model-oriented projects.

Benefits related to business development consistently show value in McGraw Hill Construction BIM research. Here, marketing new business, offering new services and maintaining repeat business all earn a top rating from between 10% and 20% of all contractors.

Certain benefits are still emerging, such as improved safety and faster cycle times for workflows, and for client and regulatory approvals.

There are three types of BIM benefits examined in this research:

- Internal Benefits: Business benefits that accrue primarily to the contractor that is using BIM
- Project Benefits: Benefits that primarily improve the project on which BIM is being deployed
- Process Benefits: Benefits that enhance project workflows and processes between the parties on a BIM project

Percentage of Contractors Citing BIM Benefit as One of Top Three for Their Organization

Source: McGraw Hill Construction, 2013



Top Internal Benefits of BIM

Many contractors are turning BIM capability to their advantage as a way to improve profitability and enhance business development.

- **French contractors tend to be at the extremes, ranking first for increased profits and maintaining repeat business, but second to last in believing that BIM is enhancing their overall image and last in leveraging BIM to market new business.**
- **The South Koreans and Japanese, on the other hand, are the leaders in marketing new business and offering new services, perhaps because BIM is more of a novelty in their regions.**

MORE TRADE CONTRACTORS GIVE TOP RATING TO INTERNAL BENEFITS THAN GENERAL CONTRACTORS

Three of the five internal benefits studied in this research show interesting differences between general and trade contractors' ratings.

- **Enhancing Your Organization's Image:** This top rated internal benefit across all contractors scores especially strongly with trade contractors, where 43% place it among their top three BIM benefits versus only 31% of general contractors. This may relate to the growing awareness of the importance of having all the build team members skilled with BIM; therefore, trade contractors with BIM skill are recognized and acknowledged.
- **Increased Profitability:** In the middle of the ranking for internal benefits with 14% of all contractors rating it as one of their top three benefits, improved profitability earns a top rating from almost twice as many trade contractors (22%) than general contractors (12%).
- **Maintaining Repeat Business:** Owing to the nature of repeat business for trade contractors with general contractors that are successful working with them, 16% of trade contractors rate this benefit among their top three, as compared with only 12% of general contractors. This reflects how BIM can consistently make a trade contractor more attractive to general contractors as a repeat project team member.

Percentage of Contractors Citing Internal BIM Benefits as One of Top Three for Their Organization (By Country)

Source: McGraw Hill Construction, 2013



Top Project Benefits of BIM

Contractors in all regions report that projects are benefiting directly from BIM.

Reduced errors and omissions earned the highest overall average among all BIM benefits (with 41% of contractors including it among their top three) and a top rating from almost two thirds of South Korean (63%) and over half of Canadian (51%) contractors. The relatively low ranking given to it by French and German contractors may relate to errors and omissions being less of a problem in those regions, therefore other BIM benefits earned more recognition from them, such as profitability (39% in France) and reduced overall project duration (38% in Germany).

Reduced rework is an important benefit because it can affect project cost and duration, as well as positively impacting productivity and the overall efficiency of the project delivery process. **Forty percent of contractors with a very high BIM Engagement Index say reduced rework is among their top three BIM benefits compared with just 28% of those with a low BIM Engagement Index,** highlighting the increasing impact of this benefit on more BIM-intensive projects.

LARGE CONTRACTORS RATE SEVERAL PROJECT BENEFITS MORE HIGHLY

Company size influences ratings of project benefits, perhaps because of the complexity of projects and the resulting scale of the positive impact that BIM benefits can bring to larger firms.

- **Reduced errors and omissions** earns a top three rating from half (50%) of large contractors as opposed to a third (34%) of small ones.
- **Reduced rework** is also more widely appreciated among large contractors (40%) than small (23%).

Top Process Benefits of BIM

Contractors' use of BIM is improving project workflows and processes on their projects.

The ability for contractors to collaborate more effectively with owners/design firms is the leader among process-related BIM benefits.

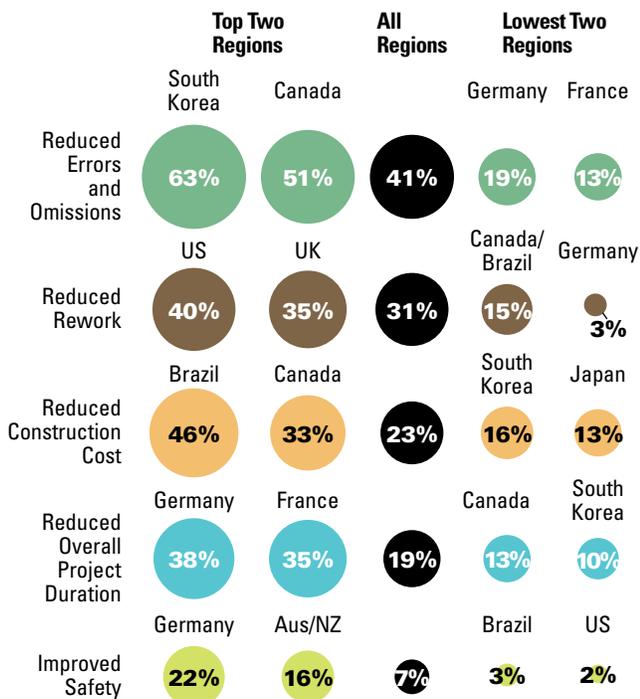
- **This benefit earns a top three rating from over twice as many contractors at a very high BIM engagement level (48%) than those at a low BIM engagement level (22%), highlighting the collaborative value of BIM.**
- **More large contractors select this as a top benefit (41%) than small firms (25%), probably an indication of the greater complexity and larger teams their projects entail, where more collaboration yields greater benefit.**

Better cost control and predictability is a critically important benefit that will greatly improve project delivery, and although almost half (44%) of German firms cite it among their top choices, the average across all regions is only 21%. This indicates a need for greater maturity and experience for more contractors to take advantage of it.

Faster cycle times of workflows, and client and regulatory approvals are still developing as benefits, with only 22% of German and 20% of Japanese contractors designating any of them as top benefits.

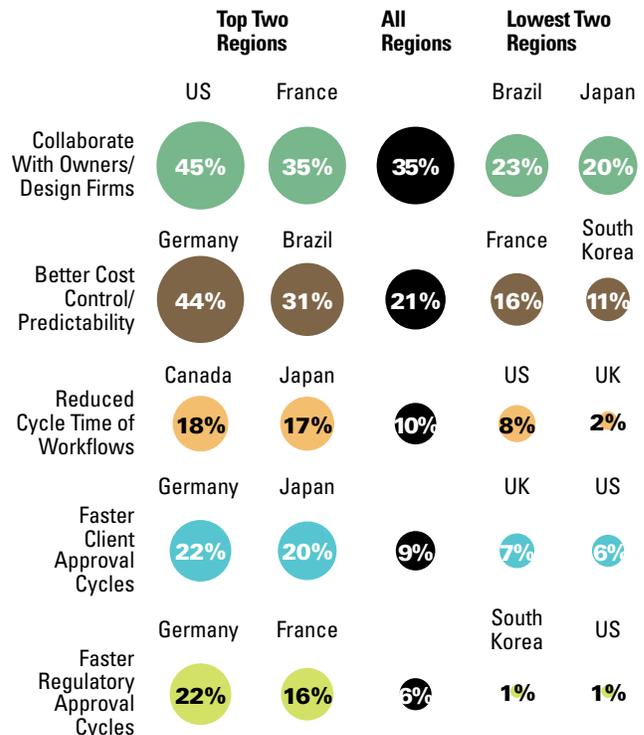
Percentage of Contractors Citing Project BIM Benefits as One of Top Three for Their Organization (By Country)

Source: McGraw Hill Construction, 2013



Percentage of Contractors Citing Process BIM Benefits as One of Top Three for Their Organization (By Country)

Source: McGraw Hill Construction, 2013



Contractors' Current Perception of ROI

There is no single widely accepted method for calculating a company's return on its investments (ROI) in BIM, but most users have a perception of the value they are receiving for the time, money and effort they have expended on their BIM program. The ROI discussed throughout this analysis is not project ROI, but the estimated ROI on investment in BIM.

Perceived ROI on BIM

Since 2009 McGraw Hill Construction has asked users to share their perception of ROI as part of its BIM research in Asia, Europe and North America. Each BIM user is asked to estimate if their ROI on their BIM investments falls into one of seven numerical ranges. The seven ranges are divided into three broad tiers for trend analysis.

- **Tier One: Negative/Break-Even ROI on BIM Investments**
 - Negative
 - Break-Even
- **Tier Two: Moderately Positive ROI on BIM Investments**
 - Less Than 10%
 - 10%–25%
- **Tier Three: Very Positive ROI on BIM Investments**
 - 26%–50%
 - 51%–100%
 - Over 100%

Typical Pattern of ROI on BIM

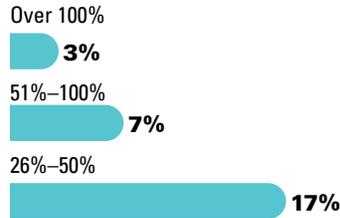
A consistent pattern emerges across those studies.

- **Companies in their early years of BIM adoption exhibit negative or break-even ROI on BIM investments,** especially smaller organizations for which it takes longer to absorb the initial costs of software, hardware training and development of content and business processes to support BIM.
- **Contractors generally reach positive ROI more quickly than design professionals** because they generally receive a greater share of the financial benefits of BIM (e.g., reduced rework, increased profits, etc.) than design firms.
- **Users with the deepest BIM engagement, as represented by their skill, years of experience and level of BIM implementation, report the highest ROI on their BIM investments.**

Contractors' Perceived ROI on BIM

Source: McGraw Hill Construction, 2013

Very Positive ROI



Moderately Positive ROI

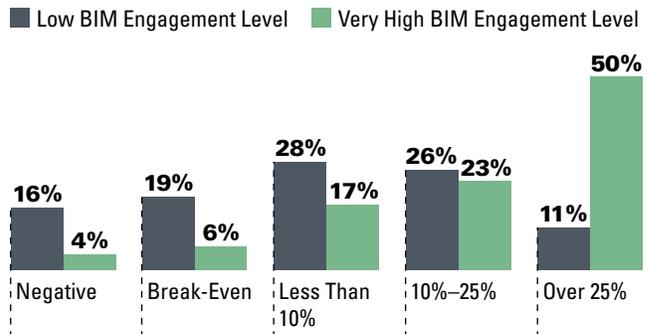


Negative or Break-Even ROI



Contractors' Perceived ROI on BIM (According to BIM Engagement Level)

Source: McGraw Hill Construction, 2013



ROI Among Contractors in this Research

The first chart shows the perceived ROI on BIM investments from contractors surveyed in this research.

- Three quarters (75%) of contractors currently believe they have a positive ROI on BIM investments.
- More trade contractors (14%) are receiving greater than 50% ROI on their investments in BIM than general contractors (10%).
- At the same time however, almost a third (31%) of trade contractors are in the negative or break-even groups, compared with less than a quarter (23%) of general contractors, probably representing many recent adopters that are still absorbing the impact of BIM investment.

Impact of BIM Engagement on ROI

As is consistent with all previous McGraw Hill Construction BIM research, the contractors in this study with deeper levels of BIM engagement are reporting much higher ROI on their BIM investments.

- Most (90%) of the contractors at very high BIM engagement have a positive ROI on their investments versus only about two thirds (65%) of the low BIM engagement firms.

- Half (50%) of the contractors that have very high BIM engagement are in the very positive ROI tier compared with only 11% of their low engagement counterparts.

Variation by Country/Region

The relatively large percentage of contractors reporting negative or break-even ROI on BIM investments in the US (26%), UK (41%) and South Korea (52%) probably reflects a recent increase of adoption by contractors in those regions, versus the more stable markets in France, Germany and Japan (3% each).

Even with the relatively large number of negative and break-even contractors in the UK (41%), the overall average for positive BIM ROI in Western Europe (UK, France and Germany) is 84%. This is up sharply from 2010, when McGraw Hill Construction research found only 40% of Western European contractors reporting positive ROI on their BIM investments.

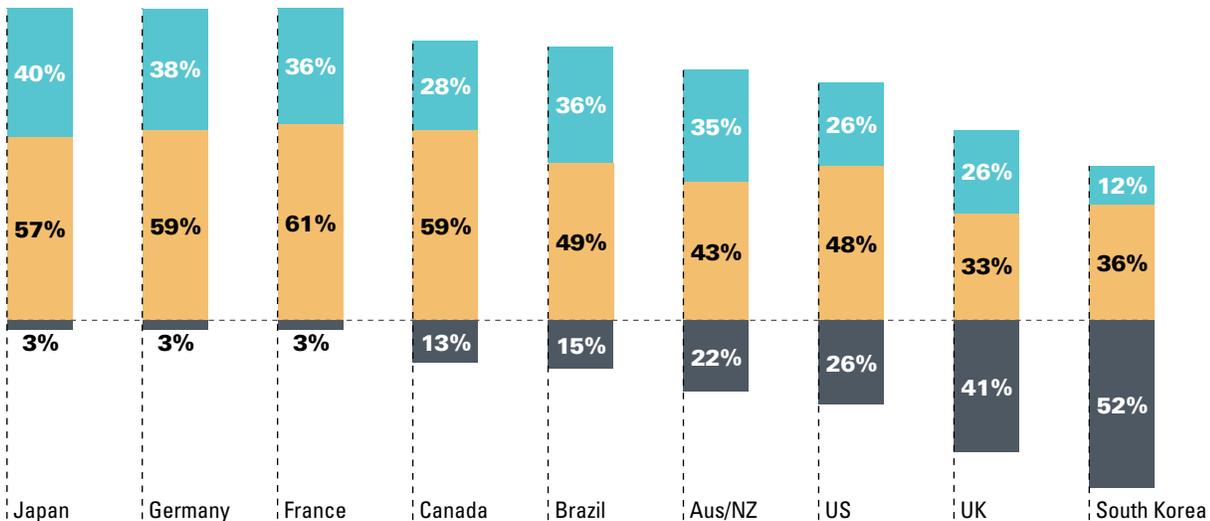
Future Dynamics of BIM ROI for Contractors

The near future will be very dynamic as more contractors adopt BIM, populating the negative or break-even ROI tier, and existing BIM users move up into the positive tiers by gaining skills and experience, implementing more deeply across their organizations and amortizing the initial startup costs of their BIM programs. It can be expected that this current snapshot of regional ROI on BIM investments will continue to change dramatically until BIM reaches a broad level of implementation across all regions and the cost/benefit ratio stabilizes for all users.

Contractors' Perceived ROI on BIM (By Country)

Source: McGraw Hill Construction, 2013

- Very Positive ROI (Over 25%)
- Moderately Positive ROI (Up to 25%)
- Negative or Break-Even ROI



THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

Formal Measurement of ROI

Many contractors engage in formal measurement of their ROI for BIM investments at a project level. **The contractors surveyed for this research broke down into almost equal thirds in terms of their frequency of measuring ROI.**

- **Regular Measurement:** 33% measure BIM ROI on at least 25% of their projects, including a small group (6%) that measure it three quarters of the time or more.
- **Occasional Measurement:** 35% do it, but less than a quarter of the time.
- **No Measurement:** 32% are not currently measuring their ROI on BIM investments at all.

Over a third (34%) of general contractors are conducting regular measurement, compared with only 22% of trade contractors. And 43% of the trades are not measuring at all, compared with under a third (31%) of the general contractors.

BIM Engagement and Measurement of ROI

Contractors' level of BIM engagement correlates strongly with their approach to measuring ROI on BIM investments.

- **Over twice as many contractors at the medium (41%), high (41%) and very high (43%) BIM engagement levels are in the regular measurement group,** versus only 17% of the low engagement firms.
- **The largest portion of low BIM engagement contractors (45%) are in the occasional measurement group, with another 38% not measuring at all.**
- **32% of the very high BIM engagement contractors and 30% of the high BIM engagement ones do not measure,** perhaps because BIM has already established its value at their firms and it no longer needs to be formally measured in order to justify continued investment.

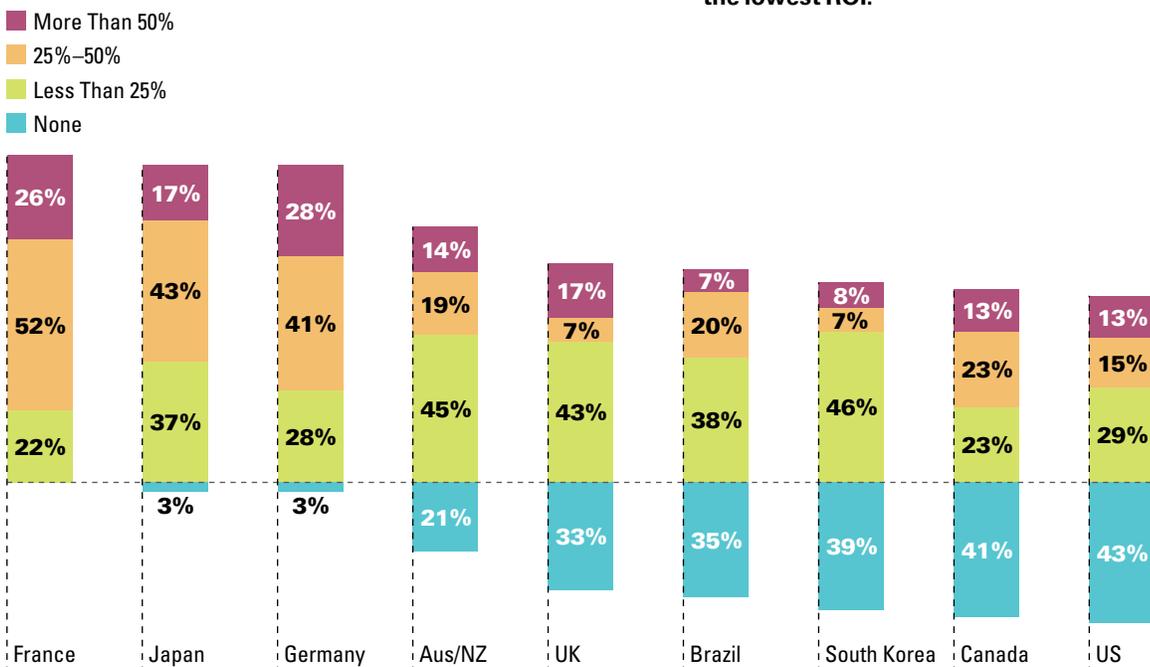
Measurement of BIM ROI by Region

The findings appear to support the old adage, "You get what you measure."

