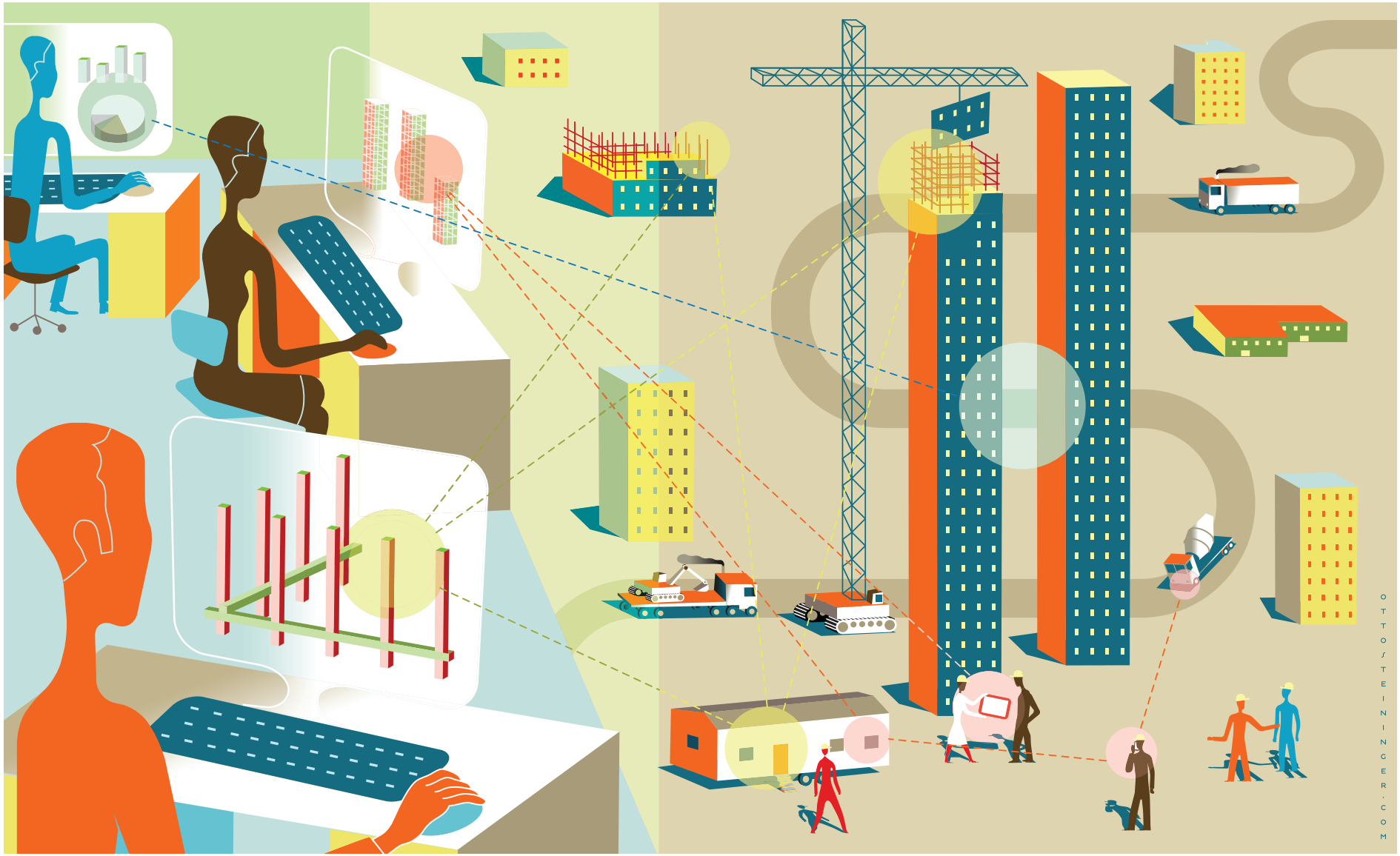
SmartMarket Brief: BIM Advancements No. 1

BIM Success Factors • Construction Modeling • Information Mobility



DODGE DATA & ANALYTICS

Premier Partner Bentley Advancing Infrastructure

Introduction

ABOUT THIS EDITION No. 01

The focus of this inaugural edition of the **SmartMarket Brief:** BIM Advancements series is on the perspectives of the largest architects, engineers and contractors on three critical topics: how they measure their success with BIM, work with models that are developed specifically for construction/fabrication, and leverage information mobility to improve efficiency and productivity.

1. BIM SUCCESS FACTORS

This research provides insight into the percentage impact of BIM on **six key project outcome metrics**, and the frequency and value of **10 project factors** that influence success with BIM. It also identifies the frequency and negative impact of **six obstacles** to BIM effectiveness, and the **four most important success factors** for BIM.

2. CONSTRUCTION MODELING

This research provides insight into the frequency and value of **seven types of construction models** produced by trade contractors, and **six key uses for construction models** on projects. It also identifies which parties are most frequently **authoring construction models** for specific uses.

3. INFORMATION MOBILITY

This research provides insight into **current and future uses of various modes** of sharing information, the **most important past and future improvements** to information mobility, and the **project benefits** it provides.

About the SmartMarket Brief: BIM Advancements Series

Dodge Data & Analytics and Bentley Systems are partnering to deliver timely, relevant technology-oriented research to the construction industry through the **SmartMarket Brief:** BIM Advancements series. Each quarterly edition provides fresh insight on three key topics that are driving transformative change. Online versions, offering more detailed content, are available at bentleytech.construction.com

Message From Bentley

The infrastructure world is changing. New technologies are making it easier to collaborate, coordinate projects and manage change amongst disciplines and throughout the lifecycle.

*The evolving ubiquitousness of **BIM** has been interesting to observe. BIM was confused with parametric modeling, sometimes associated to a single asset type (commercial building), or perceived as a product or solution. It is none of those things. Rather, it is a technology enabled methodology used to manage the processes associated with the design, construction and operation of an asset.*

Implementing BIM successfully involves behavioral, cultural and technological changes–transforming your organization, adopting new processes and implementing new standards.

*This report discusses **BIM Success Factors** and explores two other issues critical for an effective BIM strategy. First, it explores **Construction Modeling** for critical construction processes such as staging, sequencing, temporary works, work packaging and workface planning. Second, it updates earlier work on **Information Mobility** where better project outcomes are achieved with complete flow of information among applications and across distributed project teams.*

We hope you will find this report valuable.

Bentley Systems

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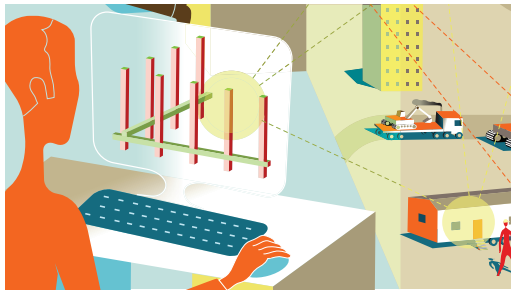

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Cover Illustration by Otto Steininger

BIM Success Factors

OVERVIEW

Enough BIM projects have been completed in recent years for the industry to be able to consistently measure the positive impact of model-based processes on key project outcomes, as well as to determine what factors contribute to and impede these positive impacts.

SUCCESS FACTORS AND OBSTACLES

To quantify improvements related to BIM, this study establishes the percentage impact of six BIM activities on seven distinct project outcomes, from the differing perspectives of architects, engineers and contractors.

To identify the drivers behind these improvements, the respondents also rated the frequency with which they experience 10 activities that should contribute to improved outcomes from BIM and their view on the relative positive impact of each. From the opposite perspective, the study also examines the negative impact of six obstacles to success with BIM.

Combining the findings about the most positive drivers and the most negative obstacles, the study identifies four key success factors that the data indicate should be top priorities for BIM teams.

Key Findings

4 **Infographic:** *BIM Success Factors*

Impact on Outcomes

5 **Moderate BIM Impact:** *Project outcomes on which BIM has at least 5% impact*

6 **Variance From Average:** *Percentage that each company-type varies from the average of all respondents for impact of BIM on outcomes*

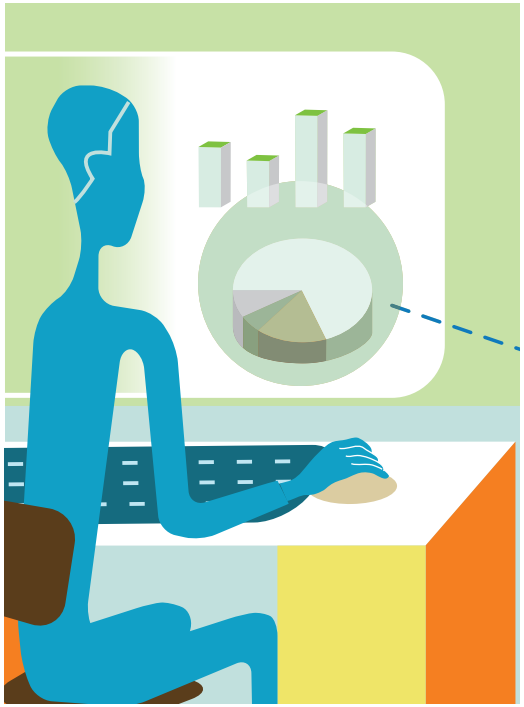
7 **High BIM Impact:** *Project outcomes on which BIM has at least 25% impact*

Success Drivers

8 **Frequency and Value: Context:** *Percentage rating high or very high frequency and value for these factors/ activities being in place at the start of a project*

9 **Frequency and Value: Process:** *Percentage rating high or very high frequency and value for these factors/ activities during projects*

19 **Variance From Average for Value:** *Greatest percentage variations by company-type from the average rating for value of BIM success drivers*



Obstacles to Success

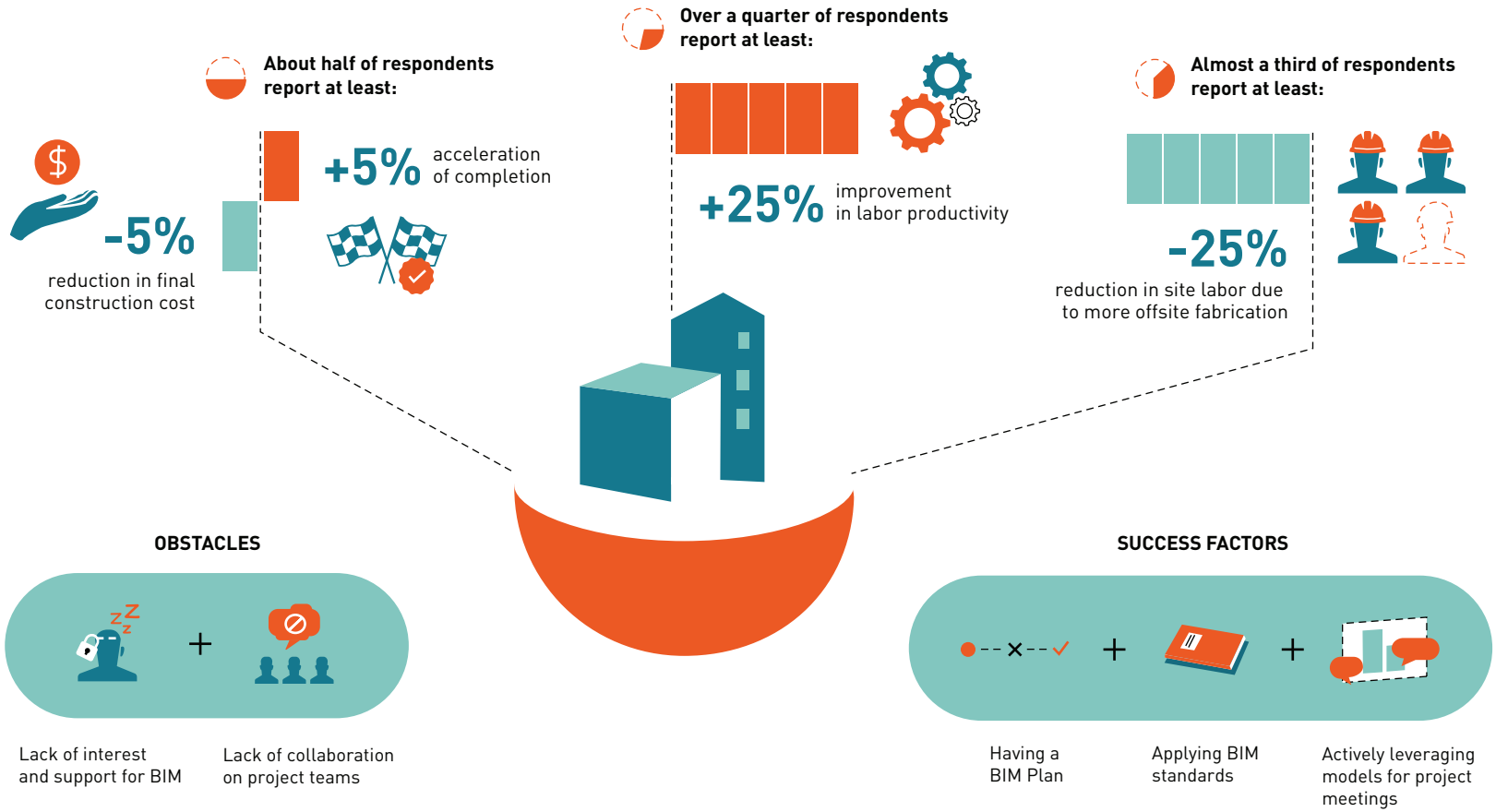
11 **Obstacles:** *Combined frequency and negative impact of factors that impede BIM success on projects*

Top BIM Success Factors

12 **Most Impactful Factors:** *Success factors with greatest net combined impact of added value from occurrence and negative impact from absence on BIM projects*

Key Findings

BIM SUCCESS FACTORS



Impact on Outcomes

MODERATE IMPACT OUTCOMES

BIM users who experience some amount of impact from BIM on these five outcomes also identified the degree of that impact as being in one of these ranges: less than 5%, 5–10% or more than 10%. The chart shows the percentage of all respondents who experience more than a 5% improvement.

DOWNSTREAM IMPACT OF UPSTREAM MODELING

The high percentage (70%) experiencing **Fewer RFIs During Construction** at a rate of 5% or more demonstrates BIM's impact on reducing uncertainty. This positive indicator of process improvement is also a likely influencing factor on the results for **Improved Labor Productivity**, shown on page 7 of this study.

REDUCTION IN COST, SCHEDULE AND MATERIAL WASTE

About half of the BIM users rated each of these factors strongly. Material waste is generated by onsite construction and often by rework. So the **Reduced Material Waste** can be seen as an indicator that BIM is reducing rework, and likely is connected to the finding on page 7 of this study about **Less Site Labor Due to More Offsite Prefabrication.**

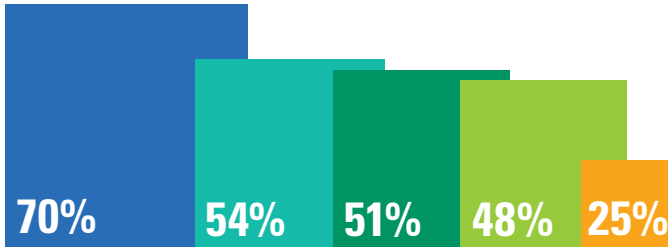
Shortened Schedule and **Lower Final Construction Cost** have been two of the most anticipated outcomes for BIM since its introduction. The fact that half of the respondents now report at least a 5% impact on both is an exciting finding and a harbinger of greater future gains.

SAFETY INCIDENTS

While it is encouraging that a quarter of users report at least **5% Fewer Safety Incidents**, the direct relationship between BIM and safety is still emerging when compared with these other outcome impacts.

Moderate BIM Impact

Percentage reporting that BIM has at least 5% positive impact on these project outcomes

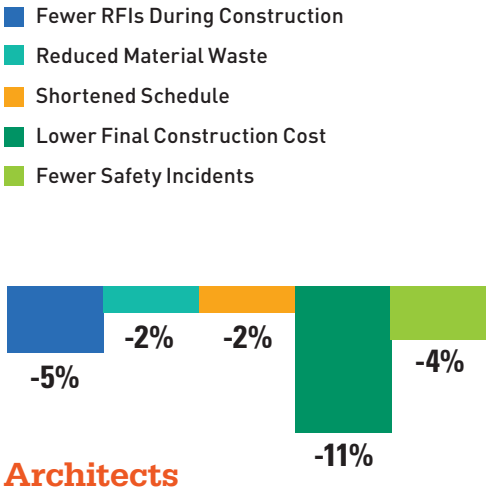


- Fewer RFIs During Construction
- Reduced Material Waste
- Shortened Schedule
- Lower Final Construction Cost
- Fewer Safety Incidents

Impact on Outcomes

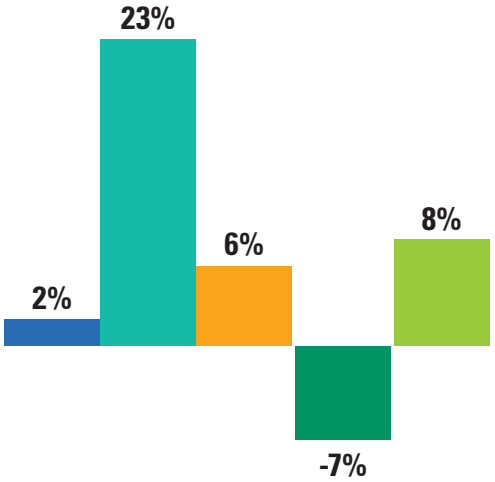
COMPANY TYPE VARIANCES

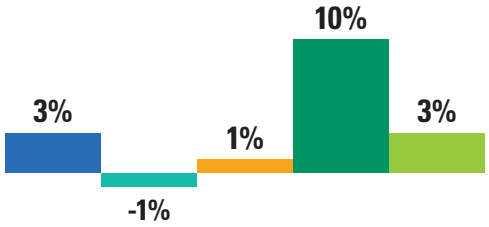
The chart shows how much the response of each company type varies from the average of all respondents for the five outcomes.



Variance From Average

Percentage that each company type varies from the average of all respondents for impact of BIM on outcomes





Architects

Architects are generally slightly lower than the total average in rating the impact of BIM on the five moderate outcomes. The most variance (-11% below average) is found with **Lower Final Construction Cost**. This may reflect their distance from the detail of day-to-day construction budget management and, therefore, less of an opportunity to see firsthand the direct connection between model-based processes and cost reduction.

Engineers

Generally higher than average, engineers are most positive (23% above average) about the impact of BIM on **Reduced Material Waste**. Similar to architects, engineers are lower than average in their identification of **Lower Final Construction Cost** from BIM. Interestingly, engineers are highest among the professions in citing **Fewer Safety Incidents**. This may be because the sample contains a large proportion of structural engineers, and falls are a particularly serious problem among those related trades.

Contractors

Close to average on all the outcomes, contractors' strongest variation (10% above average) relates to **Lower Final Construction Cost.** This finding makes sense because of their direct involvement with and responsibility for the final cost, which would put them in the best position to appreciate the positive impact of model-based processes.

Impact on Outcomes

HIGH-IMPACT OUTCOMES

Because the percentage of impact from BIM can be quite large on these labor-related outcomes, architects, engineers and contractors who reported at least some degree of impact were asked to identify the degree of that impact as being in one of these ranges: less than 25%, 25%–50% or more than 50%. The chart shows the combined percentage of all respondents who experience more than a 25% improvement.

DIRECT IMPACT OF BIM ON LABOR

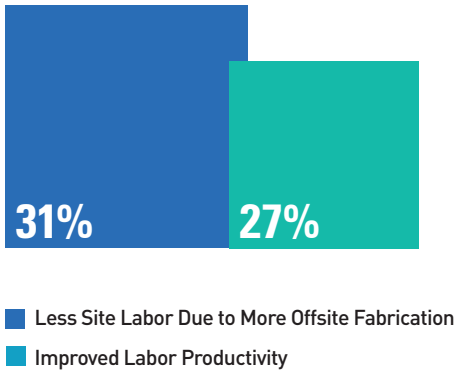
The explosive growth of model-driven prefabrication has been extensively documented in the BIM research reports from Dodge Data & Analytics' SmartMarket Report series. Now that many of the projects on which this practice has been deployed are complete, almost a third (31%) of the respondents reports seeing at least 25% **Less Site Labor Due to More Offsite Fabrication**. This trend can be expected to increase as further industrialization of the construction process gains traction.

Addressing the labor still deployed at the jobsite, over a quarter (27%) of those reporting some impact find they get at least 25% **Improved Labor Productivity** as a result of model-based processes. Among contractors, only 7% report no impact on productivity.

In an industry facing increasingly critical labor shortages, these positive impacts of BIM on labor confirm its benefit as a force-multiplying resource enhancement.

High BIM Impact

Percentage reporting that BIM has at least 25% positive impact on these project outcomes



Success Drivers

CONTEXT-RELATED FACTORS

Many factors influence a team's ability to improve project outcomes by deploying BIM. The five factors in this chart relate to resources and activities that, if they are in place early in a project, can provide a context for BIM success.

FREQUENCY AND VALUE OF CONTEXT FACTORS

This chart combines two key indicators for five context-related success factors.

- The percentage of respondents who report high or very high frequency for each of these factors on their BIM projects.
- Among that high-frequency group, the percentage who put a high or very high value on having these factors in place on their BIM projects.

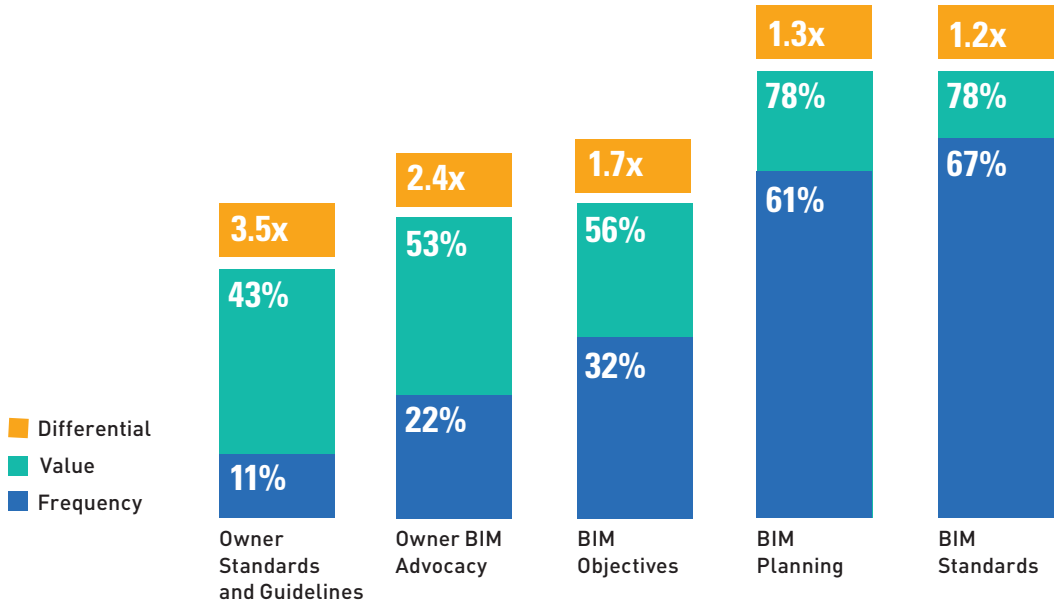
BIM Planning and **BIM Standards** are the highest rated context factors for both frequency and value. This combination of ratings indicates that, while not currently being implemented on every project, these factors are well positioned to become standard operating procedures for BIM projects.

The development of specific **BIM Objectives** for a team early in a project as an integral part of the BIM plan is only half as frequent as **BIM Planning** itself. Even though the frequency is low, its relatively high-value rating (56%) among those that do set objectives points to a practice that needs to be emphasized and incorporated in all BIM plans.

The two owner-related factors, **Owner BIM Advocacy** and **Owner Standards and Guidelines** for BIM are lagging in reported frequency while both, particularly advocacy (53%), earn strong value ratings. This points to the need to educate owners more fully on BIM benefits to generate their advocacy, and encourage owners to employ standards to ensure that they consistently enjoy those benefits.

Frequency and Value: Context

Percentage rating high or very high frequency and value for these factors/activities being in place at the start of a project and the differential factor, indicating unmet market demand



Success Drivers

PROCESS-RELATED FACTORS

The five elements in this chart are BIM-related factors and activities during the project process that can drive better outcomes.

FREQUENCY AND VALUE OF PROCESS FACTORS

Similar to the chart for context-related factors on page 8, this chart combines two key indicators for five process-related success factors.

- The percentage of respondents who report high or very high frequency for each of these factors on their BIM projects.
- Among that high-frequency group, the percentage who place a high or very high value on having these factors occur on their BIM projects.

BIM-Integrated Project Meetings is the factor that rates the highest score for value (78%) among respondents who report experiencing any of these factors frequently. Similar to **BIM Planning** and **BIM Standards** among the context-related factors, the use of models to improve project meetings seems to be an increasingly important practice.