- **The regions that most actively measure ROI on BIM investments (France, Japan and Germany) also report the highest ROI on BIM.**
- **Two of the three regions that measure least frequently (US and South Korea) are also among the three with the lowest ROI.**

Percentage of Projects on Which Contractors Formally Measure BIM ROI (By Country)

Source: McGraw Hill Construction, 2013



Importance of ROI Metrics

Contractors that measure ROI on BIM investments use a variety of metrics to do so. Contractors were asked to rate the relative importance of five basic categories of metrics to their company's process of measuring ROI. **Financial metrics are the most popular among all contractors, with an average of 69% rating them with high or very high importance.**

- **Financial Metrics** (such as reduced cost, higher profitability, higher productivity)

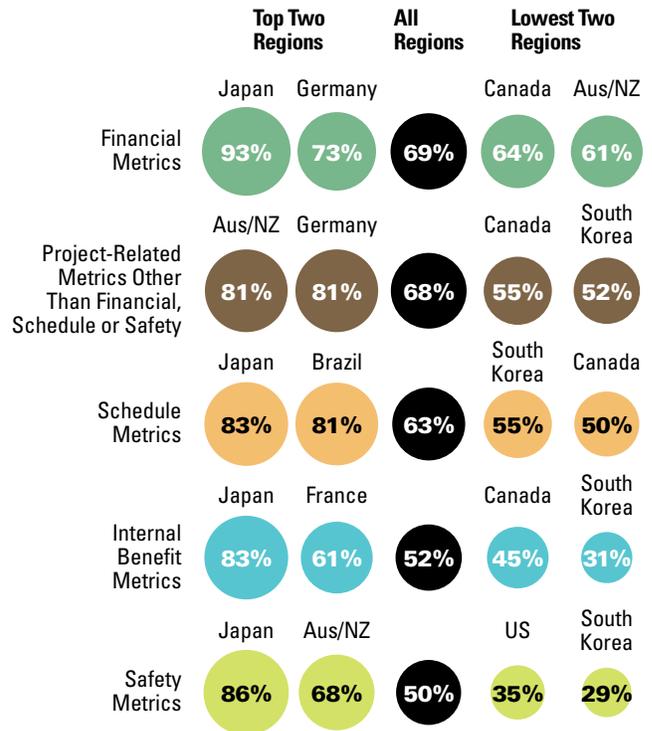
 - These metrics have the top single rating among all metrics in all regions (93% in Japan) and the highest low rating (61% in Australia/New Zealand).
 - They are favored somewhat more by general contractors (69%) than trade contractors (62%).
 - They are especially preferred by contractors at a very high BIM engagement level (81%).
- **Schedule metrics** (such as faster project delivery): **These metrics are rated with high or very high importance by almost a third (63%) of all contractors surveyed.** They are given a very high importance rating by 31% of general contractors, compared with only 20% of trade contractors, likely due to the general contractor's greater role of responsibility for overall project schedule.
- **Safety metrics:** Methods for measuring the impact of BIM on safety are still an emerging metric among contractors globally.

 - Safety only scores as high or very high with 50% of all contractors, with small companies (56%) leading large (46%).
 - Japanese firms (86%) stand out in giving it a top rating. The relatively low rating from South Korean (29%) and US (35%) contractors should be interpreted as a lack of experience with measuring BIM impact on safety rather than a lack of interest in safety by those contractors.
- **Project-related metrics other than financial, schedule or safety** (such as fewer RFI's, fewer unplanned changes, higher customer satisfaction, less disruption in project process)

 - This broad category appeals to over two thirds (68%) of all contractors and almost three quarters (73%) of those at a very high BIM engagement level.
 - Slightly more general contractors (69%) rate this category at high or very high importance than trade contractors (62%), probably because of their greater ability to experience positive impact over the scope of the full project.

Percentage of Users Citing ROI Metrics as High or Very High Importance (By Country)

Source: McGraw Hill Construction, 2013



- **Internal benefit metrics** (such as enhanced marketing, offering new services, staff recruitment/retention)

 - Over half of general contractors (53%) give high/very high ratings to these types of metrics, compared with trade firms (41%).
 - Twice as many of the contractors with very high BIM engagement rate this category of metric as top (very high) in importance versus just 10% of those with low BIM engagement, indicating that commitment to BIM directly impacts business performance.

Improvements to ROI

Contractors were asked to designate the three most important BIM benefits in terms of how much an increase in each specific benefit would directly improve their company's ROI on BIM investments. The top five are shown in the chart, both by region and in total, with analysis by engagement level and firm type listed below.

Contractors' BIM Engagement Level Influences Their Preferences

Not surprisingly, the contractors with deeper BIM engagement have strong opinions about what benefits, if increased, would improve the ROI on their investment in BIM.

Contractors with low BIM engagement gave more value to better communication and understanding from 3D visualization (57%) than those with very high BIM engagement (48%). This is likely due to the relative novelty of their level of exposure to this potent tool among these early users, who until recently had to rely on 2D drawings and a few sketches to understand complex design intent. Much more experienced BIM users come to take this capability for granted and have likely gotten as much value as possible from it and, therefore, are focused elsewhere for improvement.

To that point, the contractors most highly engaged with BIM cited the improved process outcomes (77%) and improved productivity of personnel (43%) more frequently than those on the lowest engagement tier (47% and 34%, respectively). This is a natural outcome of their extension of BIM benefits beyond improved visualization into substantial business benefits related to workflow efficiency, improved utilization of resources and better project outcomes.

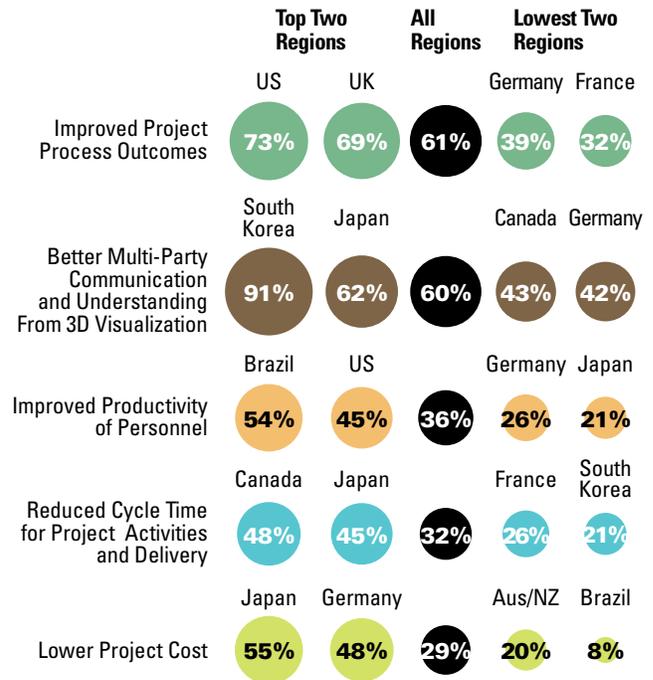
Variation by Type of Firm

A greater percentage of general contractors included improved process outcomes such as fewer RFI's (Requests for Information) and field coordination problems (62%), reduced cycle time for workflows and project delivery (33%), and lower project cost (29%) among their top three than trade contractors (53%, 26% and 21%, respectively). This may relate to the more administrative nature of their role on projects.

Several other BIM benefits, which did not score among the top five shown in the chart, showed distinct preferences by trade contractors:

Percentage of Users Citing Factors That Would Have High/Very Impact on Improving ROI for BIM (By Country)

Source: McGraw Hill Construction, 2013



- Half again as many trades (21%) included improved jobsite safety in their top three than did general contractors (14%), which makes sense because it affects them more directly.
- A similarly high proportion of trades (40%) selected increased ability to prefabricate as a top driver of increased ROI, compared with 28% of general contractors. This is understandable because of their direct involvement with that practice and the outstanding benefits it provides for productivity, speed, safety and quality. For more information, refer to McGraw Hill Construction's 2011 *Prefabrication and Modularization SmartMarket Report*.
- Positive impact on sustainability garnered a top-three designation from 19% of trade contractors, compared with 15% of general contractors, perhaps because of several trades' intimate involvement with systems that influence energy performance and on the specific aspects of reducing material and labor utilization on the jobsite.

BIM Investments

BIM programs require ongoing investments in hardware, software, training and processes in order to realize their potential value. Since 2009 McGraw Hill Construction has been tracking the categories of BIM users' investments, both in terms of current spending and plans for future investing.

The chart at right shows the percentage of contractors that anticipate top (high or very high) levels of priority on each of eight specific categories of BIM investment over the next two years and compares that total average with the average of contractors with a high/very high level of BIM engagement. **Notably, no investment earned less than a third (32%) of contractors' designation as top priority, so investment plans overall are diverse and robust.**

Top Investments Planned by All Contractors

On average, contractors around the world are focusing most highly on investing in their internal collaborative processes, BIM training and BIM software. These investments align around the central goal of improving a company's BIM capabilities by bringing in more technology, training staff on its use and creating the internal BIM workflows and processes for them to work collaboratively in a model-based environment. These three types of investments are the fundamental building blocks of a contractor's BIM program.

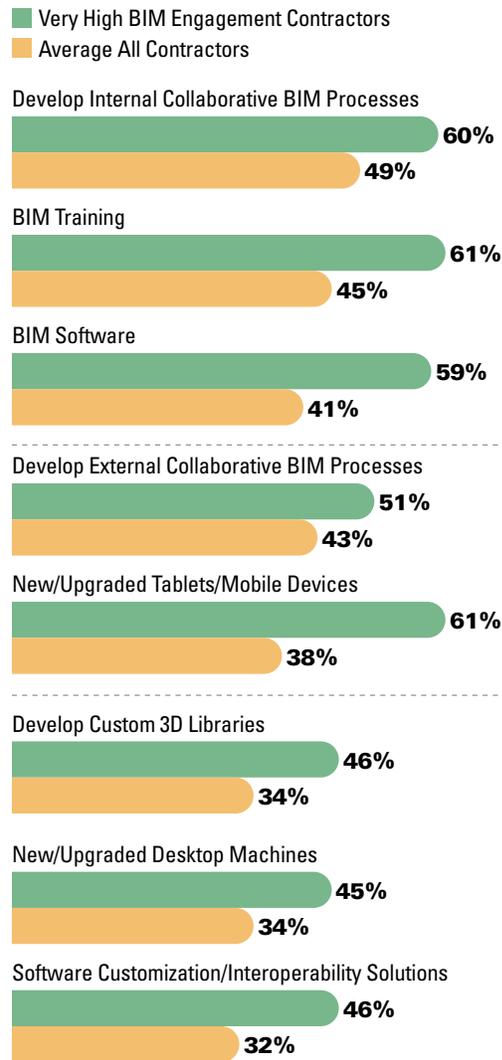
The next lower tier of planned investment priorities focuses outside the contractor's office.

- Developing external collaborative BIM processes:** Collaboration skills, standardized deliverables and repeatable workflows are vital to improving the effectiveness of the broader BIM ecosystem, and they represent an important evolution of BIM maturity for the whole industry.
- New/upgraded tablets/mobile devices:** Bringing the value of BIM from the office to the project site is an area of increasing interest for all contractors, and investing in the hardware and connectivity to enable that is a first important step.

Percentage of Contractors Assigning High or Very High Importance to Specific Categories of BIM Investments Over Next Two Years

(According to All Contractors and Those With a High Level of BIM Engagement)

Source: McGraw Hill Construction, 2013



The final three investment priorities are more specialized, addressing unique needs of individual companies.

- **Developing 3D custom libraries:** Model-based content for BIM is critical. Although a growing number of manufacturers produce BIM content for their products, most BIM users need additional content that supports their specific activities. Typically a combination of internal skills and third party content creation consultants are filling this need.
- **New/upgraded desktop machines:** Depending on the software that is being used and the file sizes that are being created and managed, many contractors need to upgrade their desktop hardware, and they will typically procure powerful computers for any new BIM staff.
- **Software customization/interoperability solutions:** Once contractors engage with BIM, it becomes important to tailor the functionality to their specific needs and to integrate the data with other applications. Again, a combination of internal skills and third-party IT integration specialists are meeting contractors' needs.

Investments Planned by Contractors at a Very High Engagement Level

Keeping an eye on the behavior of the industry's BIM leaders is a good way to predict what everyone else is likely to be doing shortly thereafter. In this instance the very high BIM Engagement contractors plan significantly greater-than-average investments in all categories.

- **The biggest difference is with new/upgraded tablets/mobile devices, where 61% of the most engaged contractors are citing its top importance versus just 38% of the total.** This speaks to the goal among the more advanced users to get the value of BIM out to the staff in the field.
- **BIM software shows the second largest variance,** likely indicating that the most engaged contractors plan to add more BIM users to their staff.

Variation by Region

Combining the percentages of contractors in every region that designated each BIM investment as a top (high or very high) priority over the next two years, produces an average for each region that reflects the intensity of planned BIM investment by its contractors.

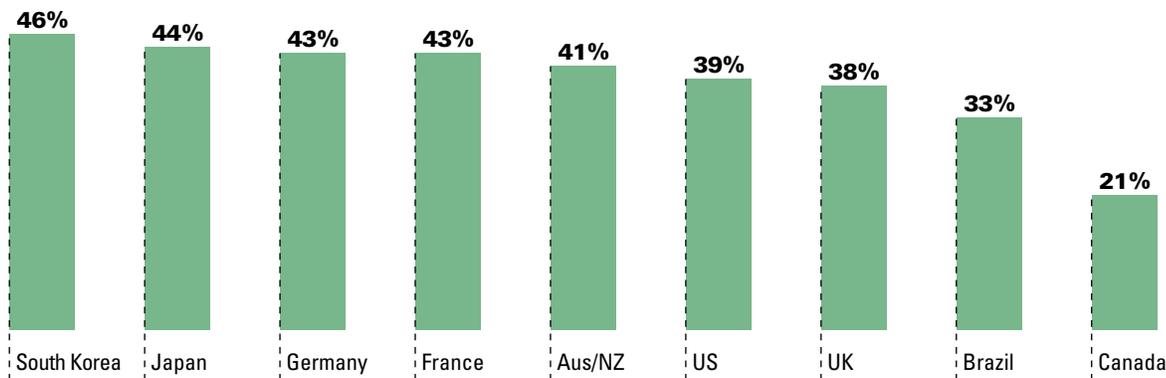
- **Among the regions, South Korean contractors show the most enthusiasm for BIM investment, with an average of almost half (46%) designating top priority for all categories of BIM investment combined.**

The rapid recent growth of BIM in South Korea—demonstrated in the 2012 *Business Value of BIM in Korea SmartMarket Report*—is a likely driver for this commitment to expansion.

- **Most other regions fall in a tight range between 44% (Japan) and 38% (UK), establishing a reasonable baseline for the overall global industry.**

Average Percentage of Contractors Assigning High or Very High Importance to All BIM Investment Categories Over Next Two Years (By Country)

Source: McGraw Hill Construction, 2013



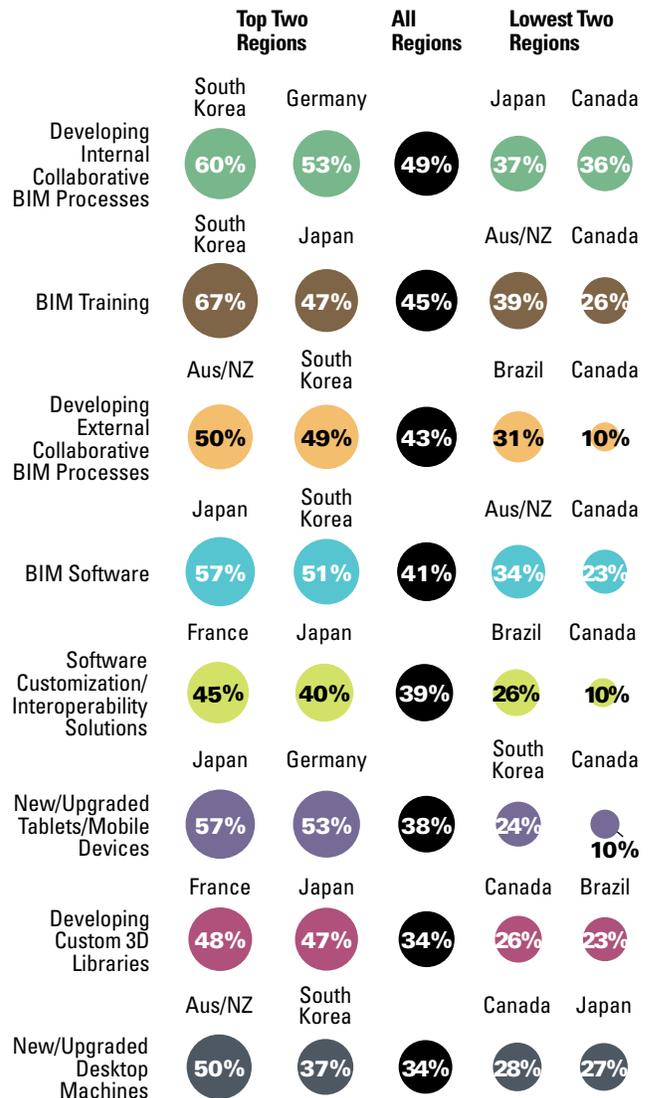
- **At 33%, Brazil somewhat trails the majority of other regions**, perhaps because BIM is relatively new and contractors are not ready to commit until more evidence is available on the benefits they say are most important to them (such as reduced construction cost) and ones they indicate would most positively impact their ROI (such as process outcomes and productivity).
- **Canada at 21% provides the most conservative outlook on continued BIM spending.** Their highest rated investment is internal collaborative processes, which at 36% is well below the average for all other regions.

Identifying the top two and lowest two regions for each investment category provides another comparative profile on investment planning.

- **The overall investment leaders, South Korean contractors are most committed to BIM training (67%),** an important way for their contractors to deepen engagement, which results in higher enjoyment of benefits and better ROI.
- **The Australia and New Zealand region shows unique leadership in external collaborative processes (50%) and upgraded desktop hardware (50%).** The interest in external collaborative processes speaks to their growing focus on integrated processes, and their hardware investment plans may be a sign of a growing focus on developing complex models, which are larger files and require more processing power.
- **French firms are planning the most work on developing custom 3D libraries and software customization/ interoperability,** reflecting their relatively advanced BIM maturity.
- **Japanese and German contractors show the most interest in getting BIM out into the field with their designation of new/upgraded tablets/mobile devices as a top investment category.**

Percentage of Contractors Assigning High or Very High Importance to Specific Categories of BIM Investments Over Next Two Years (By Country)

Source: McGraw Hill Construction, 2013



Data: BIM Activities and Practices

Project Types Using BIM, According to Contractors

BIM is being deployed on a growing variety of project types all over the world; not only in buildings but infrastructure, industrial and natural resources projects as well. Contractors in this research indicated all of the project types where they are currently using BIM. The charts show both the overall frequency of their responses by project type and the detail on percentages of contractors per project type in each region.

BIM Project Types in All Regions

BUILDING PROJECT TYPES

Buildings are the dominant category for contractors using BIM, probably because its usage began mostly with architects for buildings projects, and that drew most contractors into engagement with BIM.

- **BIM for commercial buildings is especially strong with 85% of very high BIM engagement contractors using it versus the overall average of 63%.**
- **Government buildings also attract an above-average number of very high BIM engagement contractors (79%), compared with the overall average of 49%, and only 29% of low BIM engagement firms.**
- **BIM for institutional buildings, especially healthcare, is tremendously popular among very high BIM engagement contractors (85%), compared with the average of 54%, and is dominated by large firms (64%) as opposed to medium (40%) or small (38%) contractors.**
- **Residential is still an emerging sector for BIM. Very high BIM engagement contractors (37%) are above the 23% average for multifamily, while low BIM engagement companies (8%) outpace the 6% average for single family projects, also the only project type dominated by small (10%) versus large (2%) contractors.**

NON-BUILDING PROJECT TYPES

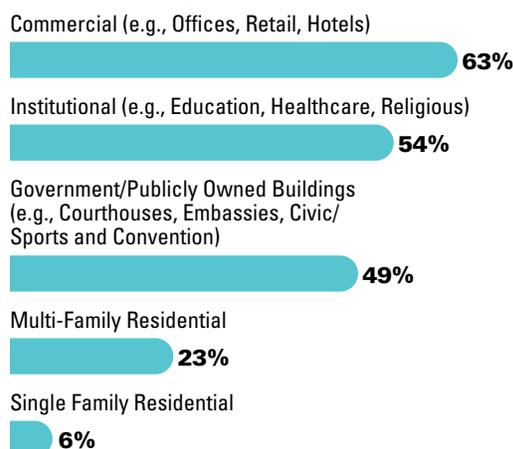
Industrial/manufacturing is the most penetrated non-building category for contractors to use BIM.

- **Well over half (57%) of the very high BIM engagement firms are involved, versus 32% across all contractors.**
- **Large contractors (35%) only show a slight edge over medium (31%) and small (29%) ones, indicating a well-established distribution across the industry.**
- **A higher percentage of trade contractors are using BIM (42%) than general contractors (30%), reflecting the importance of their role on industrial/manufacturing projects.**

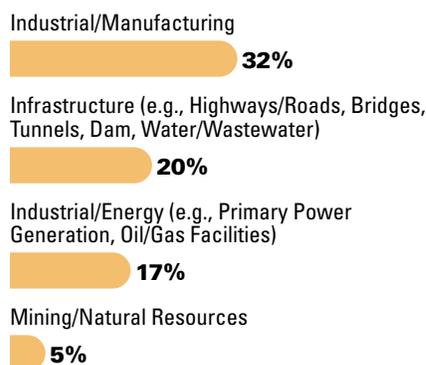
Percentage of Contractors That Are Using BIM on Specific Project Types

Source: McGraw Hill Construction, 2013

Building Project Types



Non-Building Project Types



Industrial/energy is a more specialized sector with only 17% of all contractors surveyed using BIM. Among projects in this sector, large firms (31%) are dominant over medium (12%) and small (7%) ones, and contractors at the very high BIM engagement level are far above average (39%), reflecting the skill and sophistication required to apply BIM in this technically demanding market.

BIM Activities and Practices

Project Types Using BIM, According to Contractors

CONTINUED

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

BIM for infrastructure (e.g., highways/roads, bridges, tunnels, dams, water/wastewater) is a relatively small but growing activity globally. McGraw Hill Construction's 2012 *BIM for Infrastructure in North America SmartMarket Report* showed that while only a quarter (27%) of infrastructure contractors were using BIM in 2009, almost half (46%) were doing so by 2011, and the percentage using it on over half of their infrastructure projects almost doubled from 16% to 29% over the same period. This research on BIM for infrastructure in nine global markets shows:

- A third (32%) of very high BIM engagement contractors use BIM for infrastructure, compared with only 8% of low BIM engagement firms.
- Large firms (30%) show much higher than average (20%) participation in this activity.

At 5% overall, mining and natural resources is the least active sector for BIM. Very high BIM engagement firms (16%) handle most of the activity, and large companies (11%) outnumber medium (3%) and small (2%) ones.

BIM Project Types by Region

The matrix shows the detail for contractors' regional involvement with various BIM project types.

- Buildings projects are common across all regions, with Germany far greater than average in multifamily (44% versus 23%) and single family (22% versus 6%).
- Infrastructure is also fairly consistent across all regions with UK (33%), Canada (31%) and Brazil (28%) showing the most activity.
- Although all regions show strong industrial/manufacturing BIM activity, Japan (47%) stands out, which aligns well with its general commitment to state-of-the-art manufacturing processes.
- Industrial/energy BIM activity is more localized, with Canada (28%), South Korea (21%) and UK (20%) all well above average (17%).
- Mining and natural resources activity is concentrated in Canada (18%) and Australia and New Zealand (11%), where these industries are most prevalent, and also somewhat popular in UK and Brazil (6% each).

Percentage of Contractors That Are Using BIM on Specific Project Types (By Country)

Source: McGraw Hill Construction, 2013

Building Projects	■ Over 40% ■ 30% to 40% ■ 15% to 29% ■ Under 15%								
	UK	France	Germany	US	Canada	Brazil	Japan	South Korea	Aus/NZ
Commercial (Offices, Retail, Hotels)	69%	68%	59%	66%	54%	53%	63%	48%	70%
Institutional (Education, Healthcare, Religious)	61%	32%	31%	77%	41%	31%	23%	35%	39%
Government/Publicly Owned (Courthouses, Embassies, Civic/Sports and Convention)	54%	10%	22%	68%	44%	12%	0%	51%	37%
Multifamily Residential	33%	35%	44%	18%	26%	19%	23%	20%	26%
Single Family Residential	17%	19%	22%	1%	10%	16%	0%	1%	4%
Non-Building Projects									
	UK	France	Germany	US	Canada	Brazil	Japan	South Korea	Aus/NZ
Infrastructure (Roads, Bridges, Tunnels, Dam, Water/Wastewater)	33%	19%	16%	14%	31%	28%	13%	24%	25%
Industrial/Manufacturing	26%	23%	19%	35%	36%	31%	47%	24%	34%
Industrial/Energy (Primary Power Generation, Oil/Gas Facilities)	20%	13%	3%	18%	28%	12%	0%	21%	16%
Mining/Natural Resources	6%	0%	0%	4%	18%	6%	0%	1%	11%

Top Design/Pre-Construction BIM Activities for Contractors

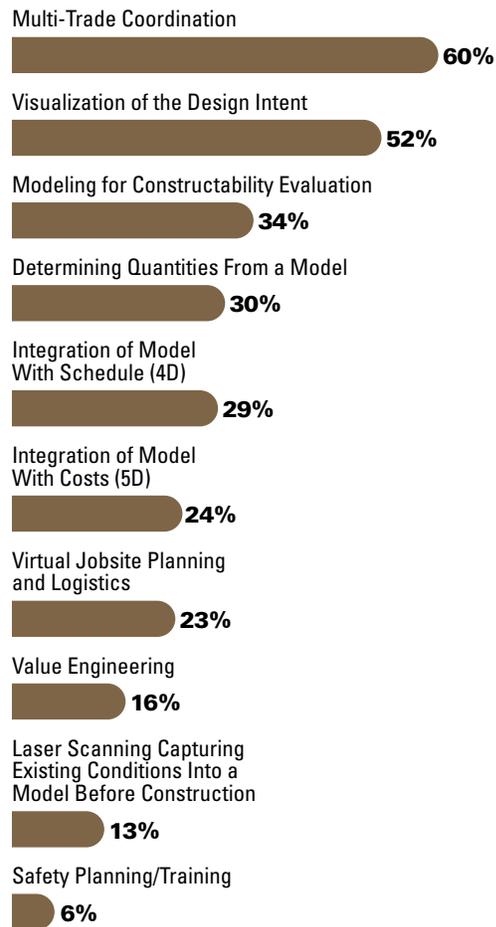
Contractors are finding numerous innovative ways to apply BIM to projects prior to the start of construction. In this study contractors were asked to select the three top ways that their organizations are leveraging BIM during design and pre-construction.

Consistent with all of McGraw Hill Construction’s previous research on BIM around the world, **the top valued pre-construction activities relate to virtual coordination among trades, and the outstanding ability of BIM and related software tools to communicate the design intent.** The following look at these top activities in terms of the overall averages and by how they compare by level of BIM engagement, firm type and firm size.

- **Very high BIM engagement contractors indicate above-average preference for the following:**
 - Multi-trade coordination (82% compared with the average of 60% for all contractors)
 - Modeling for constructability evaluation (46% compared with 34%)
 - Determining quantities from a model (39% versus average of 30%)
- **Schedule (4D) and cost (5D) integration rate among the top three most important with over a quarter of contractors (29% and 24%, respectively).** These activities are likely to grow as the technical and interoperability challenges of integrating model data with contractors’ legacy scheduling and costs systems become easier to manage.
- **General contractors are most above average in their preference for visualization of design intent (55% compared with an average of 52% for all contractors),** likely because they are responsible for all the build team’s accurate understanding of the project.
- **Trade contractors are most above average in determining quantities from a model (49% compared with an average of 30% of all contractors),** which makes sense because it relates directly to their responsibilities.
- **Large contractors are most above average in their preference for multi-trade coordination (70% compared with the average of 60%) and virtual jobsite planning and logistics (30% compared with the average of 23%),** probably because the value of these activities is most evident on larger, more complex projects.

Percentage of Contractors Citing the Top Three Activities for Which Their Organization Leverages BIM During Design/Pre-Construction Phase

Source: McGraw Hill Construction, 2013



THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

Top Design/Pre-Construction Phase BIM Activities by Region

Contractors show variety across regions in their designations of important pre-construction phase BIM activities. The chart at right shows the highest and lowest results for the top five activities.

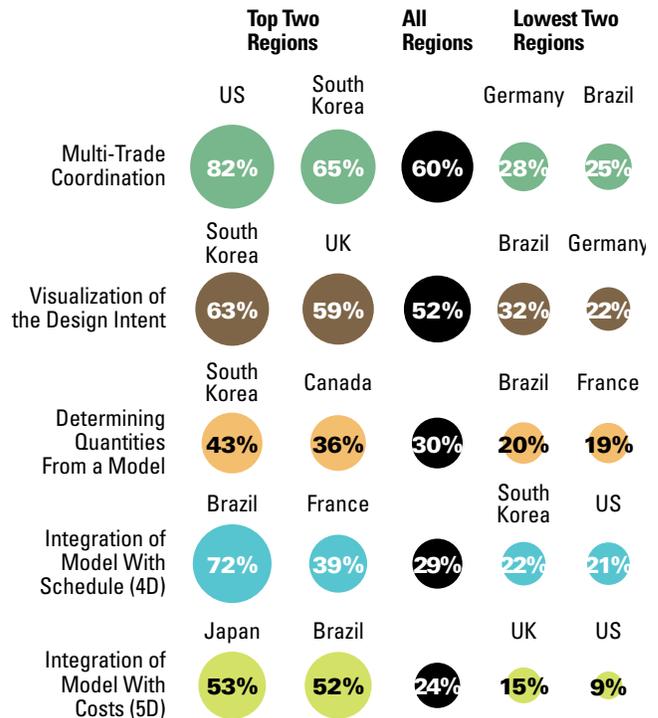
- The 57 percentage point range in the regional responses for multi-trade coordination is unusually large, going from US-based contractors, who almost unanimously (82%) consider it to be a top pre-construction activity, to Brazil (25%) and Germany (28%), where it has not gained as much acceptance.
- German (22%) contractors are also at the low end for designating visualization of the design intent as a top activity, versus South Korea (63%) and the UK (59%).

Some regions express the most enthusiasm for activities that score relatively low averages across all the countries/regions. Please note that the chart at right only reflects five of the top responses, but some of the differentials below are less popular overall.

- Japan (53%), Brazil (52%), France (48%) and Germany (41%) designate integration with costs (5D) as a top activity compared to the average of 24%.
- German firms (41%) far outweigh other regions for their enthusiasm about virtual jobsite planning and logistics, where the UK is second (30%) and the average is just 23%.
- French firms (29%) are more than twice as positive as average (13%) about laser scanning to capture existing conditions, and Japanese contractors (13%) are more than double the average (6%) for safety planning/training with BIM.

Percentage of Contractors Citing Activity as One of Top Three Ways Their Organization Leverages BIM During Design/Pre-Construction Phase (By Country)

Source: McGraw Hill Construction, 2013



Top BIM Activities During Construction by Contractors

The chart shows how many contractors selected specific construction-phase BIM activities as being among the top three that best enable their organizations to leverage BIM data effectively.

BIM Activities That Reduce Rework

The explosive growth and value of model-driven layout in the field is shown clearly in its top ranking among all contractors. This correlates directly with the consistently top-rated BIM benefit of reduced rework, by leveraging the precision of laser guided instrumentation and the granular accuracy of the model to prevent errors in physical location of work-put-in-place, such as sleeves and penetration in slabs, or embeds for attachment of building envelope elements.

The other field-based BIM activities, augmented reality, laser scanning for validation of work in place, GPS control of construction equipment and model-driven robotics, all scored lower in this research, but each is also directly tied to the powerful benefit of reducing rework, so all of them can be expected to show increased popularity in future studies as they become more widely available, understood and used.

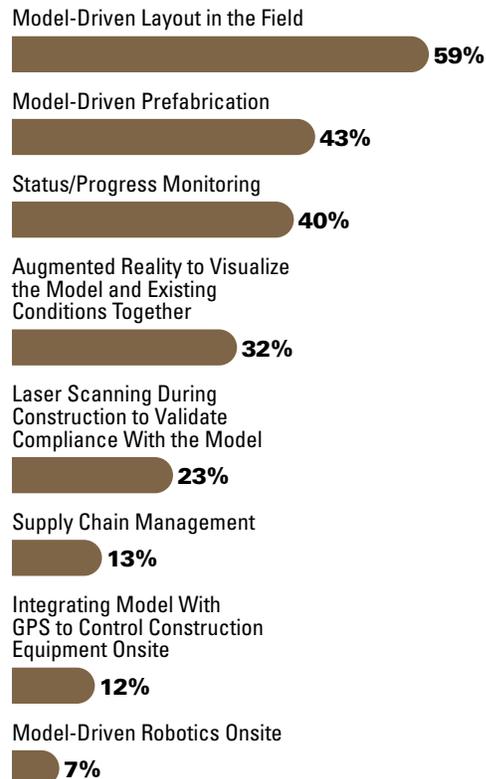
Model-Driven Prefabrication

Model-driven prefabrication is the second most widely selected activity by contractors, with 43% placing it among their top activities that help them effectively leverage BIM. Model-driven prefabrication is well established as a highly beneficial BIM activity with profound impacts on cost, schedule, productivity and quality. Currently most popular with mechanical, electrical, plumbing and structural trades, the creation of increasingly larger and more complex assemblies at offsite facilities that provide safer, more controlled environments at lower labor cost will continue to expand to include many other project elements. Premanufactured bathroom pods, for instance, are becoming common on healthcare projects in the US, and the practice is spreading to other countries as more teams acknowledge their efficiency and quality.

Ultimately, the combination of computer-controlled production equipment with detailed fabrication-level models will enable mass customization such that most of the elements required to assemble a project will be available from factories rather than constructed onsite from raw materials. More information on this topic is available in McGraw Hill Construction's 2011 *Prefabrication and Modularization SmartMarket Report*.

Percentage of Contractors Citing Activity as One of Top Three Ways Their Organization Leverages BIM During Construction Phase

Source: McGraw Hill Construction, 2013



THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

Business-Oriented BIM Activities

The business-oriented BIM activities, status/progress monitoring and supply chain management, are still developing, but many of the software companies with existing tools for these activities are working on integrating BIM data so that their customers can leverage BIM for improved timeliness and accuracy. Therefore, it is reasonable to expect that the percentage of contractors rating these as top activities will increase in future research.

Variation by Level of BIM Engagement

In most cases the contractors with a very high BIM engagement level show above-average preference for these construction-phase BIM activities. This is especially true for model-driven prefabrication, where 61% of the most engaged BIM users rate it among their top three activities versus the average of 43% across all contractors.

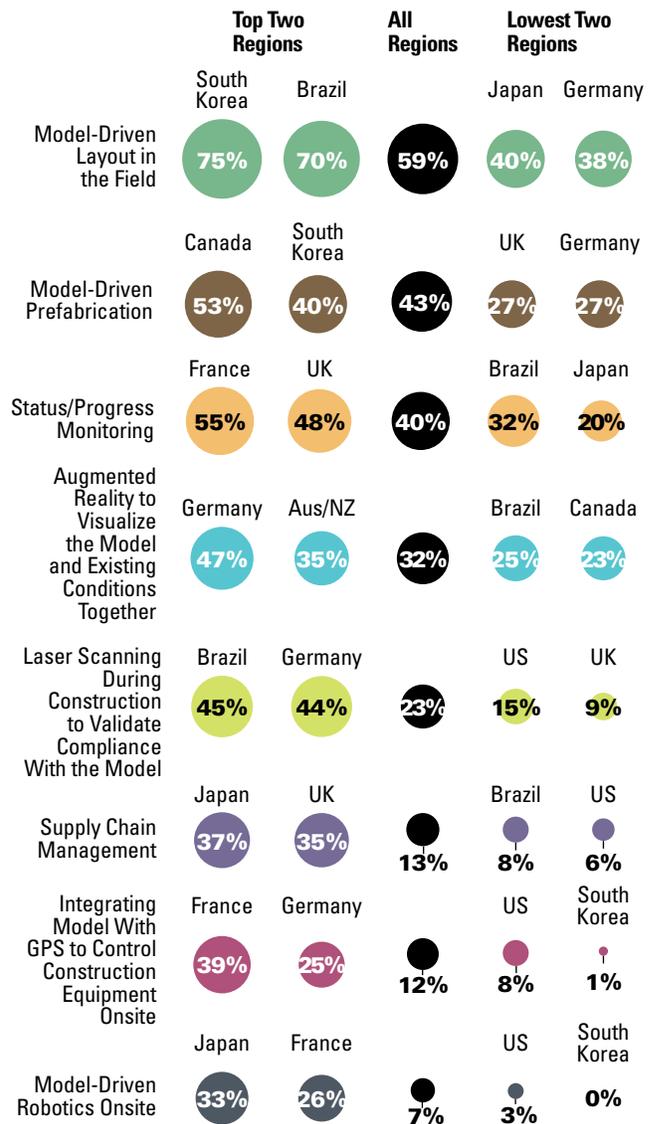
Top Construction Phase BIM Activities by Region

Regional differences appear in the responses from contractors about their designations of the three most valuable BIM activities during construction.

- **South Korean contractors lead the other regions in their support of model-driven layout in the field**, reinforcing the rapidly growing use of BIM in that market. Interestingly it is also very strongly cited in Brazil, one of the newer areas for BIM, again highlighting this activity's relative ease of deployment and immediate value in avoiding costly rework and enhancing onsite productivity.
- **Model-driven prefabrication is highly valued in Canada**, where many contractors report using BIM on non-building work, suggesting that they are actively leveraging models to prefabricate on those projects.
- **German firms, who show the least interest in two of the three leading construction phase BIM activities, indicate top preference for augmented reality (47%) and laser scanning (44%),** indicating their focus on advanced BIM activities during construction.
- **French and UK contractors show the most interest for status/progress monitoring, the one business-related activity in the top five.** This may be influenced by the fact that BIM has been in the market for the longest time in Europe, and contractors have had more opportunity to develop procedures for this activity.

Percentage of Contractors Citing Activity as One of Top Three Ways Their Organization Leverages BIM During Construction Phase (By Country)

Source: McGraw Hill Construction, 2013



One of the biggest untapped BIM business opportunities for contractors relates to models for owners that facilitate ongoing operations and maintenance. Contractors are in the ideal position to modify, create and manage models as an entirely new service with decades of potential revenue.

The fundamental task of converting one or more models originally intended for design, fabrication or construction into a format that accurately shows exactly what was actually built for owners ranks as the top post-construction activity for contractors. It is an especially common practice among contractors at a very high BIM engagement level, where almost all (95%) say they have moderate or high involvement versus the average of 64% among all contractors.