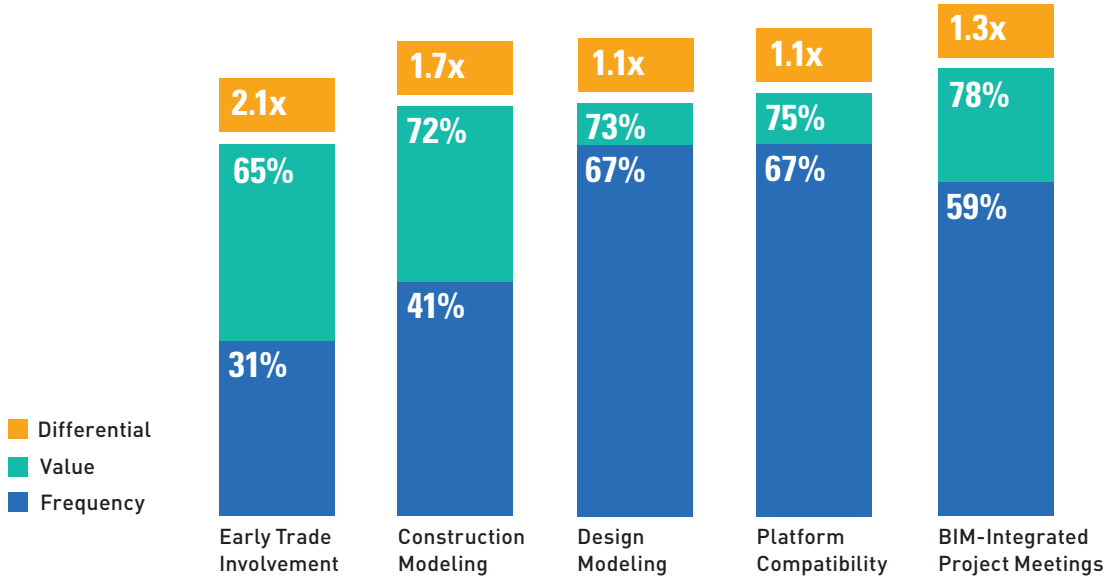
Having **Platform Compatibility** among the members of a project team is the most frequently used factor and is also considered very valuable. This probably reflects the work of many technology companies to accommodate an increasing level of interoperability in their tools, which is certainly appreciated by users.

Both **Design Modeling** and **Construction Modeling** are highly valued, but the latter is distinctly lagging in frequency. This suggests a strong market demand for more modeling by contractors and a related need for specialized tools, content, standards and processes to optimize the use of modeling.

The data suggest that **Early Trade Involvement** is the biggest unmet opportunity. Less than a third report seeing it frequently, but nearly two thirds of that group rate it as highly valuable because increasing its frequency is likely to generate improved outcomes.

Frequency and Value: Process

Percentage rating high or very high frequency and value for these factors/activities during projects and the differential factor, indicating unmet market demand



Success Drivers

MOST COMPANY TYPE VARIANCE ON VALUE

Focusing just on the scores for value, the chart shows the three drivers with the greatest amount of difference between the rating by a specific company-type and the average rating by all respondents.

ENGINEERS LEAST SUPPORTIVE OF EARLY TRADE INVOLVEMENT, MOST IN FAVOR OF BIM-INTEGRATED PROJECT MEETINGS

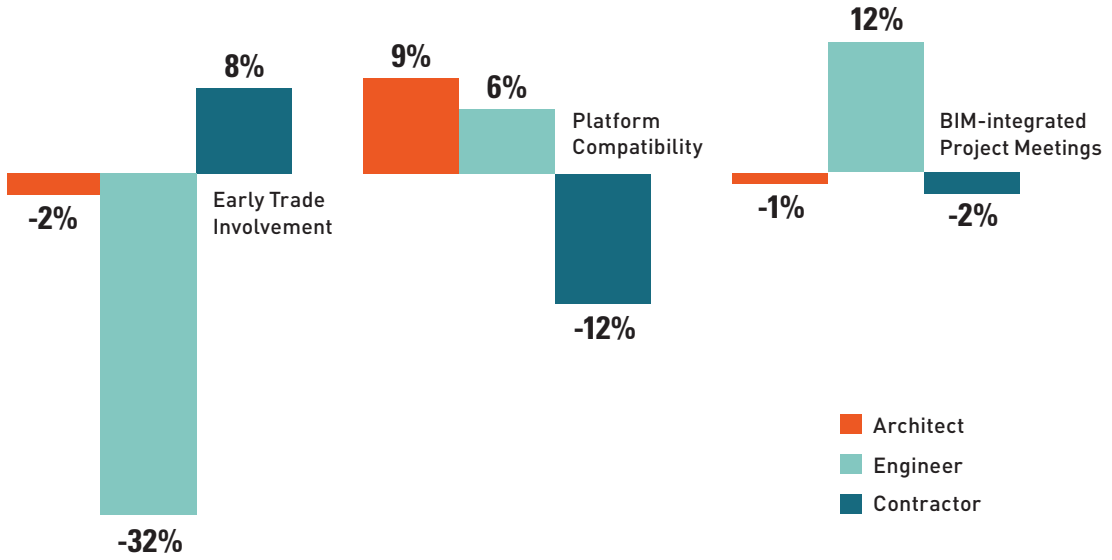
Engineers (structural and civil for this study) ascribe far less value to **Early Trade Involvement** than do architects and contractors. This may indicate that integrated engineering and construction is still emerging in these sectors. Simultaneously, engineers show the strongest support for **BIM-Integrated Project Meetings**. These findings suggest that, though resistant to early involvement by trades in the design, engineers are amenable to leveraging models with the core project team.

CONTRACTORS LEAST, ARCHITECTS MOST CONCERNED ABOUT PLATFORM COMPATIBILITY

This finding makes sense because architects regularly engage with multiple consultants and others in creating design models and are therefore challenged more by interoperability issues than contractors, who are often able to take advantage of tools that can work seamlessly with multiple model formats (e.g., for spatial coordination). This may change as design and construction processes become increasingly integrated, and contractors will gain a greater appreciation for the value of improved compatibility between technology platforms.

Variance From Average for Value

Greatest percentage variations of high/very high responses by company type from the average rating for value of BIM success drivers



Obstacles to Success

OBSTACLES TO BIM SUCCESS

The success experienced by BIM users can be undermined when BIM is not embraced by the entire project team, when it is not used in a collaborative manner or when the most important success factors discussed on pages 8 and 9 are absent. The chart shows a combination of the frequency and the negative impact for six factors that each has the potential to be a significant obstacle to BIM success.

SOCIAL FACTORS UNDERMINE SUCCESS

Low Level of Team Interest/Support for BIM and **Low Level of Collaboration** among team members are the most dangerous obstacles to BIM success. While there is, fortunately, a low frequency reported for the former, the relatively high frequency for the latter is troubling . These social factors cannot be addressed by implementing BIM standards or plans. They require more effective vetting during the team formation process.

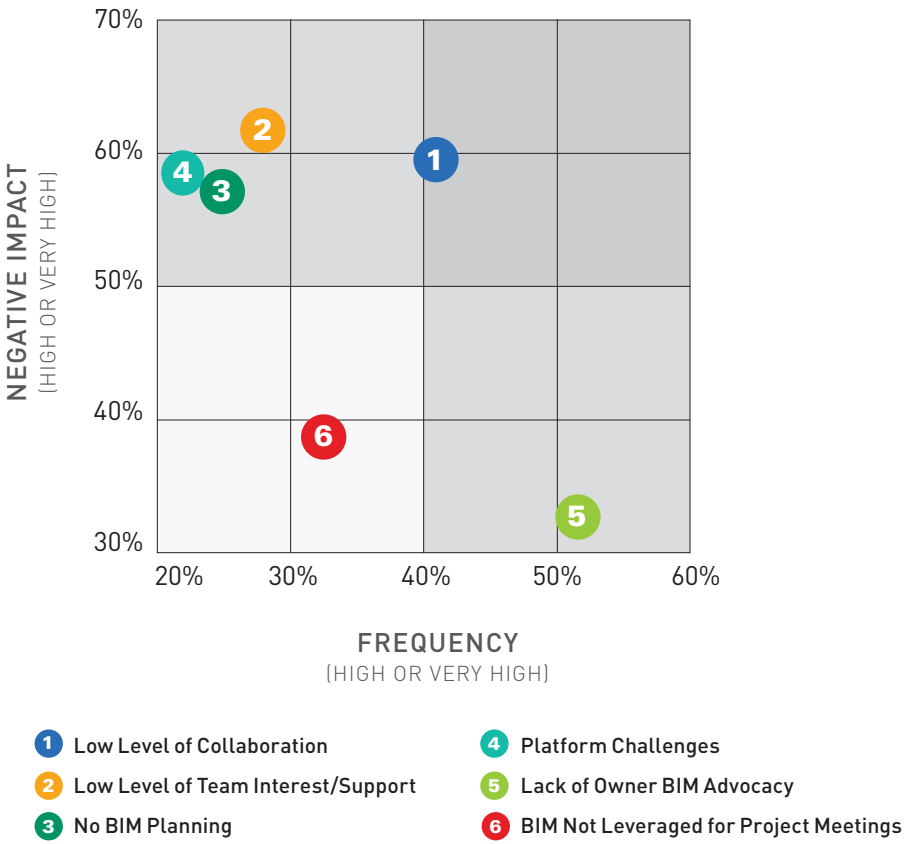
LACK OF BIM SUCCESS DRIVERS HAS NEGATIVE IMPACT

The high scores for **BIM Planning** and **Platform Compatibility** as valuable BIM success factors are amplified here through the high negative impact ratings for their absence. Fortunately, both show low frequency.

The high frequency yet relatively low negative impact of **Lack of Owner BIM Advocacy** indicates that teams have become used to being able to achieve BIM success without it. Although as the previous success factor data indicates, it is beneficial when you have it.

Obstacles

Combined frequency and negative impact of factors that impede BIM success on projects



Top BIM Success Factors

MOST IMPACT ON BIM SUCCESS

The chart shows the four factors that have the greatest net impact on BIM success, calculated by combining the negative impact rating of their absence (obstacles) and the positive value rating of their occurrence (drivers).

TOP MUST-HAVES TO ENABLE BIM SUCCESS

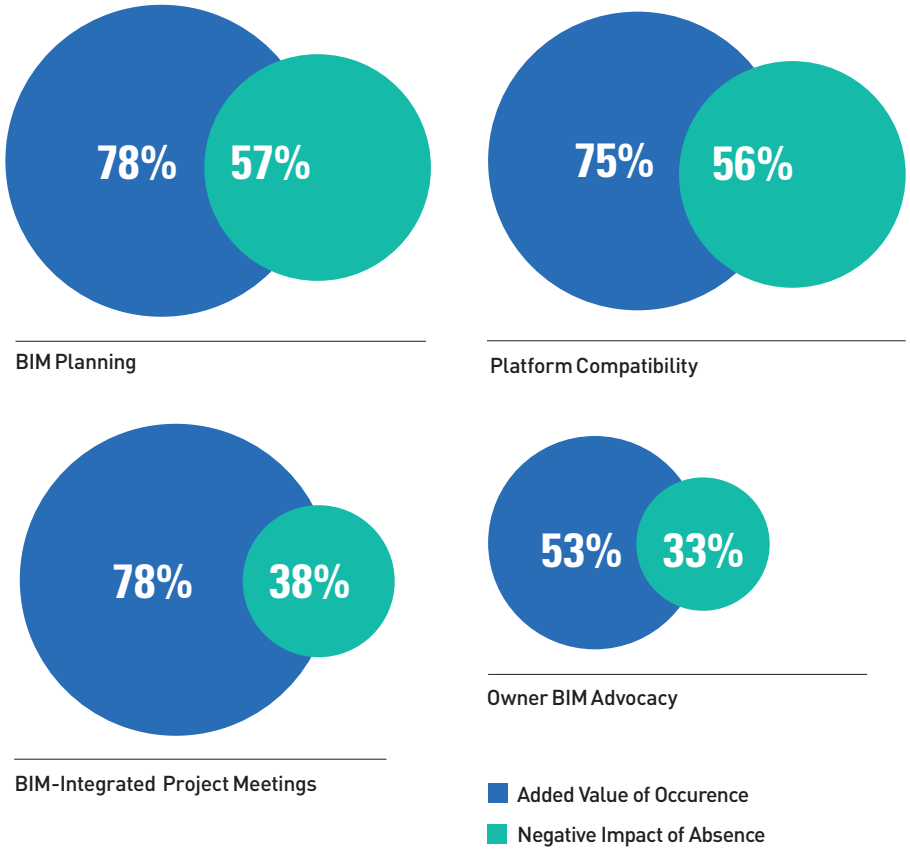
BIM Planning and **Platform Compatibility** rise to the top of the net impact rating with high positive values given for their occurrence and strong negative impact ratings for their absence. Close behind those leading factors, **BIM-Integrated Project Meetings** score equally strongly for value, but are somewhat less harmful in their absence. Clearly, if a team wants to focus on a few major factors to create an environment that is conducive for BIM success, these three are generally within their control to implement and should generate appreciably positive outcomes.