Enriching the model with maintenance and operation data to make it more useful to owners is the next most popular activity, where again the very high BIM engagement contractors (59%) are above the average (49%) for their level of involvement.

Using the model to close out a project is not quite as common yet, although its above-average involvement by very high BIM engagement contractors (57% versus the average of 44%) indicates it will probably grow in popularity.

The new service opportunity to maintain a model for an owner is still emerging as a practice with less than a third (31%) moderately or highly involved. The business model for this practice has to be further developed and standards for maintenance need to be established before it will be widely practiced.

Top Post-Construction Phase BIM Activities by Region

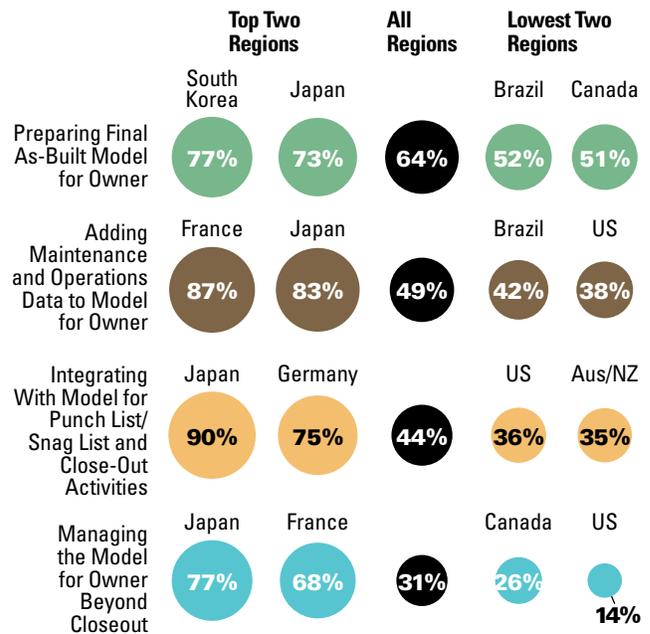
There are wide regional differences in this still-developing category of activities.

- Japanese and French contractors lead among all the regions for most involvement in post-construction BIM activities, with South Korean firms (77%) taking a slight lead over Japanese (73%) on preparing as-built models.
- The large percentage point ranges between the highest and lowest regions for these activities speak to their emerging nature, where some regions are barely participating and others are strongly involved.

Top Post-Construction BIM Activities for Contractors

Percentage of Contractors Conducting Activity at Moderate or High Frequency During Post-Construction Phase (By Country)

Source: McGraw Hill Construction, 2013



The Relative Value of Post-Construction BIM Activities

Because post-construction BIM activities are a new and emerging field, there is still significant debate about where the business value can be found. Contractors were asked to identify which of the four post-construction activities studied in this research provides the most value.

- **About four in 10 (39%) assign the greatest value to adding maintenance and operations data to models for the owner.** General contractors (41%) are somewhat more likely than average to hold this opinion, which is probably a result of their responsibility for aggregating and turning over all this information to owners at project completion, traditionally in paper format.
- **Trade contractors (41%) find greater than average (29%) benefit from the final as-built model,** perhaps because many of them are involved long term in servicing what they have installed and they appreciate the accuracy and usefulness of an as-built model.

Regional Differences in the Relative Value of Post-Construction BIM Activities

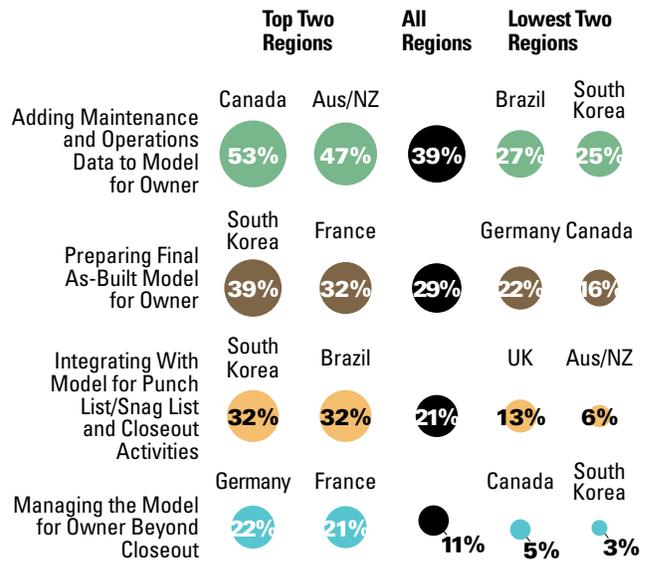
Perspectives among regions vary on the value of post-construction BIM activities, with no one region emerging as a consistent champion across all activities.

- **Although more South Korean contractors see top value in the final as-built model (39%) and using BIM for closeout (32%) than any other region, they are last in their support of adding maintenance data (25%) and managing the model for owners beyond closeout (3%).**
- **Canadian contractors (53%) are most in favor of adding maintenance data to a model, but they are in the bottom two for both as-built modeling (16%) and managing a model for an owner after closeout (5%).**
- **Australia and New Zealand contractors place second in valuing adding maintenance data to a model but are least enthusiastic about using BIM during closeout. Similarly, Brazil, which places second for contractors praising BIM for closeout, is second to last as it relates to adding maintenance data to a model.**

Another indication of the early-stage nature of post-construction BIM activities is the absence of a difference of opinion between contractors with very high BIM engagement and those with low BIM engagement, a variance that is consistent among the more established BIM activities. This speaks to the lack of experience with post-construction BIM activities that even the most engaged contractors have to draw on in order to make a value judgment.

Percentage of Contractors Citing BIM Activities That Provide the Greatest Value During Post-Construction Phase (By Country)

Source: McGraw Hill Construction, 2013



THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS DATA

The use of BIM to support sustainability goals is increasingly valuable. Tools for analysis and simulation are helping design professionals to generate higher-performing design solutions, and contractors can leverage models in a variety of ways to improve the quality and reduce the environmental impact of their work. In addition, an emerging area of BIM activity relates to owners using models to improve building performance by optimizing facilities management.

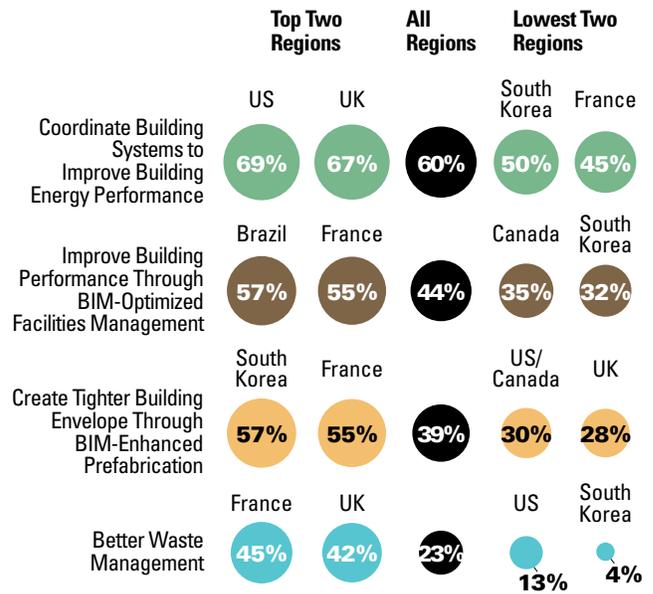
Contractors identified sustainability-related BIM activities they engage in either often or always.

- **Almost two thirds (60%) of contractors are leveraging BIM to coordinate systems with the goal of improving energy performance, with high (67%) and very high (68%) BIM engagement firms doing it somewhat more than average.**
- **BIM for building performance in facilities management is a much more common practice among very high BIM engagement contractors (55%) than the average (44%), and appears to be taking hold in Brazil (57%) and France (55%) more than other regions.**
- **Prefabrication to create tighter building envelopes is less frequent overall (39%), but large companies (45%) exhibit an above-average involvement, and South Korean and French firms (57% and 55%, respectively) show leadership in this area.**
- **Although using BIM to manage waste more sustainably is the least practiced (23%) by all contractors, it scores more strongly with trade contractors (30%), perhaps because they have the greatest ability to impact material waste.**

Specialized BIM Activities for Sustainability

Percentage of Contractors That Are Conducting BIM Activities for Sustainability (By Country)

Source: McGraw Hill Construction, 2013



Accessibility to Models

The ways in which contractors make models available to staff on the jobsite varies a great deal by region. The charts show the percentage of contractors that indicated they use each method either often or always.

Computers

Providing computers for field staff to use in the job trailer is almost a universal practice for contractors in France (97%), Japan (87%) and Germany (85%), as well as among contractors with a very high BIM engagement level (86%) across all regions.

Wireless Handheld Devices

Mobile devices are increasingly popular among contractors, so the current average of 42% that report deploying them often or always is certain to increase, especially as screen resolution and connection bandwidth improve. As a leading indicator of that trend, 63% of very high BIM engagement level contractors are currently deploying them that frequently.

Onsite Computers (Kiosks)

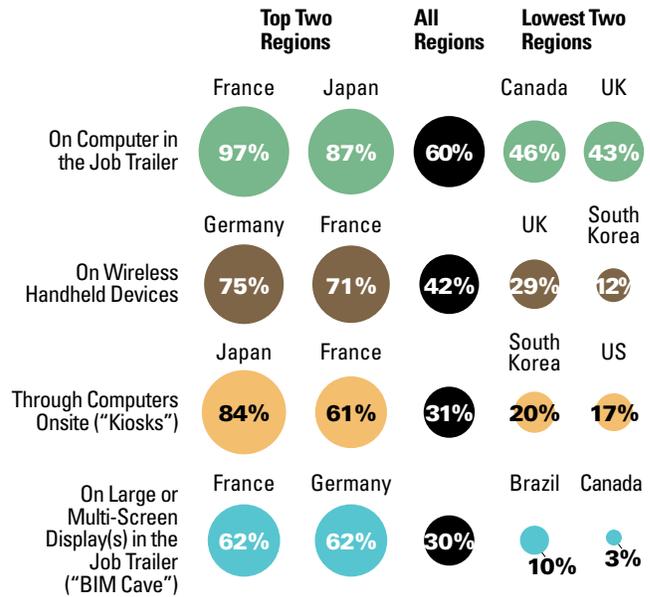
Kiosks on the site with computers and wireless connectivity are less often used (31% average), but they can be an effective productivity enhancement because they combine normal screen size with the benefit of bringing the model to where the work is taking place. This allows them to engage field workers quickly and efficiently. As a new approach, their frequency of use is distributed fairly evenly across contractors at all levels of BIM engagement. Among regions, the electronics-oriented Japanese take a prominent lead, with 84% deploying jobsite BIM kiosks often or always, five times the rate in the US where they are still relatively rare (17%).

Large or Multi-Screen Displays

Large or multi-screen displays in the job trailer (also sometimes known as “BIM caves”) are an exciting new method of immersive engagement with the model. Most commonly used in France (62%), Germany (62%) and Japan (60%), they require greater investment, but can facilitate much more effective communication by taking advantage of the powerful visualization capability of BIM.

Percentage of Contractors That Often or Always Make Models Available to Field Personnel on the Project Site Using These Methods (By Country)

Source: McGraw Hill Construction, 2013



Contractors' Perspectives on Project Team BIM Practices

Owners Demanding BIM Use on Their Projects

BIM has the most chance of being successful and effective when the project owner actively wants the project team to use it, and the number of owners demanding BIM on their projects is growing worldwide. This includes government agencies in many countries and an increasing number of healthcare, educational and commercial owners in markets such as retail, hospitality and corporate office buildings. These owner-driven BIM mandate programs have been effective for introducing the benefits of BIM to a large number of design and construction firms, many of whom become active BIM users thereafter with their other clients and project teams, driving BIM even wider through the industry.

General contractors were asked how frequently owners are demanding BIM in their market. The following commentary reflects a combined percentage of those that gave responses of often or always. The use of combined responses of often and always also applies to all the other data on how team members influence the use of BIM by firms throughout this article.

- More than a third (39%) of general contractors report that owners are either often or always demanding BIM, with Germany (90%) reporting the highest percentage.
- The percentage of general contractors in the UK (23%) currently reporting high frequency of owner mandates is well below the average, but they should increase dramatically as the government BIM mandates go into effect in the coming years.
- Over half (56%) of the very high BIM engagement level general contractors are experiencing a great deal of owner demand for BIM, probably because these firms are working with the most BIM-intensive owners.

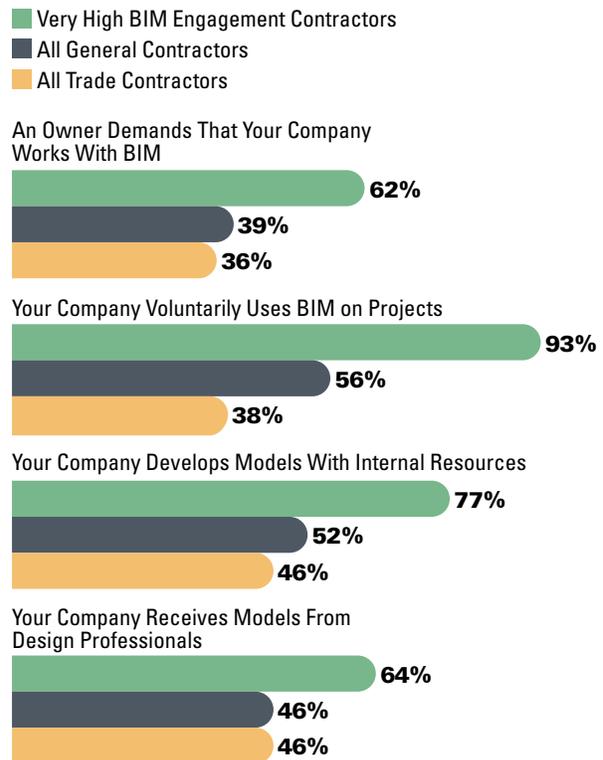
Contractors' Voluntary Use of BIM

A growing number of contractors are using BIM voluntarily.

- The majority of general contractors (56%) say they often or always use BIM voluntarily, although fewer trade contractors (38%) are committed at that level, pointing to the need to grow BIM engagement among those companies.
- Not surprisingly, most very high BIM engagement level firms use BIM voluntarily, including 94% of general contractors and 83% of trade contractors, with 61% of general contractors saying they always do so, demonstrating complete commitment to BIM.

Percentage of Contractors That Often or Always Report These Practices (According to Level of BIM Engagement)

Source: McGraw Hill Construction, 2013



- French general contractors lead all regions in this category, with three quarters (74%) citing their voluntary commitment to BIM on most projects.
- Other above-average regions for general contractors include established BIM markets like the US (66%) and the UK (65%), and also Brazil (63%), where it would appear that the relatively recent introduction of BIM is gaining advocates quickly.
- Canada (30%), Japan (33%) and South Korea (37%) show the fewest numbers of general contractors who are either often or always voluntarily using BIM, perhaps indicating a need for more owner-mandated programs.

Contractors' Development of Models With Internal Resources

Many contractors are building internal modeling staffs and committing to investments in software, hardware and training to create models, either when they are not available from design professionals or for specific purposes such as coordination, prefabrication, sequencing or constructability evaluation.

Contractors were asked how frequently they create models with internal resources.

- Over three quarters (79%) of general contractors and over two thirds (67%) of trade contractors at a very high BIM engagement level frequently build models with internal resources.
- Among regions, general contractors in Brazil (69%), Australia (67%) and France (57%) show above-average commitment to building models, along with half (50%) of the trade contractors in the US.

Contractors Receipt of Models From Design Professionals

Contractors frequently must conduct BIM activities without receiving models from design professionals. This is because many designers are still not using BIM, and some of the ones that do are reluctant to share their models with contractors, in both cases creating the inefficient need for extra work by the contractor.

- Very high BIM engagement contractors are more frequently receiving models from designers, with trade contractors from that group (75%) more successful than general contractors (62%), both of which greatly surpass the average of only 46% across all levels of engagement.
- Japanese general contractors (67%) take a strong lead regionally, perhaps providing a model for success that can be copied in other regions.

General Contractors' Practices With Trade Contractors

In all McGraw Hill Construction's research around the world, the top reason given for not adopting BIM is that no one has asked the company to do it. **A growing practice everywhere is for general contractors to ask trade contractors to be responsible for developing models for their part of the work.** This requirement has been a major driver for BIM adoption among trades, and its continued growth as a BIM practice will also drive deeper BIM engagement among the companies that adopt.

Percentage of General Contractors That Often or Always Engage in These Practices (By Level of BIM Engagement)

Source: McGraw Hill Construction, 2013

- Very High BIM Engagement General Contractors
- All General Contractors

Your Company Demands That Trade Contractors/Fabricators Develop Models



Your Company Receives Models From Trade Contractors/Fabricators Without Having to Demand Them



- German (61%), Japanese (56%), and French (53%) general contractors most frequently demand models from the trade contractors on their projects, and German and French firms also lead in receiving models without demanding them (55% and 50%, respectively). This reflects more well-established inter-company practices in these regions where BIM has been used for a long time.
- Very high BIM engagement firms are significantly more active in these practices than average, indicating that modeling by trade contractors is a trend the rest of the market is likely to follow.

Trade Contractors' Modeling Practices

The number of trade contractors that are actively modeling varies greatly by geography and across specialties. Although the ultimate goal is for all trades to be modeling their work on all projects everywhere, it is not uncommon currently for only one trade to be producing models on a project.

One quarter (25%) of trade contractors across all regions in this research indicated that they are either often or always the only trade modeling, still representing a large proportion of the industry. A third (31%) claim it rarely or never happens, and a similar amount (36%) say that most of the major trades are often or always modeling on their projects, a positive trend that needs to accelerate.

Using the Cloud

All business software users around the world are exploring ways to use offsite servers for hosting large amounts of data and the applications that work with it, all of which is generally referred to as putting these things in “the cloud.”

Construction Companies' Use of the Cloud

Contractors are no exception to this trend, and while this research shows that no more than half the respondents on average are currently using the cloud for project or business activities, the shift from desktop and enterprise to cloud-based services is certain to continue.

- As a leading indicator of that change, contractors currently at the very high BIM engagement level are already significantly more active in the cloud than the overall average.
- More general contractors are frequently using the cloud than trade contractors for project activities (52% versus 41%), hosting models (47% versus 30%) and company business activities (39% versus 26%).
- Large contractors are 50% to 100% more highly involved in all these cloud activities than small companies, likely because the larger companies have more skilled information technology staff to help guide and manage this transformative initiative.

Contractors' Concerns About Security of the Cloud

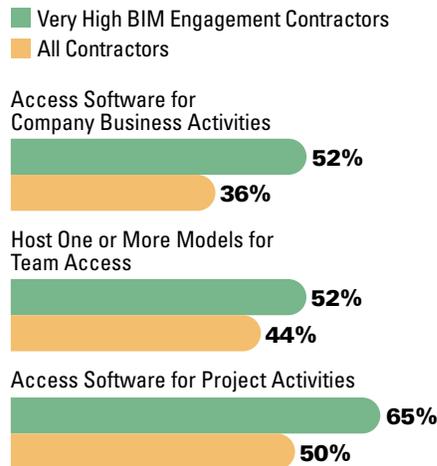
Security of the information hosted in the cloud is a growing issue. Overall, 62% of the contractors surveyed expressed a moderate or high level of concern.

- South Korean contractors (79%) top the list, while Japanese (43%) and German (31%) firms seem to worry the least.
- Two thirds of general contractors (63%) express moderate to high concern, compared with half (50%) of trade contractors, which reflects general contractors' greater level of responsibility for large amounts of sensitive project information.
- Not surprisingly, the very high (72%) and high (70%) BIM engagement level firms express greater than average concern.

As more firms engage the collaborative benefits of BIM, the industry will need to address issues of security, as well as bandwidth, mobile access, latency and new usage-based business models.

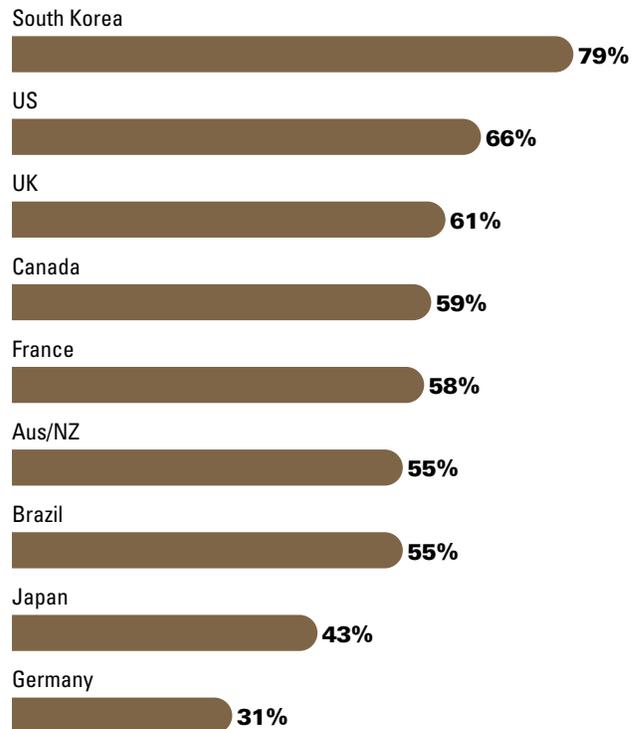
Percentage of Contractors That Often/Always Conduct Activities With the Cloud (According to Level of BIM Engagement)

Source: McGraw Hill Construction, 2013



Percentage of Contractors Expressing Moderate/High Level of Concern About Security of the Cloud (By Country)

Source: McGraw Hill Construction, 2013



BIM and Field Data: How Detailed Field Conditions Are Creating Better 3D Models

The promise of field-accurate information inside a 3D Building Information Model is rapidly becoming a useful reality on construction sites and in early design discussions, thanks to better software-importing capabilities and newer, less-expensive field-scanning technologies.

Thanks to faster data connections and capital investments in storage capacity and equipment, construction managers are using laser scanning as a BIM-enabled, whole-project verification tool.

Investments in Laser Scanning

Previously the purview of surveyors, a “scan” is a powerful laser recording of field data that captures a site’s shapes, and possibly its appearance, and converts those conditions into a cloud of data points that can be uploaded into a 3D BIM. Last August, Providence, Rhode Island-based Gilbane Building Company purchased a FARO Focus 3D laser scanner. Counting software and operations training, the bill came in around \$60,000, a far cry from the six-figure cost of older scanners, but still a major investment.

“We’ve found that laser scanning has a huge barrier to entry in cost, but if you own it, you find use cases for it that you otherwise wouldn’t have considered,” said John Tocci, Jr., director of virtual design and construction at Gilbane. “On one project, 30 minutes of scan time in the field and 30 minutes of post-processing and uploading the point cloud into a Revit model saved \$30,000.”

Using Laser Scans in BIM for Prefabrication

Tocci said Gilbane has seen both cost savings and major field safety improvements from importing laser scans into Revit models. Prefabrication and coordination of mechanical, electrical and plumbing (MEP) systems installation has saved rework money on every project on which Gilbane has used its scanner. Prefabrication of ductwork and systems has eliminated field work and stopped what might have been weeks of MEP rough-in activities.

One such project was the renovation of Kreger Hall at Miami University in Oxford, Ohio. The 85-year-old building will become the new home of Miami’s Physics Department when the renovation is completed next year. The original plans were a hand-drawn set. By laser-scanning 50,000 square feet of the building in one day, Gilbane’s virtual design and construction (VDC) staff was able to get accurate measurements for prefabrication, scheduling and sequencing of the \$12 million upgrade that will turn the existing building into labs and physics lecture halls. Gilbane was able to drive the entire MEP, structural and building coordination activities on the project from a 3D model.

“It would have been an unrealistic expectation to believe trade contractors could go in and come out cleanly and install everything the first time based on ancient 2D

documents,” Tocci said. “The scan gives them that level of reliability. The value to the project from prefabrication and site knowledge on that project alone will exceed six figures. If someone is telling us from finished floor to underside of beam, you have 11-feet, eight inches, we can say, ‘no we have 11 feet even.’”

Network and Hardware Requirements

Like similar big data solutions, your network and hardware need to be up to the task to share and upload the point-cloud data. Gilbane has a primary server with three terabytes of storage and a secondary server that has 16 terabytes. Computers with 32 GB of RAM, high-end graphics cards and solid-state hard drives are also necessary. It’s not unusual to have a point cloud take up more than 200 GB of hard drive space. To share these data sets, Gilbane’s outbound network traffic can generate 65 GB of network activity in a single day.

Gilbane’s initial uses—five projects across the US spanning higher education renovations to work for the National Institutes of Health in Washington, D.C.—have generated such a value-add that they’re purchasing a second laser scanner this year. The VDC group is hoping to add the Faro Focus3D X 330 to its laser-scanning tool kit for long-range outdoor scans. ■

Data: North America

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS

BIM for Construction Data From Contractors in Canada and the United States

Contractors in North America are far more advanced at BIM use compared with those in other parts of the world, and they are planning to invest in increasing the depth of use. Of particular importance is collaboration of owners as well as improving process outcomes and reducing errors and omissions.

BIM Engagement

There are three components that comprise the BIM engagement level (see page 14): experience with BIM, expertise level and implementation level—shown at right.

Compared with those in the other regions, contractors in the US and Canada are notably higher in expertise, translating to 20% being at the very high engagement level.

Project Types

In North America, BIM is used most heavily on building projects. Specifically, US contractors are extremely heavily engaged in BIM on institutional and government buildings. In Canada, there is more use of BIM on infrastructure projects (see page 31).

ROI on BIM

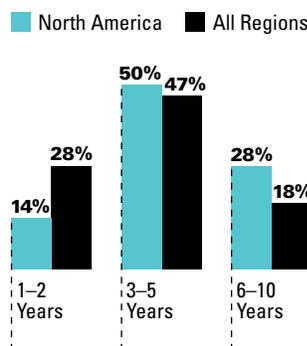
Overall, 76% of North American contractors rate positive ROI on BIM, with more than a quarter rating it at a very high level. However, a nearly comparable level rate it as break-even/negative. This lack of agreement may be due to the high share that are not engaging in any formal measurement of ROI—41% in Canada and 43% in the US.

The average for the North American contractors match the overall average for the factors deemed the most important to improve ROI. However, individually, there are some differences:

- **Improved project process outcomes and improved productivity of personnel:** Higher in the US at

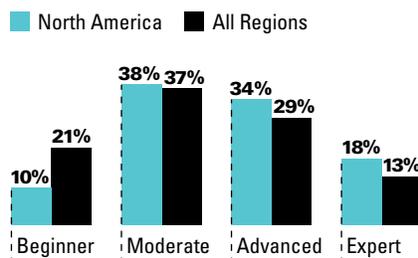
Length of Time Using BIM

Source: McGraw Hill Construction, 2013



BIM Expertise Level

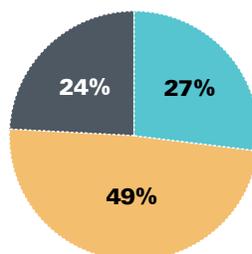
Source: McGraw Hill Construction, 2013



Perceived ROI on BIM

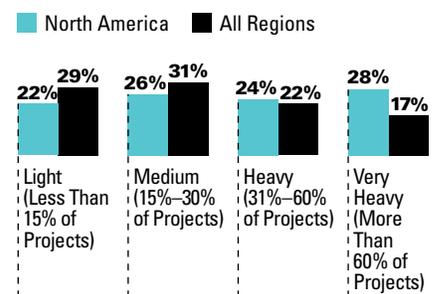
Source: McGraw Hill Construction, 2013

- Very Positive ROI (Over 25%)
- Moderately Positive ROI (Up to 25%)
- Negative/Break-Even ROI



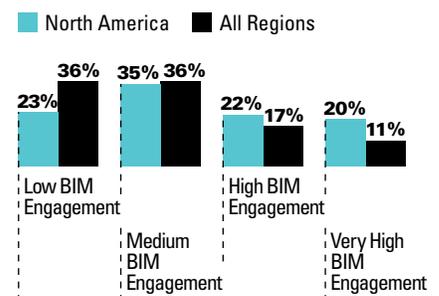
Current BIM Implementation Level

Source: McGraw Hill Construction, 2013



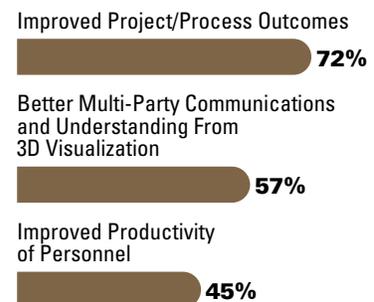
BIM Engagement Level

Source: McGraw Hill Construction, 2013



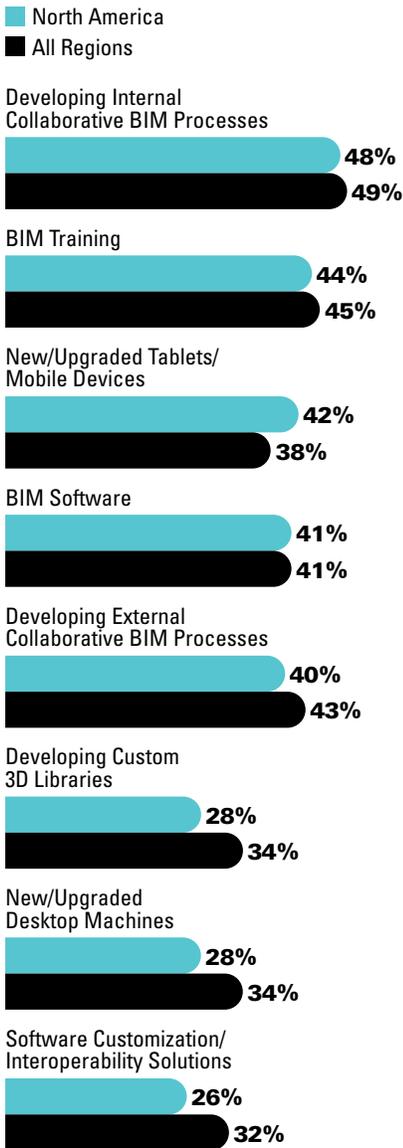
Factors Most Often Cited as Having High/Very High Impact on Improving ROI

Source: McGraw Hill Construction, 2013



Planned BIM Investments Over Next Two Years Rated as High/Very High in Importance

Source: McGraw Hill Construction, 2013



73% and 45%, respectively
 ■ **Reduced cycle time for project activities/delivery:** Higher in Canada at 48%

Planned BIM Investments

Investments deemed as important for US contractors are consistent with the average of all respondents. However, overall, investments in Canada are rated notably lower, with the highest being 36% reporting developing internal collaborative BIM processes.

Top Benefits

There are some differences among the North American contractors (averages for all North American contractors shown at right). In the US, marketing new business, offering new services, and reduced errors and omissions are all rated higher than average—at 31%, 26% and 63%, respectively. For Canadian contractors, collaborating with owners/design firms and better cost control/predictability are cited by more. (See pages 19–22.)

Top Activities

PRE-CONSTRUCTION

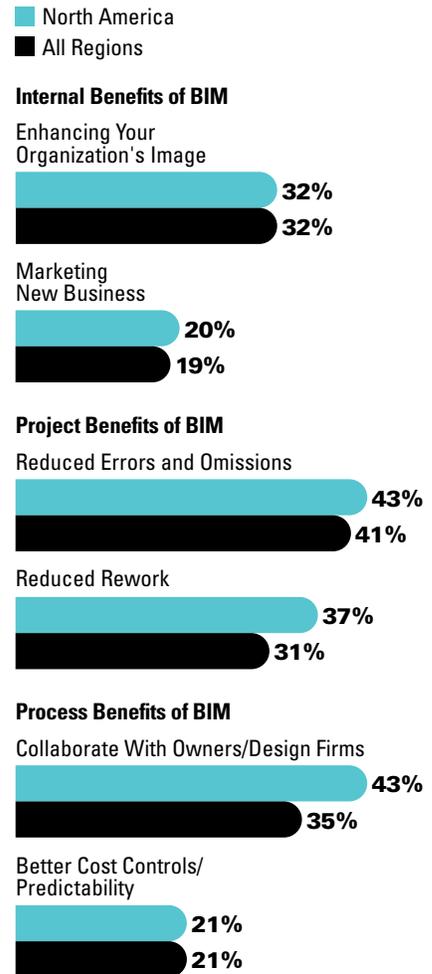
A high percentage of US contractors use BIM in multi-trade coordination (82%), visualization of design intent (52%) and modeling for constructability evaluation (45%). However, far fewer are using it to integrate model with cost (5D), as opposed to Canada where this is one of the larger uses, reported by 31%.

CONSTRUCTION AND POST-CONSTRUCTION

The top construction activities and post-construction activities are used

Top Benefits Cited by Contractors in North America (According to Benefit Category)

Source: McGraw Hill Construction, 2013



by comparable levels of contractors in the US and Canada, compared with those in the rest of the world. The only exception is managing modeling for owner beyond closeout, where notably fewer contractors in the US report this use (14%). ■

BIM for Construction Data From Contractors in Brazil

Brazilian contractors are newer to using BIM. However, they are reporting plans to invest in building capabilities and expertise, and expect to increase activity levels in the future. Of particular importance in this country are the cost benefits BIM can yield—including improved ability to predict costs.

BIM Engagement

There are three components that comprise the BIM engagement level (see page 14): experience with BIM, expertise level and implementation level—shown at right.

Compared with those in the other regions, contractors in Brazil are much newer BIM users, translating to a low BIM Engagement Index for 55% of contractors in the country and none at the very high level.

Project Types

For the most part, contractors in Brazil are using BIM on lower levels of project types, likely reflecting more specialized use of BIM versus contractors using BIM on many project types. The exception is industrial/manufacturing, where 31% are using BIM, compared with 32% for all respondents (see page 31).

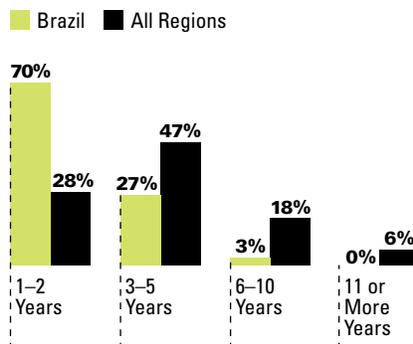
ROI on BIM

In Brazil, 85% of contractors report a positive ROI on BIM. And the share that report very positive ROI (36%) is equivalent to other key countries investigated in this study. However, this high level is likely speculative, since 35% of firms are not formally measuring BIM ROI (see page 24).

The top three business benefits that would help drive increased ROI in Brazil line up against those for all regions investigated, though improved productivity of personnel is rated more highly (see page 26).

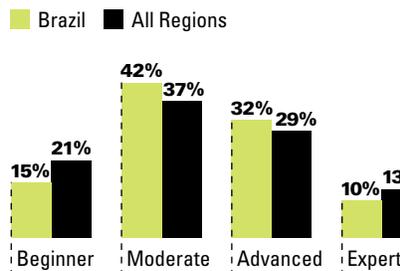
Length of Time Using BIM

Source: McGraw Hill Construction, 2013



BIM Expertise Level

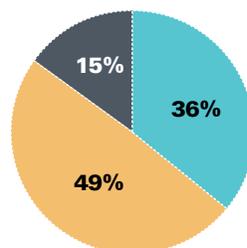
Source: McGraw Hill Construction, 2013



Perceived ROI on BIM

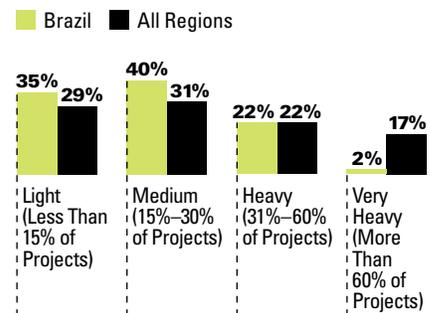
Source: McGraw Hill Construction, 2013

■ Very Positive ROI (Over 25%)
■ Moderately Positive ROI (Up to 25%)
■ Negative/Break-Even ROI



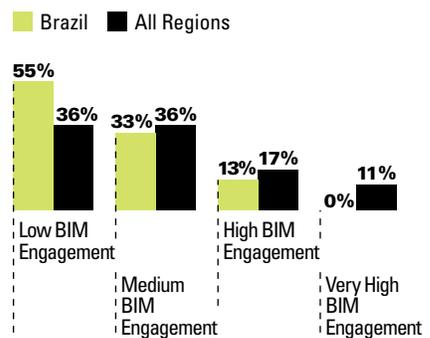
Current BIM Implementation Level

Source: McGraw Hill Construction, 2013



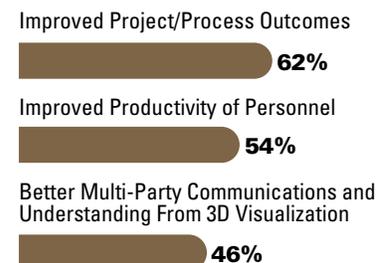
BIM Engagement Level

Source: McGraw Hill Construction, 2013



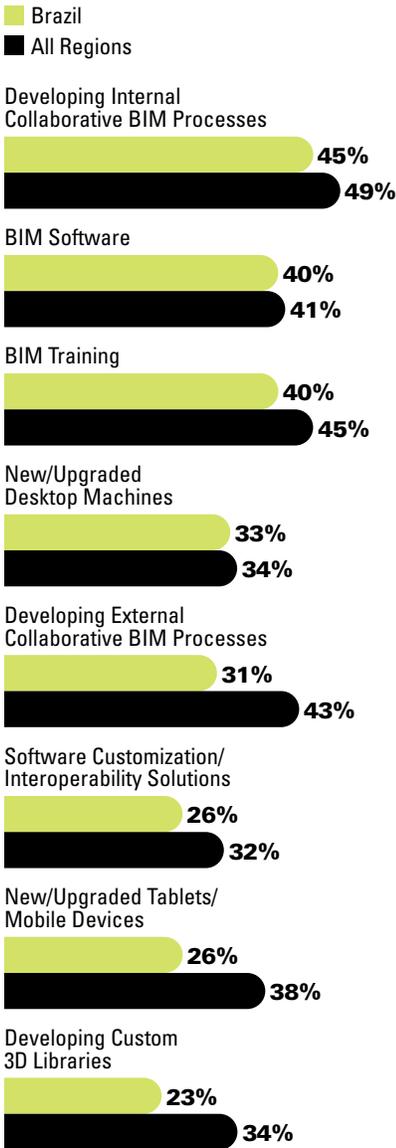
Factors Most Often Cited as Having High/Very High Impact on Improving ROI

Source: McGraw Hill Construction, 2013



Planned BIM Investments Over Next Two Years Rated as High/Very High in Importance

Source: McGraw Hill Construction, 2013



Planned BIM Investments

Developing internal collaborative BIM processes, BIM software and BIM training are investment areas that Brazilian contractors note as high/very high in importance. These are all areas that correspond to the relatively newer level of BIM use, since they reflect the need for these firms to build internal BIM capacity and expertise.