TEAMS COPE WITH LACK OF OWNER BIM ADVOCACY

The findings for **Owner BIM Advocacy** suggest that, while it is valuable when it is in effect on a project, it is not a critical factor when it is absent. Its relatively low negative impact in spite of its very low frequency of occurrence suggest that project teams are able to achieve BIM success without it. Obviously, the frequency of owner involvement will improve as owners become increasingly engaged with BIM, develop standards and guidelines and incorporate model-based processes as standard practice in their project delivery programs.

Most Impactful Factors

Success factors with greatest net combined impact of added value from occurrence and negative impact from absence on BIM projects



Construction Modeling

OVERVIEW

As a general trend in the AEC industry, modeling began with design professionals and was later adopted by contractors, primarily for coordination and fabrication. Previous research by Dodge Data & Analytics on BIM use in North America shows that adoption by contractors has now exceeded design professionals. Contractors continually expand the types and uses of models they build and increasingly integrate them with other tools and technologies to work more efficiently and improve productivity. Construction firms are achieving outcomes through model-based processes that would have been considered unattainable just a few years ago.

This study focuses on the developing practice of construction modeling, specifically by examining which types of contractors are producing models for what uses and how much value they are providing to improve project processes and outcomes.

Key Findings

14 **Infographic:** *Construction Modeling*

Modeling by Trade Contractors

15 **Modeling for Site, Structure and Shell:** *Frequency and value of construction modeling by trade contractors*

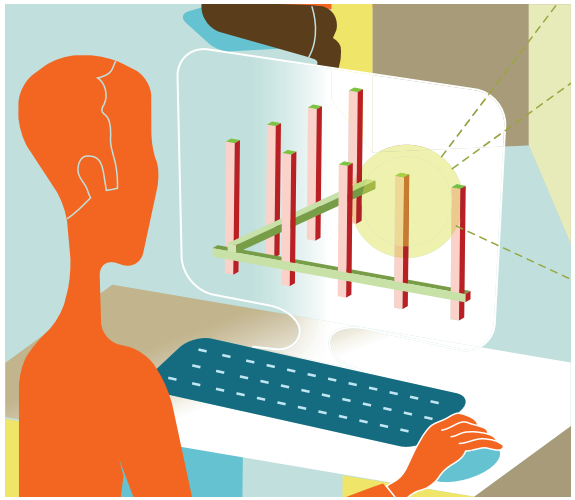
16 **Modeling for Systems and Interiors:** *Frequency and value of construction modeling by trade contractors*

17 **Most Value From Increased Modeling:** *Selection of the one type of trade contractor among those reported as infrequently modeling their work that would provide greatest value by increasing their frequency of modeling*

Uses for Construction Models

18 **Construction Model Uses:** *Frequency and value of uses for construction models*

19 **Most Value From Increased Model Use:** *Selection of the one use for construction models among those reported as infrequently occurring that would provide greatest value if its frequency were increased*



Authoring Construction Models

20 **Construction Model Authoring:** *Selection of the one party that most often authors construction models according to general contractors who frequently see these six models on their projects*

Key Findings

CONSTRUCTION MODELING

MODELING BY SPECIALTY TRADES

General Contractors who give high value rating

93% HVAC Contractors

91% Plumbing/Piping Contractors

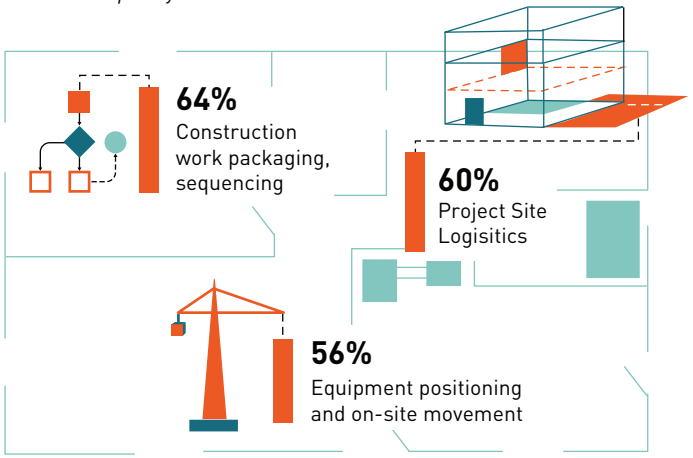
88% Structural Fabricators

Greatest unmet demand: Interior, building envelope and electrical contractors

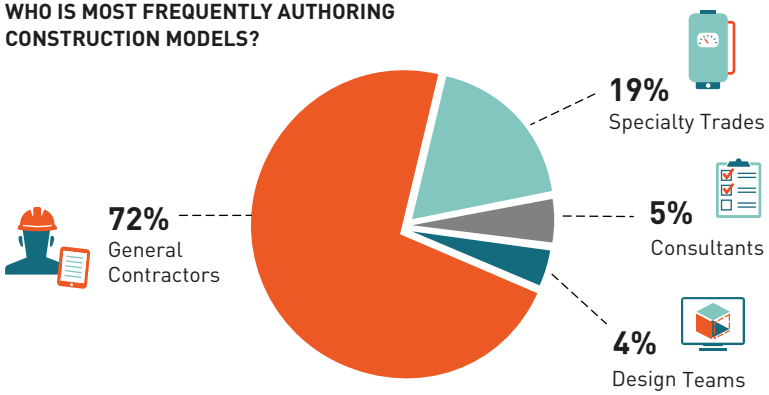
Still emerging within trades: Site, civil and geotech contractors

MODEL USAGE

Greatest frequency and value



WHO IS MOST FREQUENTLY AUTHORING CONSTRUCTION MODELS?



EMERGING USES FOR CONSTRUCTION MODELS

Crew locations and workforce planning

Safety rule checking in the model

Temporary works

Modeling by Trade Contractors

SITE, STRUCTURE AND SHELL

FREQUENCY AND VALUE OF CONSTRUCTION MODELING FOR SITE, STRUCTURE AND SHELL

This chart combines two key indicators for modeling by three types of trade contractors (site, structure and building envelope). The two key indicators are:

- The percentage of respondents who report seeing relatively frequent modeling by each of these specialty contractors (i.e., those selecting sometimes, frequently or always, versus seldom or never).
- Among that group, the percentage who places a high or very high value on the construction modeling being done by that trade.

STRUCTURAL FABRICATORS CONTINUE TO BE ACTIVE MODELERS

Aligning with all previous BIM research by Dodge Data & Analytics, structural fabricators are reported to be active modelers, with over two thirds (68%) of respondents reporting that structural fabricators model frequently. Important in this new research is the very strong (88%) rating for the high value of their contribution to model-based project processes.

BUILDING ENVELOPE OFFERS OPPORTUNITY

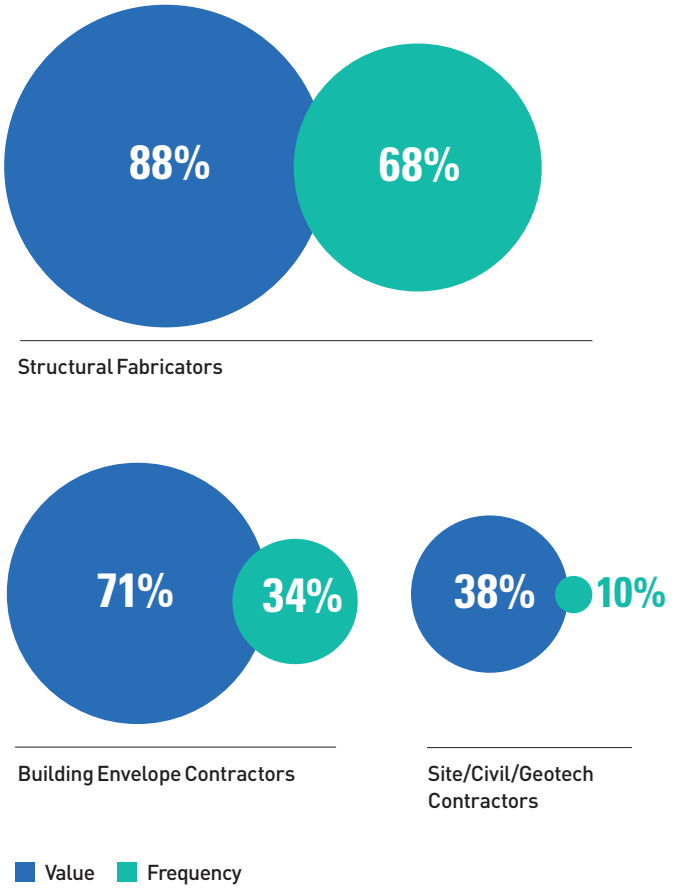
Building envelope contractors represent the most important opportunity for growth, where only about a third (34%) of respondents say they model frequently, while nearly three quarters (71%) of that group assigns a top value to their participation. This is a clear demand signal from the market and a potential competitive edge for model-savvy envelope contractors.

SITE/CIVIL/GEOTECH STILL EMERGING

Site/civil/geotech contractors lag significantly in modeling frequency, and only about a third (38%) of the respondents who see frequent modeling from this discipline assign a high value to it. These findings suggest that this market segment needs development of both skills and beneficial use cases to increase demand and activity.

Modeling for Site, Structure and Shell

Frequency and value of construction modeling by trade contractors



Modeling by Trade Contractors

SYSTEMS AND INTERIORS

FREQUENCY AND VALUE OF CONSTRUCTION MODELING FOR SYSTEMS AND INTERIORS

This chart combines two key indicators for modeling by four types of trade contractors (HVAC, plumbing/piping, electrical and interior construction). The two key indicators are:

- The percentage of respondents who report seeing relatively frequent modeling by each of these specialty contractors (i.e., those selecting sometimes, frequently or always, versus seldom or never).
- Among that group, the percentage who place a high or very high value on the construction modeling being done by that trade.

MECHANICAL CONTRACTORS DOMINATE THE RATINGS

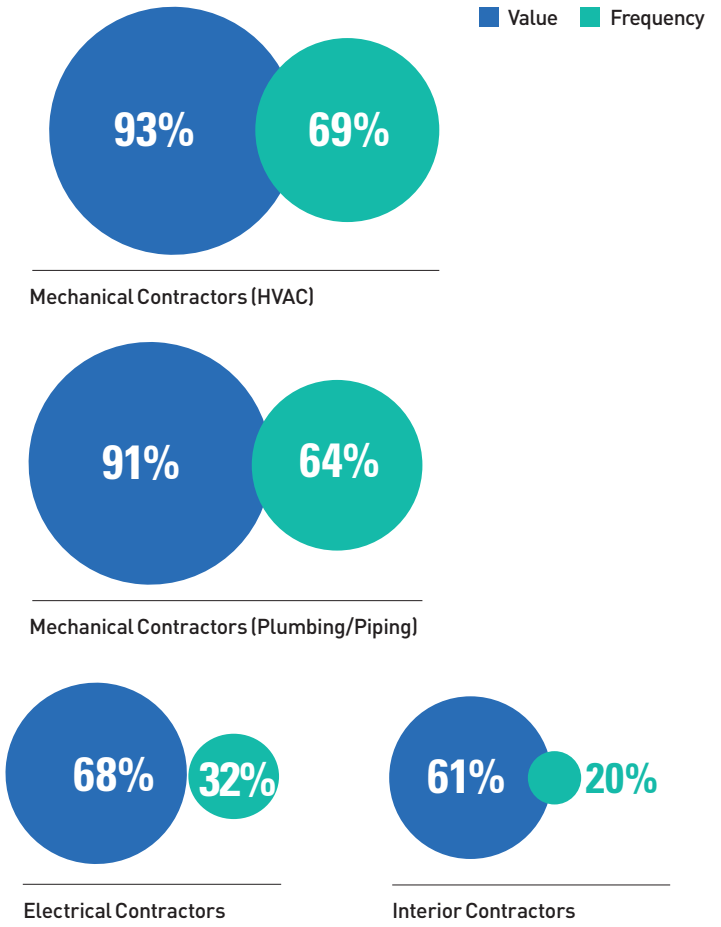
Mechanical contractors have demonstrated rapid adoption of modeling in previous BIM research by Dodge Data & Analytics, and that trend is reinforced here with high frequencies reported for both HVAC and piping/plumbing modeling. An additional finding in this study is the nearly unanimous (93% and 91%, respectively) top-level rating for their value to the BIM process. Virtual coordination and model-driven prefabrication of mechanical systems have helped to establish the value of BIM on complex projects in all parts of the world. It can be expected from these ratings that modeling by mechanical contractors will be a baseline expectation across the industry in the near future.