Top Benefits

Generally, contractors in Brazil match up against the benefits most often cited by other contractors around the world (see chart at right as well as pages 20–23), though sometimes at different priority levels.

For example, in process benefits, the top two benefits are reversed with significantly more Brazilian contractors rating cost controls/ predictability as a key benefit, compared with all respondents around the world where collaboration with owners is more often cited as a benefit. Similarly, for project benefits, reduced costs ranks higher than reduced errors and omissions.

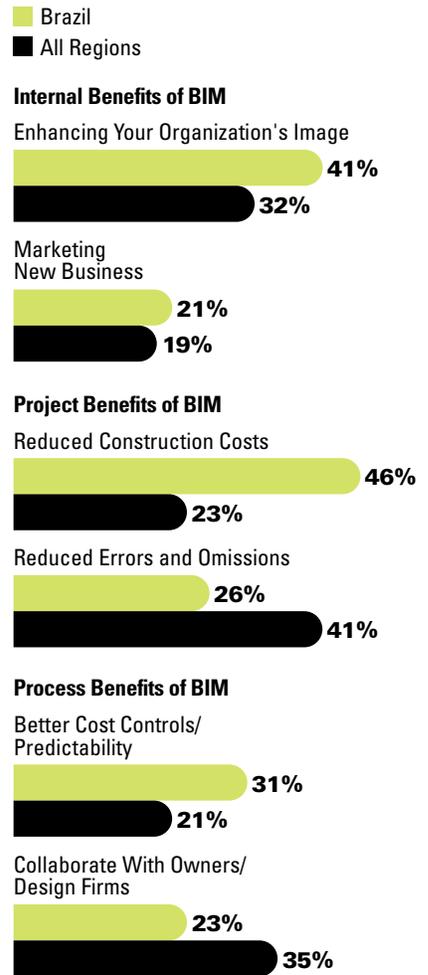
Top Activities

PRE-CONSTRUCTION

Integration of model with schedule (4D) and with cost (5D) are used by significantly more Brazilian contractors compared with all respondents. Use of 4D is reported by 72% Brazilian firms, and use of 5D is reported by 52%—compared with only 29% and 24%, respectively, for all respondents. The results reinforce the importance of using BIM for cost control.

Top Benefits Cited by Contractors in Brazil (According to Benefit Category)

Source: McGraw Hill Construction, 2013



CONSTRUCTION AND POST-CONSTRUCTION

There are no notable differences in the use of BIM in construction and post-construction activities for Brazilian contractors compared with all respondents. ■

BIM for Construction Data From Contractors in France, Germany and the UK

Contractors in France, Germany and the UK are currently at relatively low BIM engagement levels, but they are planning activities and investments to increase usage. The benefits and activities vary across the different countries, pointing to markets that are unique, versus consensus across Europe.

BIM Engagement

There are three components that comprise the BIM engagement level (see page 14): experience with BIM, expertise level and implementation level—shown at right.

Compared with those in the other regions, the European contractors are notably higher in both newer users and those at a beginner expertise level. Implementation and engagement levels are relatively consistent across the three nations, though France is a little higher.

Project Types

In the UK, BIM is used most heavily on all building projects—at higher rates than contractors in other regions. In France and Germany, the emphasis is on commercial and residential buildings, with far fewer using BIM on government-owned buildings. (See page 31 for more detail.)

ROI on BIM

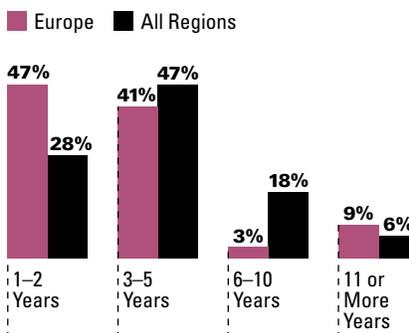
Overall, 80% of contractors in these European countries report positive ROI on BIM, though those in the UK pull down the average, with French and German contractors among the most positive (see page 23).

The averages for the European contractors for factors that improve ROI match against other nations. However, individually, there are differences in each of the countries:

- **Lower project costs:** Higher in the UK (47%) and Germany (48%)
- **Faster plan approval and permits:** In France, cited by 48%

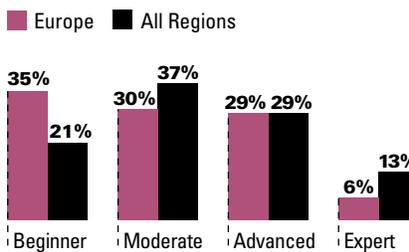
Length of Time Using BIM

Source: McGraw Hill Construction, 2013



BIM Expertise Level

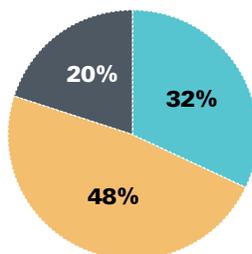
Source: McGraw Hill Construction, 2013



Perceived ROI on BIM

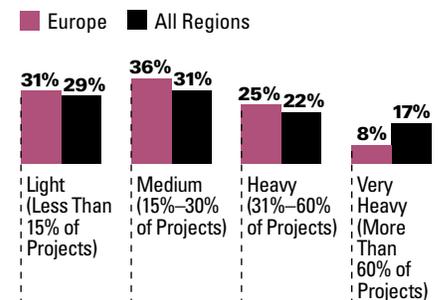
Source: McGraw Hill Construction, 2013

- Very Positive ROI (Over 25%)
- Moderately Positive ROI (Up to 25%)
- Negative/Break-Even ROI



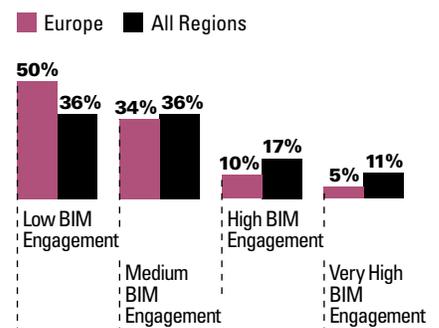
Current BIM Implementation Level

Source: McGraw Hill Construction, 2013



BIM Engagement Level

Source: McGraw Hill Construction, 2013



Factors Most Often Cited as Having High/Very High Impact on Improving ROI

Source: McGraw Hill Construction, 2013

Better Multi-Party Communications and Understanding From 3D Visualization

52%

Improved Project/Process Outcomes

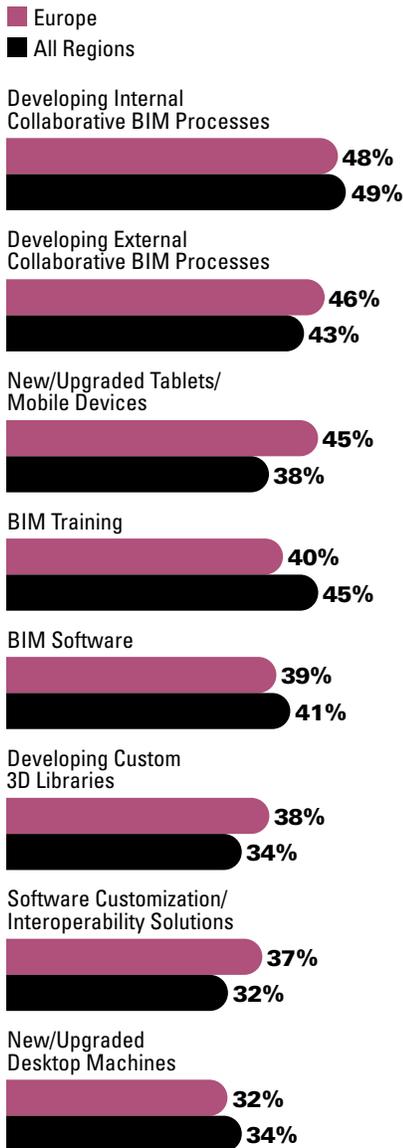
48%

Lower Project Cost

41%

Planned BIM Investments Over Next Two Years Rated as High/Very High in Importance

Source: McGraw Hill Construction, 2013



Planned BIM Investments

The investments deemed important for European contractors are consistent with the average, with the following exceptions:

- **New/upgraded tablets/mobile devices:** 48% in France and 53% in Germany
- **Developing custom 3D libraries:** 48% in France and 47% in Germany

Top Benefits

There are some differences among European contractors (averages for all European contractors shown at right). In France increased profits and reduced overall project duration are cited by more contractors—at 39% and 35%, respectively.

For German contractors, better cost controls, faster regulatory cycles and reduced overall project duration are cited by more. (See pages 19–21.)

Top Activities

PRE-CONSTRUCTION

Activities where BIM is used by more contractors in Europe compared with the average (see pages 32–33):

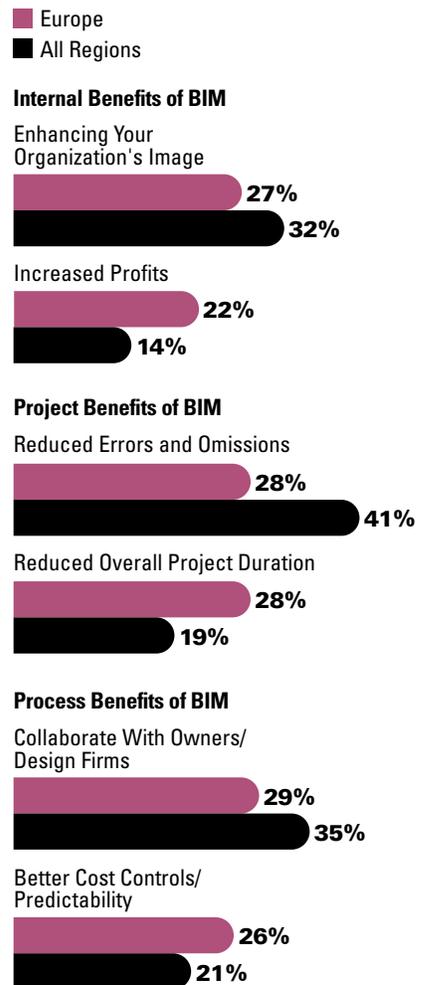
- **Integration of model with costs (5D):** Higher in France (48%) and Germany (41%)
- **Integration of model with schedule:** Higher in Germany, at 41%.
- **Modeling for construction evaluation:** Higher in the UK, at 44%.
- **Laser scanning:** Higher in France (29%) and Germany (28%)
- **Value engineering:** Higher in the UK (24%) and Germany (31%).

CONSTRUCTION AND POST-CONSTRUCTION

The top two construction activities where BIM is used by German contractors are augmented reality

Top Benefits Cited by Contractors in Europe (According to Benefit Category)

Source: McGraw Hill Construction, 2013



(47%) and laser scanning (44%), while those in France and the UK match against the average.

In France and Germany, the use of BIM on post-construction activities is higher for almost all activities (see page 36), whereas UK contractors match against the average. ■

Data: South Korea

BIM for Construction Data From Contractors in South Korea

Though at a relatively low implementation level of BIM use currently, contractors in South Korea are preparing for more intense use in the future, as they look to make investments in internal BIM expertise and processes to encourage it. Improved communication and collaboration, as well as reduced errors, are important benefits and drivers to increasing engagement.

BIM Engagement

There are three components that comprise the BIM engagement level (see page 14): experience with BIM, expertise level and implementation level—shown at right.

Compared with those in the other regions, contractors in South Korea are using BIM on fewer projects, leading to 78% of them being at low or medium engagement levels.

Project Types

Most of the South Korean contractors' BIM use is being done on buildings, particularly commercial and government-owned ones. Levels for use in non-building projects is comparable with the total for all respondents (see page 31).

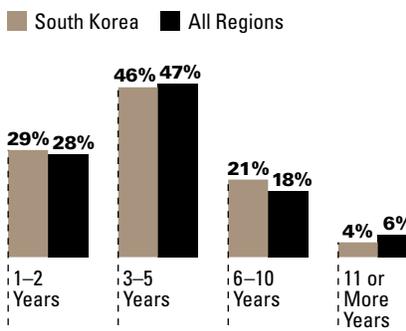
ROI on BIM

In South Korea, only 48% report a positive ROI on BIM, which is the lowest for all the key countries investigated in this study. The relatively low usage of BIM on projects and the lack of formal measurement of ROI (39% are not formally measuring BIM ROI on any projects) could be reasons for this low result.

Overwhelmingly, South Korean contractors agree that the factor that would have the most impact on improving ROI for BIM is better multi-party communications and understanding—91% versus 60% for all respondents (see page 26). This consensus does not exist in other markets.

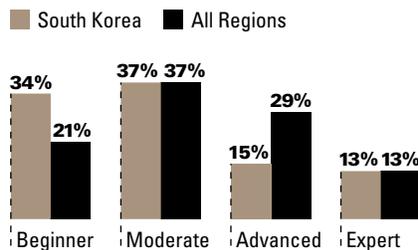
Length of Time Using BIM

Source: McGraw Hill Construction, 2013



BIM Expertise Level

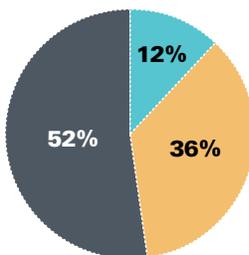
Source: McGraw Hill Construction, 2013



Perceived ROI on BIM

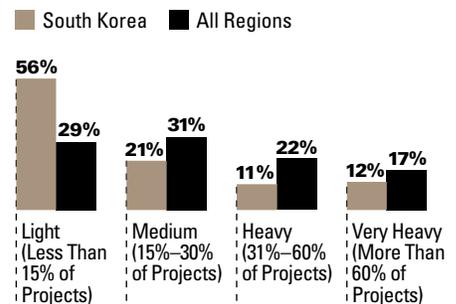
Source: McGraw Hill Construction, 2013

- Very Positive ROI (Over 25%)
- Moderately Positive ROI (Up to 25%)
- Negative/Break-Even ROI



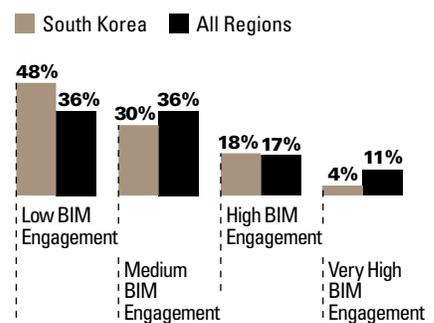
Current BIM Implementation Level

Source: McGraw Hill Construction, 2013



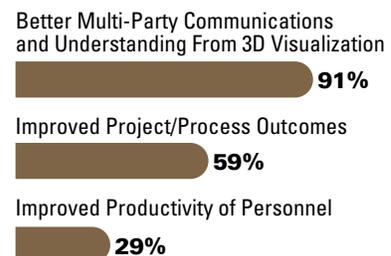
BIM Engagement Level

Source: McGraw Hill Construction, 2013



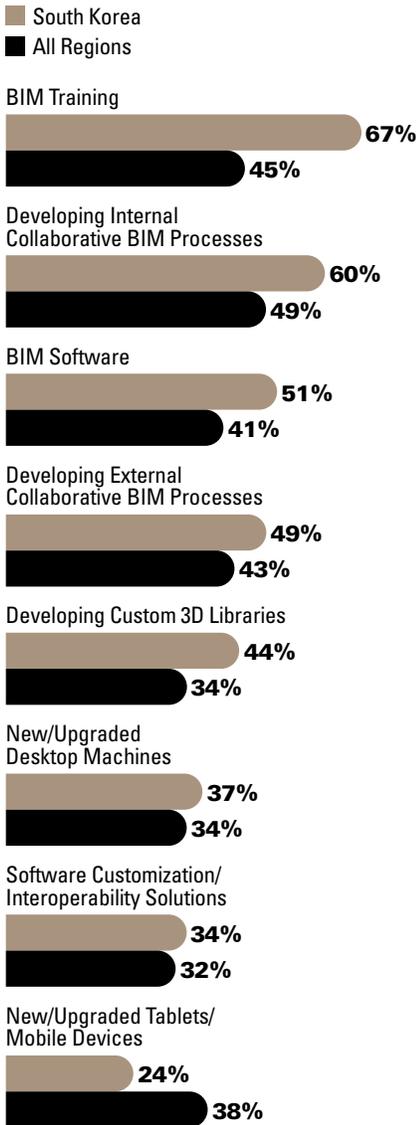
Factors Most Often Cited as Having High/Very High Impact on Improving ROI

Source: McGraw Hill Construction, 2013



Planned BIM Investments Over Next Two Years Rated as High/Very High in Importance

Source: McGraw Hill Construction, 2013



Planned BIM Investments

BIM training and developing collaborative processes are investment areas in which South Korean contractors place high/very high importance. The agreement as to the importance of BIM training makes a strong statement about the future plans for BIM use in the country, as firms prepare all their workers to become users.

Top Benefits

Overall, the top benefits reported by contractors in South Korea align with the total for all respondents. Though second for both respondents in South Korea and in total, marketing new business is noted by significantly more contractors in South Korea. Similarly, the reduction of errors and omissions is viewed as a top benefit for significantly more contractors in South Korea.

Top Activities

PRE-CONSTRUCTION

Overall, the current ways contractors are leveraging BIM in South Korea are comparable to those of all respondents (see page 32), with particularly strong use of BIM for multi-trade coordination (65%), visualization of the design intent (63%) and determining quantities from models (43%).

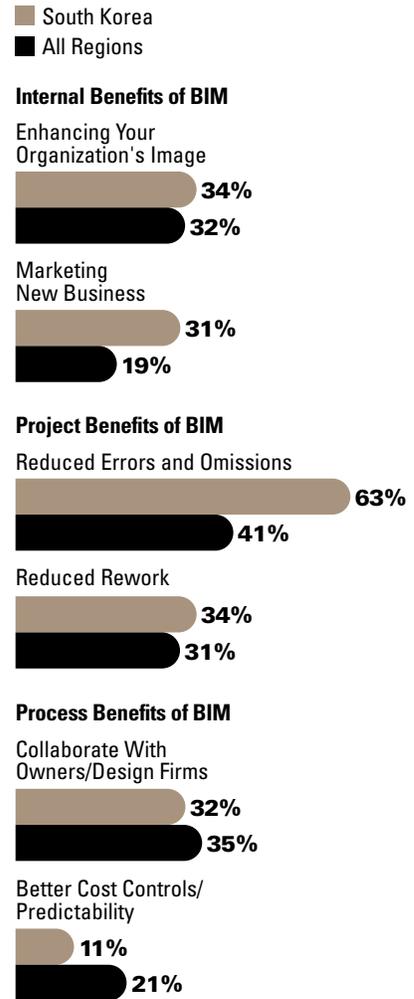
CONSTRUCTION AND POST-CONSTRUCTION

Overall, similar numbers of contractors in South Korea are using BIM for construction and post-construction activities compared with all respondents (see pages 34–36).