OPPORTUNITY FOR ELECTRICAL AND INTERIOR CONTRACTORS

Modeling by electrical and interior construction trades is much less frequent (by half and by two thirds, respectively). However, they both earn high marks for value, so the demand is clearly there for increased engagement in model-based processes by these trades.

Modeling for Systems and Interiors

Frequency and value of construction modeling by trade contractors



Modeling by Trade Contractors

GREATEST UNMET DEMAND

LOW-FREQUENCY MODELER WITH MOST POTENTIAL VALUE

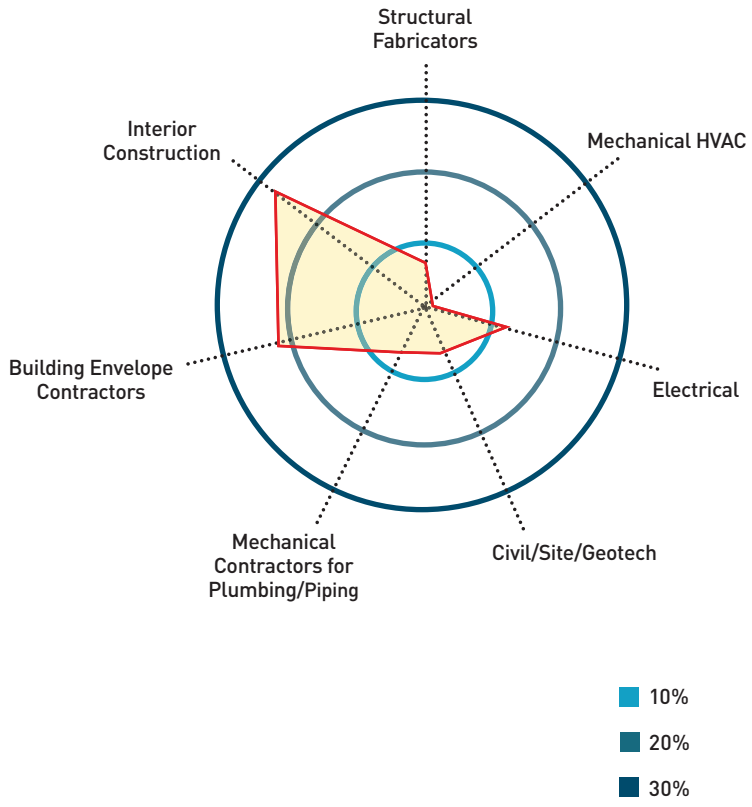
Respondents who reported low frequency of seeing modeling by specialty contractors were asked to select the one trade contractor they believe would provide the greatest value to projects if the frequency of their modeling activity increased. The chart shows what proportion of those votes was cast for each trade contractor.

BUILDING ENVELOPE AND INTERIORS IN HIGHEST DEMAND

Aligning with the previous findings on frequency and value of construction modeling, the building envelope and interior trades are highlighted as being able to provide the greatest value by increasing their participation in modeling.

Most Value From Increased Modeling

Selection of the one type of trade contractor among those reported as infrequently modeling their work that would provide greatest value by increasing their frequency of modeling



Uses for Construction Models

SIX USES OF CONSTRUCTION MODELS

FREQUENCY AND VALUE OF SIX USES FOR CONSTRUCTION MODELS

This chart combines two key indicators to evaluate six purposes for which project teams use construction models. The two key indicators are:

- The percentage of respondents who report seeing relatively frequent use of construction models for that purpose (i.e., those selecting sometimes, frequently or always, versus seldom or never).
- Among that group, the percentage who places a high or very high value on the usefulness of construction models for that purpose on their BIM projects.

VALUE RATINGS FAR EXCEED FREQUENCY

With frequency ratings ranging from 11% to only 28% and value ratings starting at 42% and going to 64%, the demand for more construction modeling is very strong across all six uses.

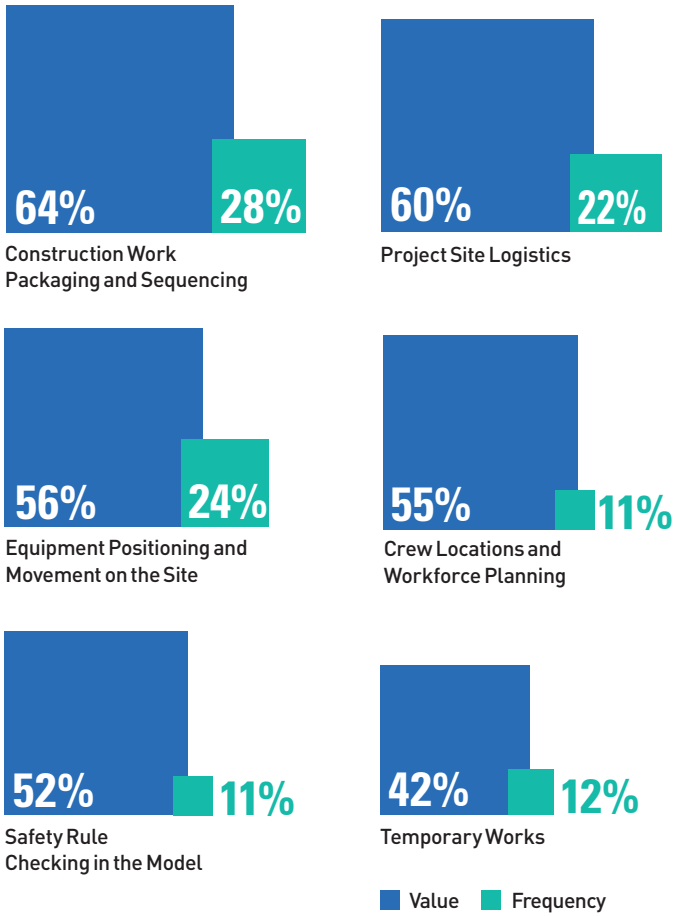
The most extreme example is **Crew Locations and Workforce Planning**, with only 11% reporting frequent implementation, but over half of those respondents (55%) citing top value for the activity. This 5X gap between frequency and value is the highest across all the uses evaluated.

The frequency/value ratio for **Safety Rule Checking in the Model** is almost as far out of synch (11% and 52%, respectively) as that for Crew Locations and Workforce Planning, and it represents an emerging application that can have a tangible positive impact on a critically important aspect of construction: worker health and safety.

The other four uses for construction models all generate value ratings over twice as high as their frequency ratings. The message to industry is clear: more construction modeling.

Construction Model Uses

Frequency and value of uses for construction models



Uses for Construction Models

UMMET DEMAND FOR MODEL USE

LOW-FREQUENCY MODEL USE WITH MOST POTENTIAL VALUE

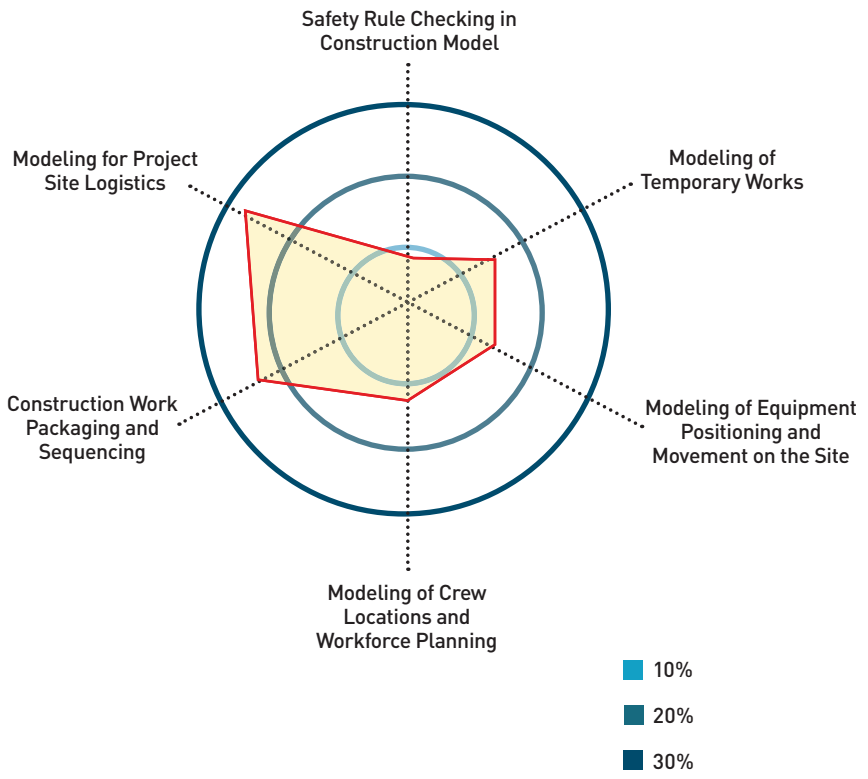
Respondents who reported low frequency of seeing models used for these purposes were asked to select the one construction model use they believe would provide the greatest value to projects if its frequency could be increased. The chart shows what proportion of those votes applies to each use.

SITE LOGISTICS AND WORK PACKAGING/SEQUENCING IN HIGHEST DEMAND

The two uses cited as the most potentially valuable by those who do not yet see them used frequently are **Modeling for Project Site Logistics** and **Construction Work Packaging and Sequencing**. These are also the two uses cited as most valuable by those who report seeing them frequently (see page 18), so this finding further confirms their importance.

Most Value From Increased Model Use

Selection of the one use for construction models among those reported as infrequently occurring that would provide greatest value if its frequency were increased



Authoring Construction Models

AUTHORING MODELS FOR SPECIFIC USES

Respondents who report seeing construction models for these six specific purposes relatively frequently (i.e., at moderate, high or very high frequencies) were asked to identify which one party most often authors the actual models: the design team, a consultant, a specialty contractor or the general contractor (which includes construction managers and design-build contractors). The chart shows the responses from general contractors who are typically in the best position to know the source of construction models on their projects. (The responses from architects and engineers do not vary significantly from the contractor responses.)

GENERAL CONTRACTORS DOMINATE AUTHORING OF CONSTRUCTION MODELS

As the data show, the general contractors currently do the majority of construction model authoring. This is not surprising because the six model uses addressed in this study apply to aspects of the overall project, rather than being trade or discipline specific.

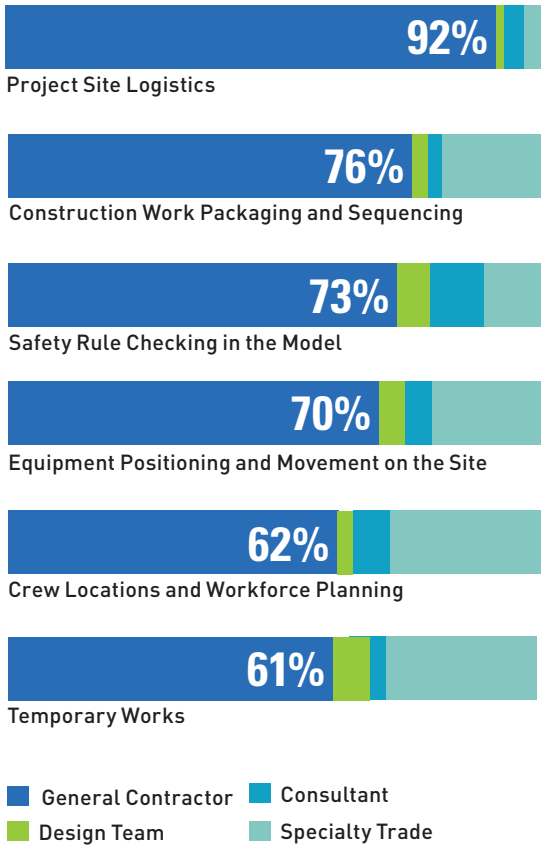
OTHER MODEL AUTHORS

Specialty trades are most frequent among the other three sources, especially for **Crew Locations and Workforce Planning** and **Temporary Works**. This is an important trend to watch as their modeling skills become applied to more than just their specific scope of work.

Consultants are used most frequently for **Safety Rule Checking in the Model**, which is appropriate for an emerging practice. Design teams are not currently producing a significant percentage of construction models, but this may change over time as integrated and collaborative project delivery processes gain more traction.

Construction Model Authoring

Selection of the one party that most often authors construction models according to general contractors who frequently see these six models on their projects



Information Mobility

OVERVIEW

Bentley Systems and Dodge Data & Analytics first joined forces to explore this topic in 2013, with research among general and specialty trade contractors that culminated in the publication of a SmartMarket Report called *Information Mobility: Improving Team Collaboration Through the Movement of Project Information.*

In order to address the future of information mobility and its contibution to greater multidisciplinary integration and collaboration, this study extends that work by surveying architects and engineers as well as contractors. It also explores new topic areas, including:

- Current and future use of various modes of information mobility by architects, engineers and contractors
- Where they have seen improvements
- How information mobility is generating positive impact on their companies and projects
- What they believe would most improve information mobility

Key Findings

22 **Infographic:** *Information Mobility*

Current and Future Usage

23 **Current and Future Usage:**
Current percentage of respondents using various modes of information mobility at high or very high levels and their future usage forecast (two years)

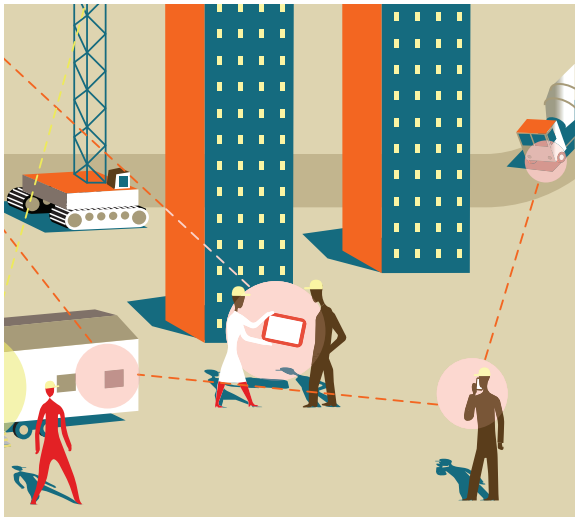
24 **Greatest Percentage Change:**
Which company types are forecasting more than a 25% increase or decrease in particular modes of information mobility

Improvements

25 **Degree of Improvement by Company Type:**
Percentage of respondents by company type who report experiencing high or low degrees of improvement in information mobility over last two years

26 **What Would Most Improve Information Mobility:**
Percentage of respondents who rated each improvement factor as high or very high

27 **Improvements by Company Type:**
Percentage above and below the average, by company type, based on their rating of the impact of various improvements



Benefits

28 **Improved Information Mobility Benefits:**
Percentage of respondents who chose each benefit as first, second and third most important

29 **Top Benefit of Improved Information Mobility by Company Type:**
Percentage of respondents by company type who gave first place importance ranking to each of the top three benefits of information mobility

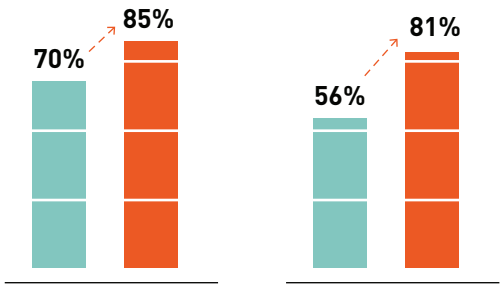
Key Findings

INFORMATION MOBILITY

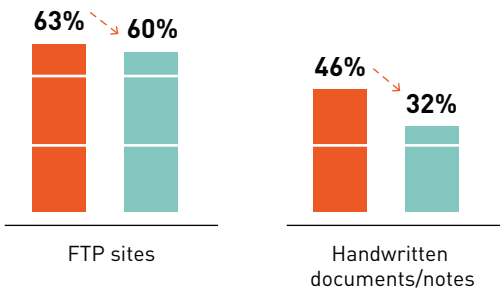
DYNAMICS OF USE

Percent high usage now, and in two years (predicted)

Highest growth

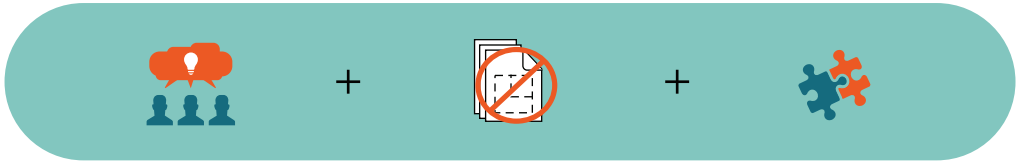


Greatest decline



PROJECT BENEFITS FROM IMPROVEMENT

Over half included these in their top 3 benefits



91% included
Improved collaboration on project teams

60% included
Reduced reliance on paper documents

54% included
Reduced unanticipated problems

MOST DEMANDED IMPROVEMENTS

76% demanded
Improved devices for use at project sites

75% demanded
More reliable or ubiquitous connectivity and bandwidth

71% demanded
More standardization and interoperability of data platforms

Current and Future Usage

USAGE OF MODES OF INFORMATION MOBILITY

Respondents were asked about the frequency of their use of various modes of information exchange currently, and what they believe the frequency of their use of these modes will be in two years.

The chart shows the combined responses of all architects, engineers and contractors who report they are currently using a mode at either a moderate, high or very high level. For dynamic comparison, it also shows how many of those believe they will be at that level of use in two years.

CLOUD SHOWS GREATEST GROWTH

Rising from fifth place today to second place two years from now, **Cloud Storage Services** shows the most growth. Though **Online Meetings** and **Information/Document Management Systems** are already very popular (currently tied for first place), they show strong continued growth, with **Shared Storage Locations** close behind.

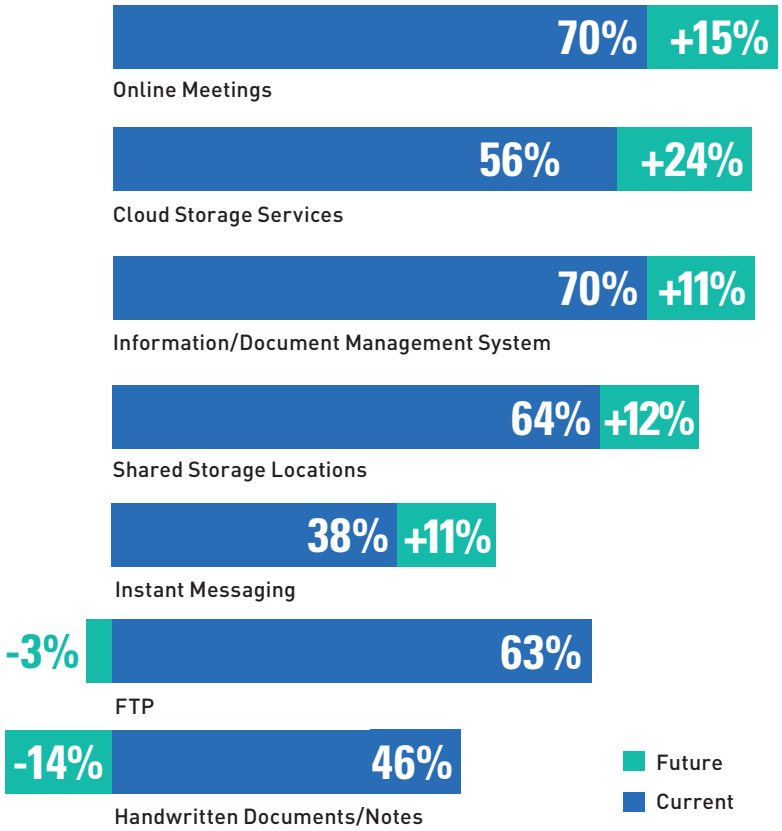
SOME MODES ARE FADING

Not that long ago, **FTP** sites were one of the only ways for teams to share large document files. While they are still frequently used by more than half the industry (63%), the predicted decline of this mode is likely to accelerate as more convenient and sophisticated workflow tools continue to proliferate.

Not surprisingly, the most dramatic forecasted reduction is for **Handwritten Documents/Notes**, an industry staple for centuries. Being rapidly displaced by electronic documents, their virtual extinction is a near certainty, especially on larger, more complex projects, many of which have gone entirely paperless.

Current and Future Usage

Current percentage of respondents using various modes of information mobility at high or very high levels and their future usage forecast (two years)



Current and Future Usage

FUTURE USE OF MODES BY COMPANY TYPE

The predicted future percentage change in usage frequency of these modes of information mobility varies between architects, engineers and contactors. Any company type predicting a change of more than 25% (higher or lower) from their current frequency level is shown in the chart.

DESIGNERS ARE ALL ABOUT THE CLOUD

The biggest proportionate increases among any group for any mode are shown by architects and engineers in their plans to increase usage of **Cloud Storage Services**. This makes sense as collaborative design modeling generates increasingly larger files and services to manage and analyze models, which are rapidly being deployed in cloud-based platforms.

ENGINEERS SEE THE HANDWRITING ON THE WALL

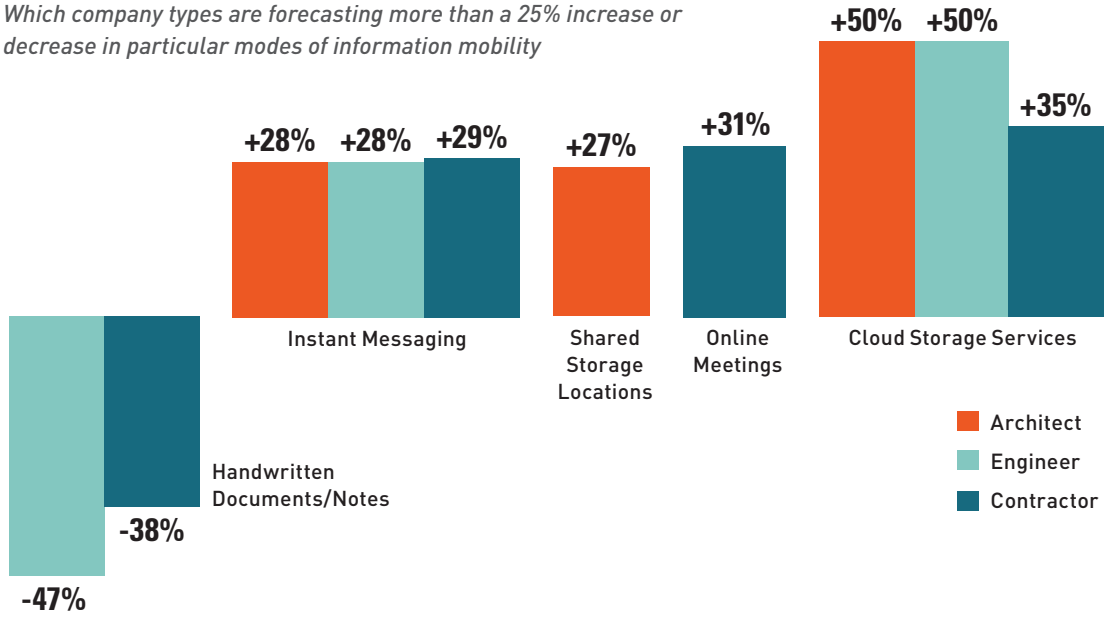
Most dramatic in their abandonment of **Handwritten Documents/Notes** are engineers. This may relate to the technical nature of much of their documentation, which benefits from electronic calculation, analysis and distribution. They are closely followed by contractors. Because they deal with distributed teams on jobsites, contractors are probably eager to move away from informal, one-of-a-kind documents that are easily lost or damaged in the fray of construction activity.

IM IS UNIVERSALLY HOT

With an almost 30% lift predicted across all company types, **Instant Messaging** looks to be a keenly shared interest and can be expected to increase, especially as smartphones multiply among all parties.

Greatest Percentage Change

Which company types are forecasting more than a 25% increase or decrease in particular modes of information mobility



Improvements

IMPROVEMENT OF INFORMATION MOBILITY

Both the technology and the connectivity required for effective information mobility have been steadily improving throughout the world. To determine how much this has been embraced and adopted by the AEC industry, architects, engineers and contractors were asked to judge how much information mobility has improved in their companies over the past two years.

For contrast, the chart shows the percentages of each company type that rated the degree of improvement as very high versus those that rated it as low.

CONTRACTORS VERY BULLISH ON IMPROVEMENT

Almost half (43%) of contractors report a very high level of improvement in information mobility, with another 36% rating it as high. At the other end of the scale, contractors have the fewest number (5%) among all company types that rate improvement as low. Clearly, this is the group that has been impacted the most, which makes sense because of the large number of companies that need to coordinate their work over a distributed jobsite and a far-flung network of fabrication shops and supplier locations.