Two notable areas of difference: (1) Significantly more contractors

Top Benefits Cited by Contractors in South Korea (According to Benefit Category)

Source: McGraw Hill Construction, 2013



in South Korea (75%) report using BIM for model-driven layout in the field, compared with all respondents (59%); and (2) Far more South Korean contractors (77%) report using BIM to prepare a final as-built model for the owner, compared with the average for all respondents (64%). ■

BIM for Construction Data From Contractors in Japan

Japanese contractors are engaging in BIM at moderate levels but are reporting significant benefits from doing so. This should help spur increased usage, as should the investments oriented toward building capacity for and expertise in BIM. Higher profits and lower costs are key factors to BIM use in Japan.

BIM Engagement

There are three components that comprise the BIM engagement level (see page 14): experience with BIM, expertise level and implementation level—shown at right.

Compared with those in the other regions, contractors in Japan are at more moderate BIM engagement levels, with 83% having used BIM for more than three years, and nearly three quarters (74%) using BIM on 15%–60% of projects.

Project Types

Most of the Japanese contractors' BIM use is being done on commercial buildings and industrial/manufacturing projects, with the other sectors rating lower usage compared with other respondents around the world (see page 31).

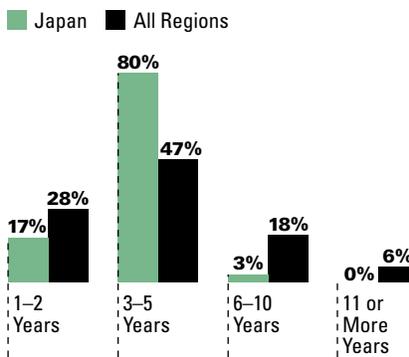
ROI on BIM

In Japan, nearly all contractors report a positive ROI on BIM. Further, the share that report very positive ROI (40%) is higher than the percentage reporting the same in any other region. More Japanese contractors are also formally measuring BIM ROI on projects compared with respondents in most other regions.

The top business benefits that would help drive increased ROI in Japan line up against those for all regions investigated, though lower project cost is significantly higher in Japan at 55% versus 29% for all respondents (see page 26).

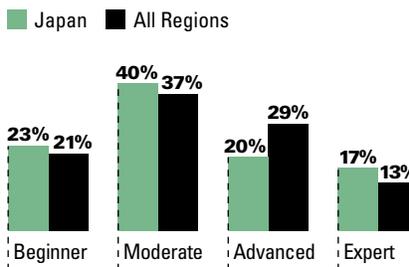
Length of Time Using BIM

Source: McGraw Hill Construction, 2013



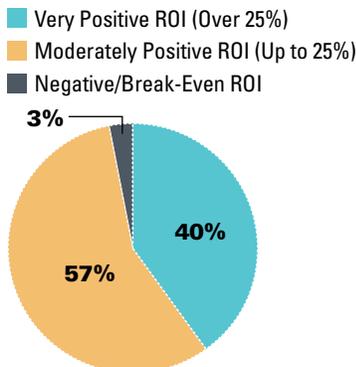
BIM Expertise Level

Source: McGraw Hill Construction, 2013



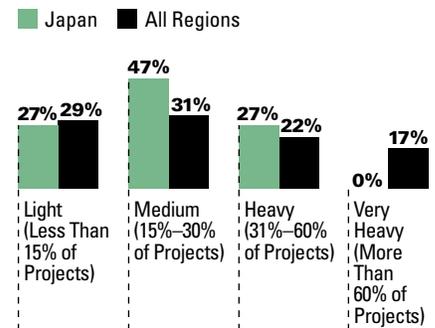
Perceived ROI on BIM

Source: McGraw Hill Construction, 2013



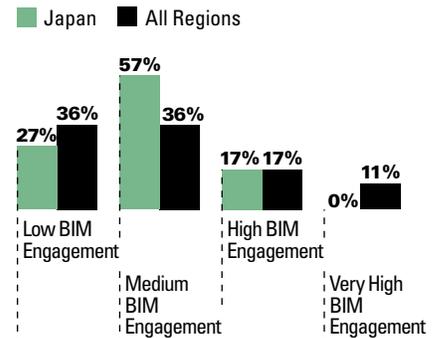
Current BIM Implementation Level

Source: McGraw Hill Construction, 2013



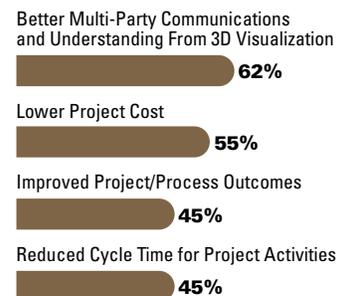
BIM Engagement Level

Source: McGraw Hill Construction, 2013



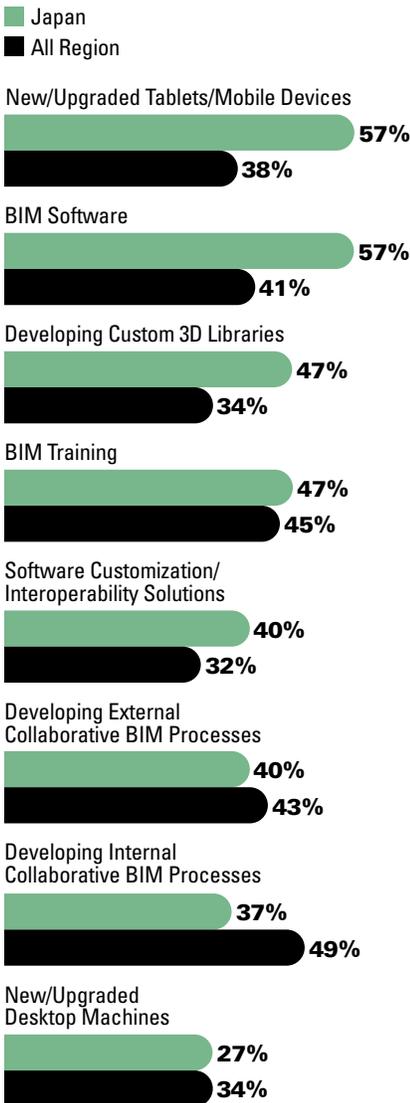
Factors Most Often Cited as Having High/Very High Impact on Improving ROI

Source: McGraw Hill Construction, 2013



Planned BIM Investments Over Next Two Years Rated as High/Very High in Importance

Source: McGraw Hill Construction, 2013



Planned BIM Investments

New/upgraded tablets/mobile devices, BIM software, developing custom 3D libraries and BIM training are investment areas in which Japanese contractors place high/very high importance. These areas all correspond to the moderate level of BIM engagement, since these are investments related to building internal capacity to accelerate BIM use.

Top Benefits

Marketing new business and increased profits are the top reported internal BIM benefits for Japanese contractors, at levels greater than for all respondents. Conversely, significantly fewer cite enhancing your organization’s image as a top benefit (see page 20), which may be representative of the Japanese culture as well as of moderate BIM users.

The top process benefits for Japanese contractors align with all respondents, though collaboration is noted by far fewer contractors in Japan. In contrast, reduced overall project duration is noted as a project benefit by far more firms in Japan.

Top Activities

PRE-CONSTRUCTION

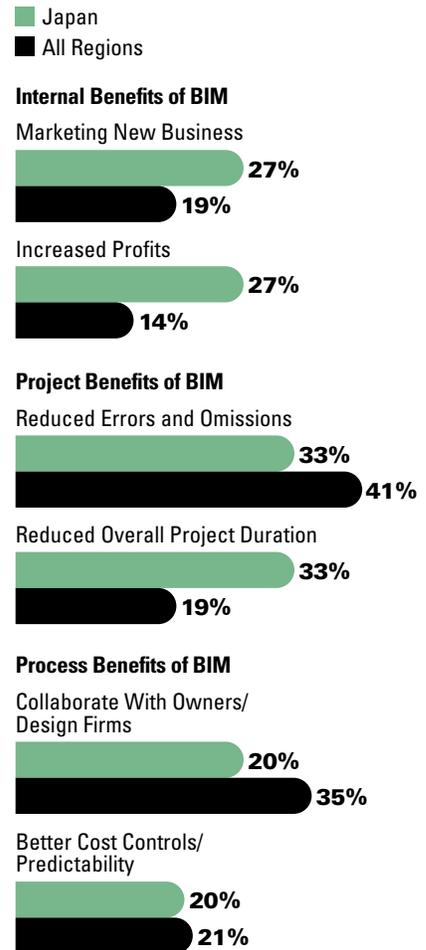
Integration of model with cost (5D) is used by significantly more Japanese contractors compared with all respondents—53% versus 29%, respectively. BIM in value engineering is also more common in Japan (30% versus 16%).

CONSTRUCTION AND POST-CONSTRUCTION

The only notable differences in the use of BIM in construction activities for Japanese contractors compared

Top Benefits Cited by Contractors in Japan (According to Benefit Category)

Source: McGraw Hill Construction, 2013



with all respondents is for BIM use for supply chain management (37%) and model-driven robotics (33%).

In Japan, the use of BIM on post-construction activities is overwhelmingly higher with almost all activities reported by significantly more contractors in Japan (see page 36). ■

Data: Australia and New Zealand

BIM for Construction Data From Contractors in Australia and New Zealand

Contractors in Australia and New Zealand, though relatively new users of BIM compared with contractors in some other parts of the world, are reporting important benefits from BIM and planning future investments, particularly in areas that extend to accelerating use of BIM across project teams, especially owners.

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS

BIM Engagement

There are three components that comprise the BIM engagement level (see page 14): experience with BIM, expertise level and implementation level—shown at right.

Compared with those in the other regions, contractors in Australia and New Zealand are slightly newer BIM users, which results in their relatively lower engagement levels—though the difference is not dramatic.

Project Types

For the most part, contractors in Australia and New Zealand are using BIM on the same projects as contractors in other regions. Notable exceptions are commercial buildings, industrial/manufacturing and mining projects where BIM is used at significantly higher rates (see page 31).

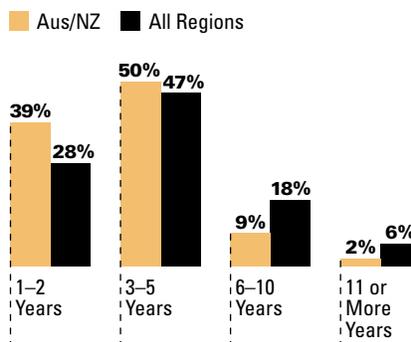
ROI on BIM

In Australia and New Zealand, 78% of contractors report a positive ROI on BIM, and those that report very positive ROI (35%) is equivalent to other key countries investigated in this study.

Two of the top three business benefits that would help drive increased ROI in Australia and New Zealand line up against those for all regions investigated. However, in Australia and New Zealand, using BIM for sustainability goals is rated as an important benefit by twice as many contractors than globally—32% compared with 16%, respectively.

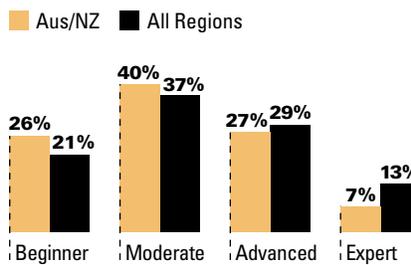
Length of Time Using BIM

Source: McGraw Hill Construction, 2013



BIM Expertise Level

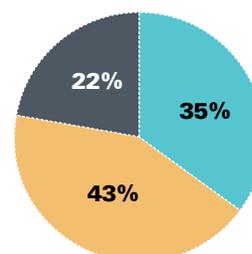
Source: McGraw Hill Construction, 2013



Perceived ROI on BIM

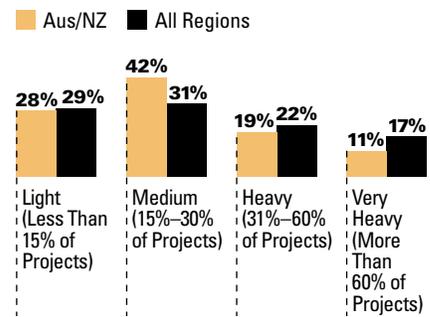
Source: McGraw Hill Construction, 2013

Very Positive ROI (Over 25%)
Moderately Positive ROI (Up to 25%)
Negative/Break-Even ROI



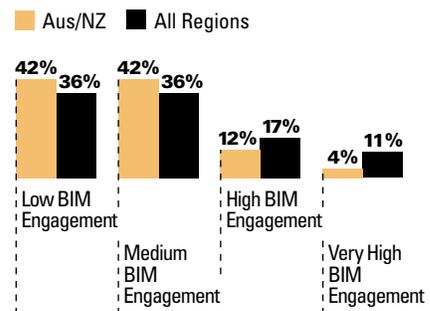
Current BIM Implementation Level

Source: McGraw Hill Construction, 2013



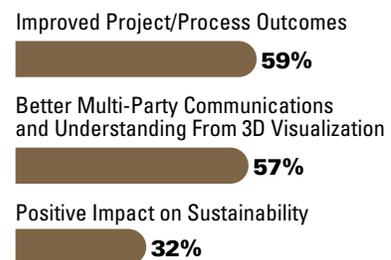
BIM Engagement Level

Source: McGraw Hill Construction, 2013



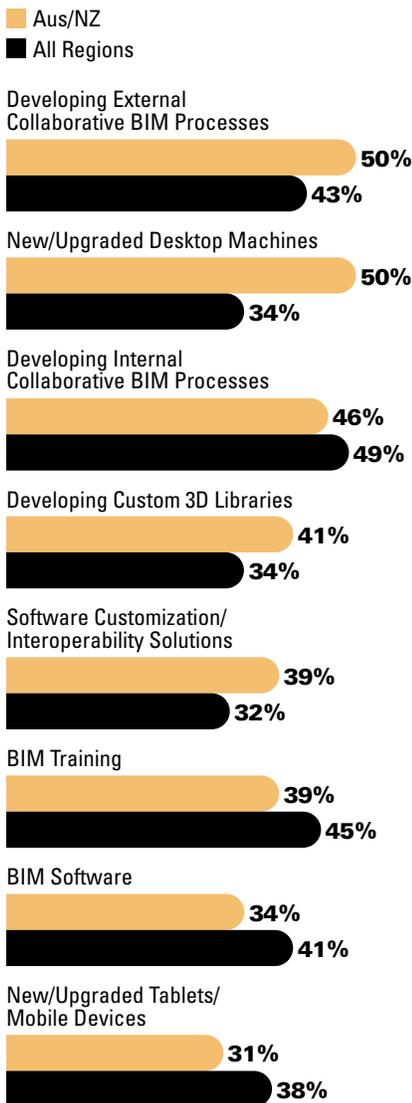
Factors Most Often Cited as Having High/Very High Impact on Improving ROI

Source: McGraw Hill Construction, 2013



Planned BIM Investments Over Next Two Years Rated as High/Very High in Importance

Source: McGraw Hill Construction, 2013



Planned BIM Investments

External collaborative BIM processes and interoperability are investment areas where contractors in Australia and New Zealand place higher importance, which corresponds to findings in the *Business Value of BIM in Australia and New Zealand SmartMarket Report (2014)*, which revealed efforts that are already underway to accelerate BIM standards and use of BIM across entire project teams, including owners. New and upgraded desktop machines is also an area of high planned investment.

Top Benefits

Generally, contractors in Australia and New Zealand match up against the benefits most often cited by other contractors around the world (see chart at right as well as pages 20–23).

The exception is increased profits. It is cited by the second highest number of contractors compared to its position as third, behind marketing new business, for all respondents.

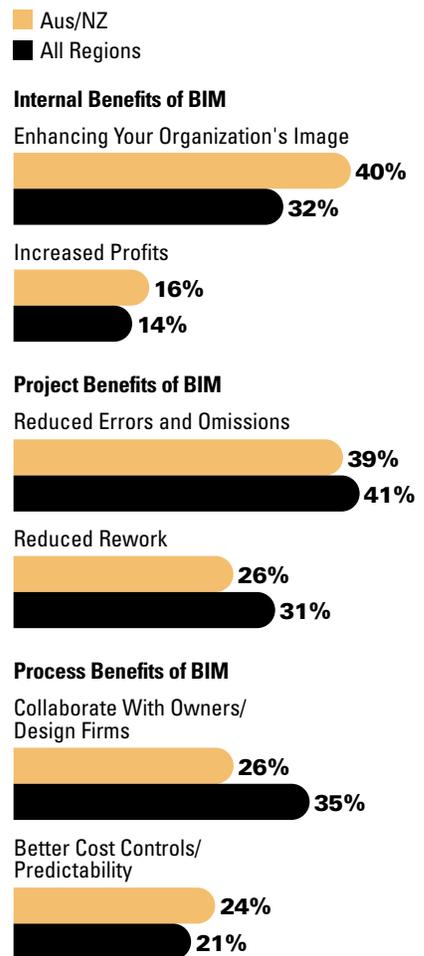
Top Activities

PRE-CONSTRUCTION

Visualization of the design intent and multi-trade coordination are cited by the most contractors in Australia and New Zealand as the top ways they are leveraging BIM for pre-construction—at 55% and 43%, respectively. It is comparable to the top for all contractors (see page 32), though in reversed order. Integration of model with cost (5D) and with schedule (4D) and safety are also used by more contractors in this region.

Top Benefits Cited by Contractors in Australia/ New Zealand (According to Benefit Category)

Source: McGraw Hill Construction, 2013



CONSTRUCTION AND POST-CONSTRUCTION

Contractors in Australia and New Zealand are using BIM for construction activities at comparable levels to all respondents.

For post-construction activities, managing the model for the owner beyond closeout is more frequently used, at 41% versus 31% for all respondents. ■

Asia: Emerging BIM Market Driven by Owner Interest in China, Hong Kong and Malaysia

Valued at well over \$1 trillion in 2012, China's construction market has the potential to see immense benefits from BIM, but structural obstacles have caused that potential to remain largely untapped. Comparisons to BIM use in Hong Kong and Malaysia provide insight into China's unique challenges.

China

STILL A NASCENT MARKET FOR BIM

Only a small percentage of firms in the Chinese market are currently using BIM, according to a survey conducted in 2012 and published in March 2013 by the China Construction Industry Association (CCIA). Li Fei, secretary general of the CCIA, explains that the survey revealed that "actual BIM implementation is still in the early stages, with less than 15% [of the 388 Chinese construction firms that participated in the research] indicating they have used BIM." However, the study also showed that 55% have heard of BIM. This awareness will be a crucial first step toward wider BIM adoption.

One aspect of adoption of BIM in China that differs from markets with earlier adoption is that contractors are the largest group of adopters, vastly outnumbering designers and owners. Dr. Li Yungui, deputy director of the Technical Center of China State Construction Engineering Corporation Limited, one of the largest construction companies in the world, states that, "For designers, BIM adoption is more challenging." Among the reasons for this challenge, he notes that, "From a designer's perspective, using BIM is often considered extra work within a fixed fee. This extra cost may include buying software and investing in the training of staff. While the additional technical skill may help designers to beat out the competition in winning

projects, the abundance of available projects in the Chinese market reduces the urgency of adoption."