ARCHITECTS LEAST IMPACTED

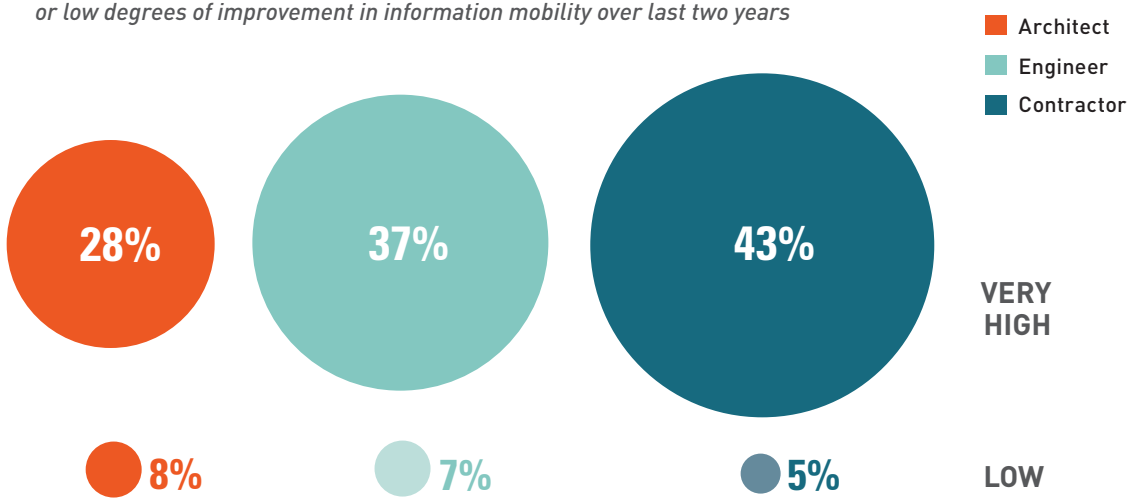
Potentially due to their focus on working in a single physical setting, with established methods of coordinating with consultants, architects report experiencing the least improvement in information mobility.

ENGINEERS CITE ADVANCES

Interestingly, civil and structural engineers report nearly as much positive change as contractors, with three quarters (74%) rating it high or very high. The nature of working in structural and civil disciplines may make them more aware of information mobility improvements, compared with architects.

Degree of Improvement by Company Type

Percentage of respondents by company type who report experiencing either very high or low degrees of improvement in information mobility over last two years



Improvements

IMPROVING INFORMATION MOBILITY

Architects, engineers and contractors were asked to rate how much each of six factors would contribute to improving information mobility among key stakeholders on their projects. The chart shows the combined responses of those who rated the impact of each factor as high or very high.

DEVICES AND CONNECTIVITY TOP THE LIST

Tactical needs for **Improved Devices for Use at Project Sites** and **More Reliable/Ubiquitous Connectivity and Bandwidth** are top of mind for three quarters of all respondents.

DATA-RELATED ISSUES ARE ALSO VERY IMPORTANT

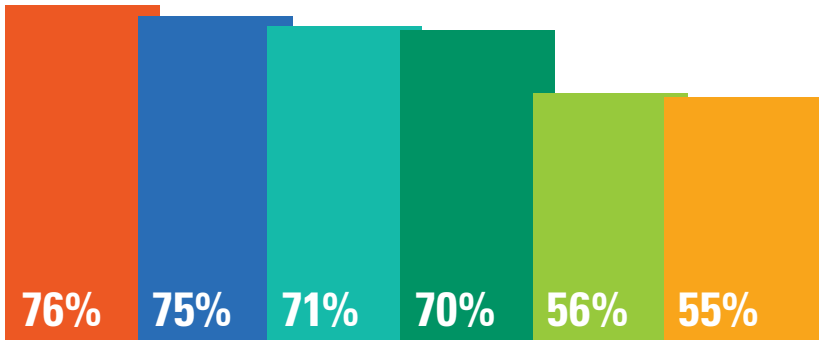
Garnering nearly as many high-impact votes as devices and connectivity, **More Standardization and Interoperability of Data Platforms** and **Ability to Store and Access Project Information in the Cloud** both address the ease with which the information itself can be accessed and used.

SOFTWARE FUNCTIONALITY IN HIGH DEMAND

Though scoring lower than the device/connectivity and data-related issues, **Mobile Apps for Communication** and **BIM Functionality in the Cloud** both earn top ratings from more than half of respondents.

What Would Most Improve Information Mobility

Percentage of respondents who rated each improvement factor as high or very high



Improvements

COMPANY TYPE DIFFERENCES

Architects, engineers and contractors have differing perspectives on which factors would be more impactful than others. The chart shows the variance by company type from the overall average related to the six factors.

CONTRACTORS MOST POSITIVE ABOUT IMPROVEMENT POTENTIAL

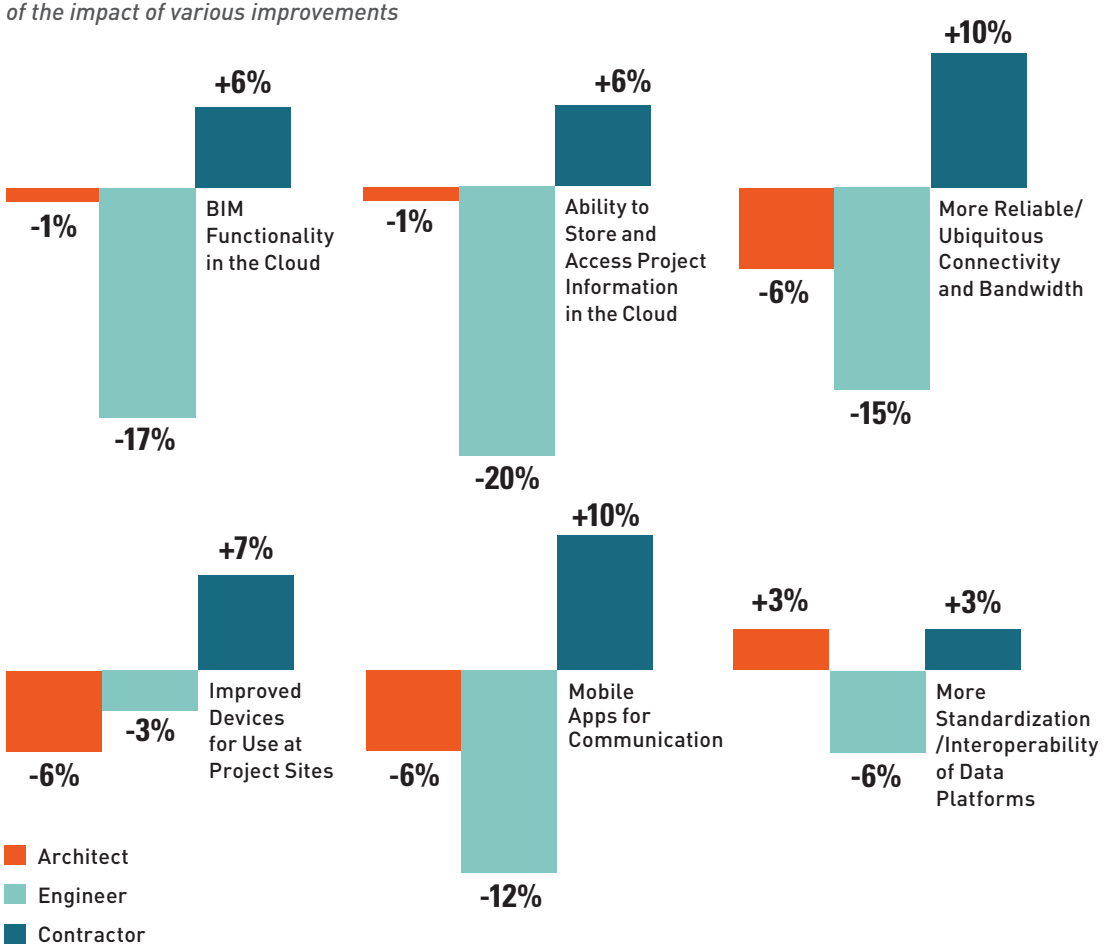
Above the average for all factors, and by as much as 10 percentage points in some cases, contractors are by far the most enthusiastic about the potential improvements to information mobility. This is especially true for the tactical needs of **Improved Devices for Use at Project Sites** and **More Reliable/ Ubiquitous Connectivity and Bandwidth**, which makes sense because they would most directly benefit from these improvements.

ENGINEERS LEAST OPTIMISTIC ABOUT IMPACT

In almost every case, engineers are further below average than contractors are above it. This is especially true for the **Ability to Store and Access Project Information in the Cloud** and **BIM Functionality in the Cloud**, perhaps indicating a relative lack of interest in the collaborative workflows with other team members these factors would enable.

Improvements by Company Type

Percentage above and below the average, by company type, based on their rating of the impact of various improvements



Benefits

PROJECT BENEFITS

The true value of improvements in information mobility is their influence on streamlining processes and impacting outcomes on projects. To determine the level of impact, architects, engineers and contractors were asked to rank, in order, the top three project benefits they receive because of improved information mobility. The chart shows the combined findings for all types of companies.

COLLABORATION IS KING

Aligning with a widespread movement toward more collaboration in the AEC industry, almost all (91%) respondents include **Improved Team Member Collaboration** in their top three project benefits of better information mobility, with over a third (34%) ranking it No. 1.

REDUCED PAPER AND PROBLEMS

Well over half of respondents cite **Reduced Reliance on Paper** (60% total) and **Reduced Unanticipated Problems** (54% total) among their top three benefits. The first finding aligns with the dramatic drops predicted for handwritten documents shown on page 23. The second is perhaps more strategically meaningful, indicating that better information mobility can be tied to greater overall predictability in project execution, which has potentially widespread collateral benefits throughout the entire project delivery cycle.

PRODUCTIVITY ENHANCER

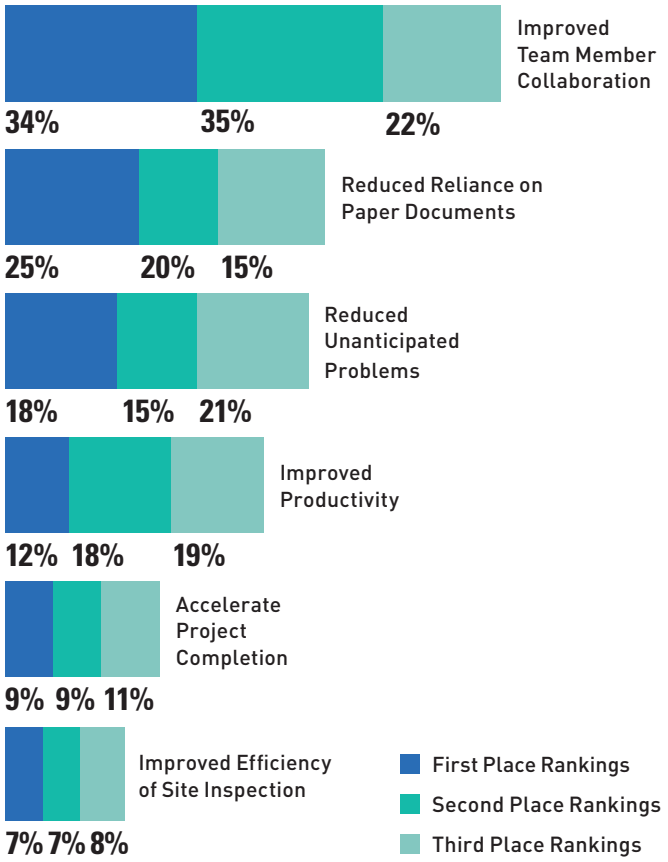
All AEC technology seeks to improve its users' productivity. Although garnering top three votes from just over half of all respondents, **Improved Productivity** should be considered more important than its fourth place position in this group implies.

EMERGING BENEFITS

Eventually it is likely that fewer unanticipated problems and improved productivity will help drive **Accelerated Project Completion**, but at this point, less than a third include it among their top three, and only 9% as the top benefit. Similarly, **Improved Efficiency of Site Inspection** is still an emerging benefit of improved information mobility.