On the other hand, Dr. Yungui finds that market forces and strong benefits are helping drive contractors to adopt BIM. "Contractors in China are technically skilled, and competition between the major organizations is fierce. Using BIM can help reduce costs through clash detection and optimization of construction schedules, allowing organizations to not only win contracts, but earn more from each contract." However, he also notes that only a few have the prerequisite skills to use BIM currently, which may help explain the relatively low use of BIM across the industry.

KEY OBSTACLES TO BIM ADOPTION IN CHINA

He Xixing, general manager of Shanghai Jianke Engineering Consulting Company, Ltd., a project management firm employing over 3,000 people, finds that his company has needed to adopt BIM, but he recognizes many structural barriers in the market. "Breaking with traditional methods can be difficult," he explains. "New developments in BIM will conflict with benefits of traditional stakeholder roles and values. For example, when we suggest the use of BIM for clash detection and MEP coordination, the GCs feel that we are threatening their familiar workflow. Typically, GCs like to submit a low bid then cut costs during the construction process. The

high degree of transparency inherent in BIM projects can reduce the flexibility available to GCs during project delivery. This makes BIM adoption difficult in a market that is driven by the demand and ideology of GCs."

Fei agrees, noting that a key barrier to BIM adoption is that it "requires altering typical management processes, which frequently results in some level of resistance."

Dr. Yungui reveals that legal requirements in the construction market work against collaboration, which therefore inhibits the use of BIM. "For projects in China, the RFP for design and construction is required to be separate—the law states that the design stage cannot involve contractors, so there is less opportunity of collaboration through BIM." Without the ability to capitalize on the transparency of BIM and its effectiveness in supporting collaboration, the Chinese market may struggle to see the full benefits BIM can provide.

With only 13% of designers who have reported using BIM, compared with over 50% of contractors, according to the survey published by CCIA, the lack of interoperability in software is also a notable problem. Xixing states, "Another challenge is that the software available in China is not yet able to easily support modeling efforts at sufficient levels of detail and accuracy required for analytic and management model uses. Such modeling requires significant investment and is rather inefficient. One

example is the Tianjin 117 Tower project, where the LDI is using BIM but has separated BIM from the design team. Therefore, this requires extra time where the model is lagging behind the actual design.

Dr. Yungui, Xixing and Fei all agree that lack of human capital is also a critical factor impacting adoption in China currently. Dr. Yungui states, “We are not seeing enough people who know about the software.” However, Xixing finds that the human capital problem goes beyond just the software to other key skills: “Finding adequately trained staff to support BIM processes is critical. First, team members operating BIM need to have the skills and capabilities of using the technology. Second, they must also have a good understanding of construction processes. Third, users of BIM need good project management capabilities to work well as a team. Very few candidates in the Chinese market today have this advanced set of capabilities.” Fei reports that the most widely recognized step for future BIM adoption in the survey is training more BIM-capable staff.

OWNERS WILL DRIVE BIM USE

Owners are likely to help drive further adoption of BIM. Dr. Yungui identifies the opportunities of facility management, which is still largely untapped in more developed BIM markets like the US and Europe, as one of the factors currently influencing BIM adoption in China: “We have seen many Chinese owners of major projects ... may go as far as requesting BIM for facility management. Oftentimes this is reflected in their RFP language.” He affirms, “Building owners/operators are receiving the most benefit from using BIM, because at the end of the

day, it is their money.

Xixing agrees that owners seeking to improve facility management are emerging as a key driver of adoption in China. “Today, BIM is leveraged to connect with construction management, reduce waste, increase efficiency and support information transfer to the O&M phase. More and more, owners and project teams are looking toward BIM for operations and facilities management.” He sees this playing an important role in the future. “Many owners want us to go beyond managing design and construction, moving into building operations and management. So now, BIM can be used to expand how we provide services to the client.”

Hong Kong

Rosana Wong, executive director of the Yau Lee Group, a large contractor operating in Hong Kong, feels that the Hong Kong market is also

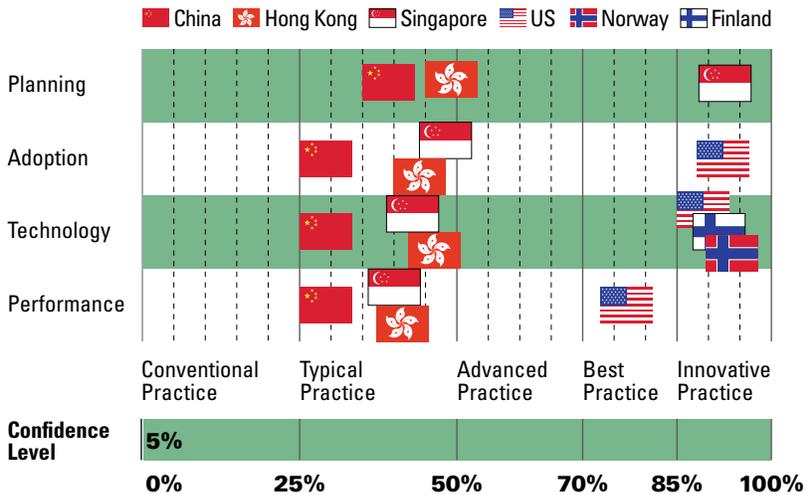
largely owner driven. She finds that “premium general contractors are the leading BIM adopters” there, but that BIM use is frequently “one-off due to unique project requirements.” For her, the key to growth in this market is “further support from the government, in terms of policy, mandates and incentives,” and she sees the potential for BIM-experienced Hong Kong firms to “support the development of the built environment in nearby countries and regions.”

Malaysia

Khor Wei Moon, director of technical design for Sunway Group, a property development and construction company, finds that BIM is “mainly a private initiative driven by the larger property developers and contractors” in Malaysia. He expects that to continue in the future, since government support for BIM adoption has been limited to training thus far. ■

bimSCORE¹ for Select Asia Countries Compared to Leaders

Source: bimSCORE, 2013



Country to country comparison in terms of the four areas of BIM maturity: planning, adoption, technology and performance. Selected Asian economies—China, Singapore, and Hong Kong—are compared with countries leading in each of the four areas.

bimSCORE provides an objective measure of BIM utilization for owners, designers and contractors to help them optimize the value of their buildings.

India: BIM Gains Relevance

As India strides to keep pace with significant gaps in its infrastructure, the construction sector—the second largest industry after agriculture accounting for 11% of India's GDP—is crying out for efficiencies to speed productivity. BIM provides one opportunity to help address India's growing needs.

Increasingly, larger construction companies in sectors such as hotels and airports are starting to implement Building Information Modeling (BIM) in India with distinct benefits but at a very high cost.

Costs of Implementation

"It's a chicken and egg situation. Unless BIM is adopted on a larger scale, costs will continue to be high, trained people will remain at a premium, and the full potential of BIM technology for visualization and walkthrough developments will continue to lag," says one software engineer. In fact, Tesla Outsourcing Services, an Indian company that delivers engineering, CAD and BIM services to clients worldwide, reported in a blog post that, according to a report by Autodesk, "Designers across the world have started implementing BIM technology in their respective construction projects; whereas their Indian counterparts have still not captured the full potential of BIM technology for visualization and walkthrough developments."

BIM technology promises delivery of coordinated design and construction information in a 3D visual environment. However, as pressures on construction companies to deliver quality value-added projects on time and within budget increase, the industry is still learning about BIM and how to utilize software to meet their needs.

"BIM is moving slowly and is used for hotel projects and luxury buildings that have lots of electro-mechanical requirements to avoid conflicts at time of construction. We find BIM useful as conflicts like a pipe going into an air-conditioning duct, not possible in CAD, can be seen visually," says Anil Lal, managing director, Systra-MVA Consulting India to ENR. "[However] we use BIM only when clients mandate it."

Mumbai-based HCC Group, one of the largest companies spanning the engineering and construction, real estate, infrastructure and urban development sectors, does not use BIM much. "It is used mostly for buildings, which is just 5%–10% of our total business", a design engineer told ENR. "For the past decade, people have been using STAAD [a structural analysis and design computer program] and now convert the STAAD model to ETABS [an analysis and design software]....[People] are (now) developing confidence [to use newer technology]." ETABS is the solution for designing a simple 2D frame or performing a dynamic analysis of a complex high-rise. It can be applied for design of building structures with a structural system consisting of beams, slabs, columns, shear walls and bracings. Different materials can be assigned to the structural elements within the same model, such as steel, reinforced concrete, composite or any other user-defined material.

Systra was recently awarded the construction of stations for the Bangalore metro system, which mandated BIM. "The software is expensive, and there aren't enough trained people [which means design takes longer]," says Lal.

Uttam Sagar, CEO, development and construction of Bangalore-based Vasoo Builders, with projects including large commercial buildings, says BIM is too complicated and has "too much information for uncertain scenarios. The inputs required for BIM feeding off structural and mechanical drawings and then having to update the drawings is very difficult. We need a separate agency for implementing BIM, which comprises around 4%–5% of design costs. Margins are paper thin, so it's not worth it for us." Sagar says using BIM for the Bangalore metro makes sense "because it's a government project ... they can afford it and want control at various points."

Factors Favoring BIM

India's steel industry leads the way with BIM, as do companies supplying prefabricated manufactured and finished products. "If you dump 1000 bags of cement at a site, it doesn't matter which one goes first," says Gautam Suri, founder, director and chief technology officer, Interarch Building Products, a company manufacturing pre-engineered metal building systems. The company has integrated SAP with BIM inhouse

as the “BIM aspect helps you model the building and on time,” says Suri. “For large projects, the sequence of deliveries is essential, and manufacturing follows a similar schedule.... Being in the prefab business, BIM is an important tool for us, and we couldn’t live without it.”

Interarch does not use standardized packages as they need to be customized and its “experience in dealing with software package vendors is that they get stuck in nitty gritty.”

Many large construction companies in India do not use BIM, though some buy a standard package and adapt their requirements to it. For instance, Punj Lloyd, a large engineering and construction group that provides integrated design, procurement and project management services for energy and infrastructure sector projects, confirmed to ENR it did not use BIM. Recently, Mike Barker, managing director, Mott MacDonald India, said the company was increasingly looking at BIM in its construction projects. BIM was used in the design of neighboring Male International Airport expansion in the Maldives. “As with all island airport projects, challenging aspects of this expansion include limited space—reclamation is restricted by the coral that surrounds the island, and problems of procurement, as most of the resources (are) imported to the site.” Shell’s R&D Centre in Bangalore is also being designed with the help of BIM, says Barker.

International Firms Using BIM in India

With India’s construction market valued currently at \$140 billion and

a forecasted growth of \$620 billion by 2020, new projects are being fast-tracked, leading many international firms to seize the opportunity, and this is helping to bring BIM into the marketplace. Vico Software, for instance, announced a partnership with Mansycom Consultants. Donald Henrich, co-founder and executive vice president of Vico Software, explains, “Because the Indian market is so broad and diverse, we knew we needed a partner who is committed in three areas: market education, technology advocacy and expert consulting services for change management. We are very impressed with Mansycom’s commitment in these areas.”

Autodesk announced it will provide its BIM software to help Jurong Consultants India, part of Singapore-based Jurong International. Jurong is creating a design center as a means of enhancing its multidisciplinary service delivery through BIM in India. “We are equipping a pool of professionals that includes engineers, architects and master planners, to provide integrated consulting services for our customers This will enable us to deliver projects that are aligned with the pace of the building industry’s transformation,” says Uma Maheswaran, CEO, India Operations, Jurong Consultants. Recently, Munich-based Nemetschek Allplan partnered with Ram Caddsys. “In India, we have a dramatically growing construction industry particularly in bridge construction, power and hydraulic engineering, which offers huge potential,” says Benjamin Hansen, director global sales for Nemetschek Allplan. Tata Consulting Engineers (TCEL) too announced it will leverage BIM solutions offered

by BIM to bring business value to its global customers in the power, infrastructure, chemical, process and building sectors

The Future of BIM

Looking at the growing market, BIM software provider, Tekla India, recently showcased its offering for concrete construction projects. According to chief operating officer Nirmalya Chatterjee, the industry is starting to reap benefits. For instance, cast-in-place concrete has been a major concern for contractors, which BIM solutions address.

The past two years have seen sophistication in systems bringing in automatic information flow and control. Interarch’s Suri is optimistic about BIM’s role in the future from engineering to execution even as more manufacturing takes place in facilities rather than onsite. Off-site prefabrication uses software to deliver sequentially and on time for pre-engineered steel structures for large buildings. Challenges in implementation remain for the time being.

“Many engineers don’t understand or know how to use the tool. On-the-job training is lacking, and software-based fabrication engineers are just not clued in. To start with, they need to learn how to use the software. That should take the fear of God away,” explains Suri.

Benefits are striking and include less material waste, speedier completion, scheduling of risks and easing of logistics issues. “To handle (logistics) manually is cumbersome as India poses many constraints of loading material for transportation. With BIM, raw material is pre-identified and what goes into which truck is predetermined,” adds Suri. ■

Methodology:

Global Building Information Modeling (BIM) Study Research

THE BUSINESS VALUE OF BIM FOR CONSTRUCTION IN MAJOR GLOBAL MARKETS

McGraw Hill Construction conducted the 2013 Global Building Information Modeling (BIM) Study to determine contractors' use of and attitudes toward BIM. The research was conducted through an internet survey to contractors between September 25th and November 5th, 2013.

A total of 727 individuals across 10 countries completed the survey, recruited through a combination of professional association invitations and supplemental panel recruiting. The organizations that provided the survey to their members or subscribers include: Air Conditioning and Mechanical Contractors Association, American Society of Professional Estimators, Association of General Contractors, Australian Construction Industry Forum, Australian Institute of Building Surveyors, BIMForum, buildingSMART Korea, Canada Green Building Council, Canadian Institute of Steel Construction, Chartered Institute of Building, Construction Industry Council, Construction Management Association of

America, Construction Management Association of Korea, Consult Australia, German Sustainable Building Council, Green Building Council Brasil, Green Building Council of Australia, International Council for Research and Innovation in Building and Construction (CIB), Korea Mechanical Construction Contractors, O'Empreiteiro, Sheet Metal and Air Conditioning Contractors' National Association, UK Contractors Group, UK Green Building Council, US Green Building Council and World Green Building Council, along with Yonsei University.

Survey Participants

The survey targeted contractors that use BIM. BIM use was self-reported.

Firms referred to as general contractors in the analysis include those that identify themselves as general contractor, construction manager at risk or construction management companies. Trade contractors were asked to identify their specialty or trade. Eighty-two percent of the respondents are identified as general

contractors in the analysis and 18% as trade/specialty contractors.

The analysis throughout the report explores the differences in the responses of small, medium and large contractors. Those are defined by their annual revenue in 2012:

- Small: Less than \$50 million
- Medium: \$50 million to less than \$250 million
- Large: \$250 million or more

The following is the list of countries included and the number of respondents from each country:

- Australia: 83
- Brazil: 40
- Canada: 39
- France: 31
- Germany: 32
- Japan: 30
- Korea: 91
- New Zealand: 36
- United Kingdom: 54
- United States: 291

BIM Engagement Index

McGraw Hill Construction has developed a BIM Engagement Index, which quantifies with a numerical score each respondent that participated in this research. The score is derived from contractor survey responses about their experiences with, expertise in and level of implementation of BIM. These responses are weighted to reflect the increasing level of engagement that is represented by more experience, skill and/or implementation. Each of the three criteria is weighted against the others to reflect its relative degree of importance for BIM engagement, with expertise being the most valuable, followed by experience, then implementation level. For more information on the BIM Engagement Index, see page 14. ■

Percentage of Global Contractors According to Their BIM Engagement Index Rating

Source: McGraw Hill Construction, 2013

BIM Engagement Levels	Range of BIM Engagement Index Scores for Each Level	Percent of Contractors in Each BIM Engagement Level (Combined Average for All Regions)
Very High BIM Engagement	23 to 27	11%
High BIM Engagement	17 to 22	17%
Medium BIM Engagement	11 to 16	36%
Low BIM Engagement	3 to 10	36%

Resources

Organizations and websites that can help you get smarter about building information modeling.



McGraw Hill Construction

Main Website: [construction.com](http://www.construction.com)
 Dodge: [construction.com/dodge](http://www.construction.com/dodge)
 Research & Analytics:
[construction.com/dodge/dodge-market-research](http://www.construction.com/dodge/dodge-market-research)
 Architectural Record: [archrecord.com](http://www.archrecord.com)
 Engineering News-Record: [enr.com](http://www.enr.com)
 Sweets: [sweets.com](http://www.sweets.com)
 SmartMarket Reports:
[construction.com/market_research](http://www.construction.com/market_research)

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A message from ...
Lisa Campbell
Vice President, Industry Strategy and Marketing, Autodesk

Lisa Campbell

Over the years Autodesk has been honored to sponsor a series of McGraw Hill Construction *SmartMarket Reports* on the adoption, usage and business value of Building Information Modeling (BIM). As greater industry demands unfold, BIM is emerging as a necessary process to promote leaner operations throughout a construction project's lifecycle. Regardless of size, contractors are at the heart of the workflows and processes that see the greatest benefits from BIM. Adopters of BIM accrue competitive, financial and operational benefits with usage and mastery of BIM processes and technologies. This first Global BIM in Construction report reinforces our view that, despite regional differences, construction companies represent the fastest-growing segment of BIM adopters and are leading the industry in innovative applications of the technology. Autodesk appreciates the opportunity to support meaningful research and analysis to learn from the industry and advance effective and efficient construction project management through BIM.



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 Associated General Contractors of America: www.agc.org
 Australian Construction Industry Forum: www.acif.com.au
 Australian Institute of Building Surveyors: www.aibs.com.au
 buildingSMART Korea: www.buildingsmart.or.kr
 Canada Green Building Council: www.cagbc.org
 Canadian Institute of Steel Construction: www.cisc-icca.ca
 Chartered Institute of Buildings: www.ciob.org
 Construction Industry Council: www.cic.org.uk
 Construction Management Association of America: www.cmaanet.org
 Construction Management Association of Korea: www.cmak.or.kr
 Consult Australia: www.consultaustralia.com.au
 German Sustainable Building Council: www.dgnb.de
 Green Building Council Brasil: www.gbcbrazil.org.br
 Green Building Council of Australia: www.gbca.org.au
 International Council for Research and Innovation in Building and Construction: www.cibworld.nl
 Korea Mechanical Construction Contractors Association: www.kmcca.or.kr
 O'Empreiteiro: www.revistaoempreiteiro.com.br
 Sheet Metal & Air Conditioning Contractors' National Association: www.smacna.org
 UK Contractors Group: www.ukcg.org.uk
 UK Green Building Council: <http://www.ukgbc.org/>
 U.S. Green Building Council: www.usgbc.org
 World Green Building Council: www.worldgbc.org
 Yonsei University: www.yonsei.ac.kr/eng/

Other BIM Resources

bimSCORE: www.bimscore.com
 buildingSMART International: www.buildingsmart.org
 National Institute of Building Sciences: www.nibs.org

■ Design and Construction Intelligence

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