Improved Information Mobility Benefits

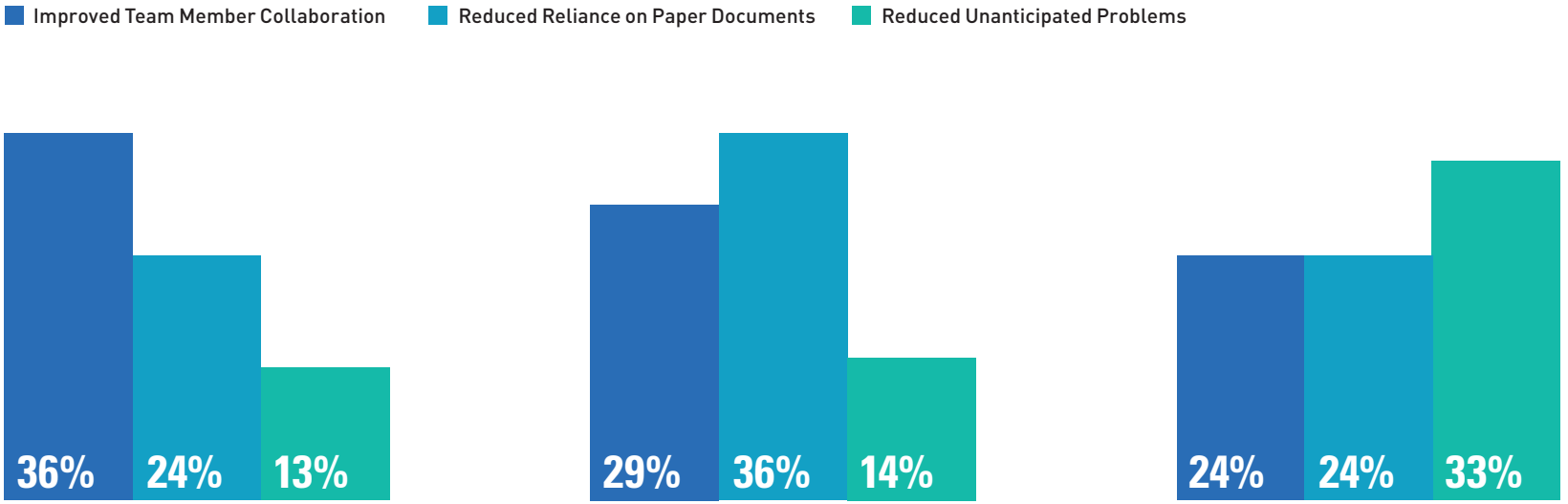
Percentage of respondents who chose each benefit as first, second and third most important



Benefits

Top Benefit of Improved Information Mobility by Company Type

Percentage of respondents by company type who gave first place importance ranking to each of the top three benefits of information mobility



ARCHITECTS

Architects put more emphasis on **Improved Team Member Collaboration** than their counterparts. This may be because of the intensity of collaboration required during the design phase, and it also may signal a growing recognition among architects of the value of collaboration with contractors in preconstruction and construction.

ENGINEERS

Engineers cite **Reduced Reliance on Paper Documents** to a far greater degree than either architects or contractors. This may be because of the technical nature of their work, which increasingly relies on computational power and is therefore more effectively communicated and distributed electronically,

CONTRACTORS

Almost twice as many contractors name **Reduced Unanticipated Problems** as the top benefit of improved information mobility than architects or engineers. This makes sense because, even though these types of problems can impact everyone, contractors are on the front line of having to deal with them at the jobsite when they occur.

Demographics

SURVEY

An online survey was fielded between April 15 and May 25, 2015. Average survey length was 15 minutes.

RESPONDENTS

Respondents include 145 architects, 31 engineers (civil and structural only) and 131 contractors, all from the US. The respondents had to have BIM experience and be employed by firms with the following minimum sizes:

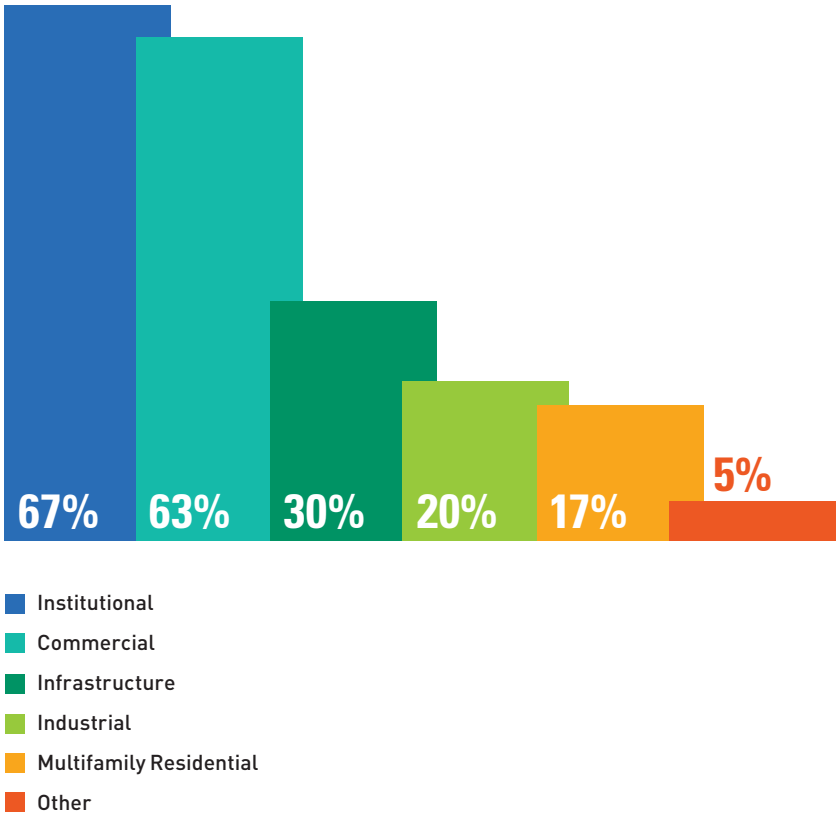
- Architects: $5 million or more in 2014 revenue
- Engineers: $10 million or more in 2014 revenue
- Contractors: $50 million or more in overall project construction value in 2014

The following charts show:

- The project experience of the respondent firms
- The BIM expertise level (self-described) of the respondents
- The regional diversity of the respondents

Primary Project Types

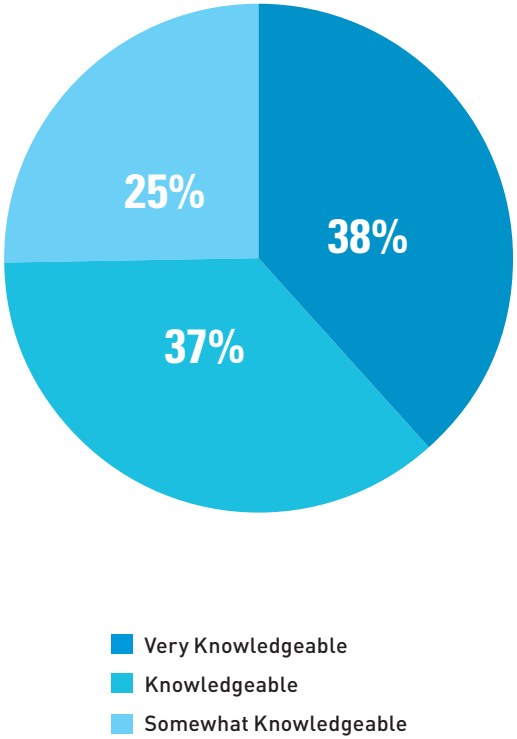
Percentage of respondents who do at least 30% of their work in these sectors



Demographics

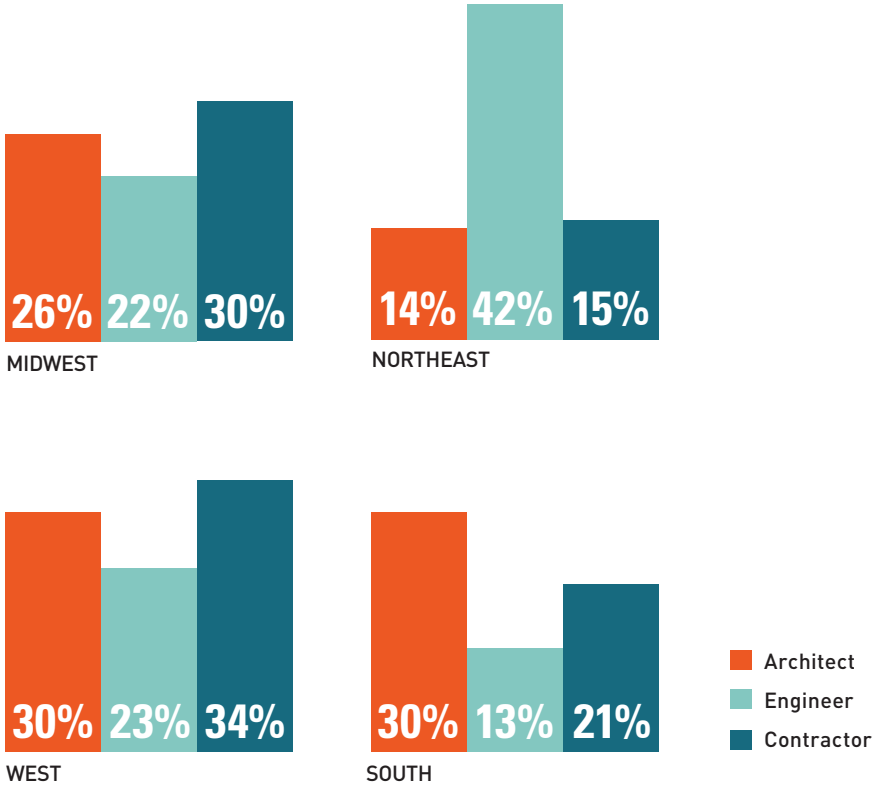
BIM Expertise of Respondents

The percentage at each self-described level of BIM expertise



Company Types and Locations

The percentage of respondents by company type from each region of the US



Contacts+Resources

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ADDITIONAL RESOURCES

Bentley Advancing Infrastructure **Bentley Systems**
www.bentley.com

AIA Practice BIM, Standards & Interoperability: **network.aia.org/technologyinarchitecturalpractice/home/bimstandards**

AIA Guide to Integrated Project Delivery: **www.aia.org/ipdg**

Associated General Contractors ConsensusDOCS, 301 BIM Addendum: **www.consensusdocs.org/catalog/collaborative**

BIMForum: **bimforum.org**

BIM Task Group (UK): **www.bimtaskgroup.org**

buildingSMART International: **www.buildingsmart.org**

National Institute of Building Sciences: **www.nibs.org**

Penn State Computer Integrated Construction "BIM Execution Planning Guide": **bim.psu.edu**

U.S. General Services Administration, Building Information Modeling: **www.gsa.gov/bim**

US National BIM Standard**: www.nationalbimstandard.org**

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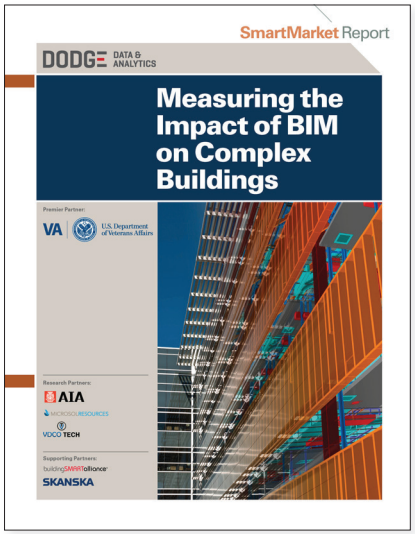
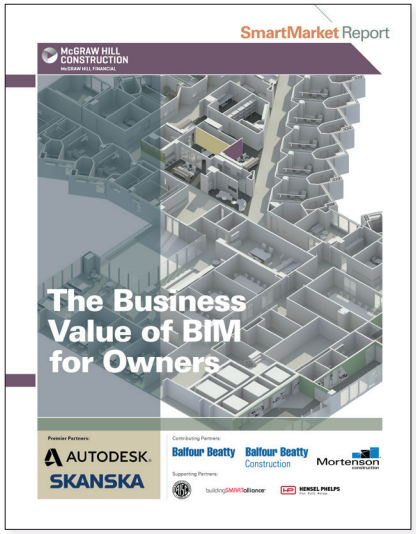
DODGE DATA & ANALYTICS

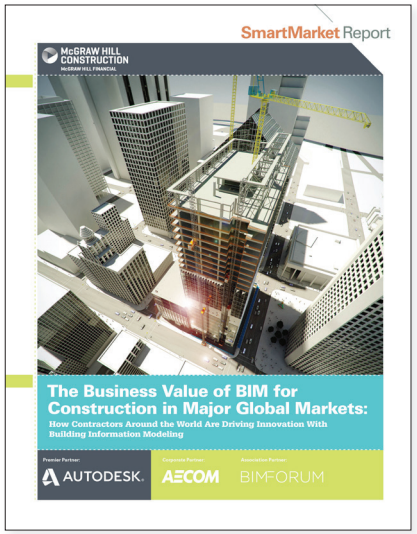
Dodge Data & Analytics: Main Website: construction.com **Dodge:** construction.com/dodge
Research & Analytics: construction.com/dodge/dodge-market-research.asp **Sweets**: sweets com
SmartMarket Reports: analyticsstore.construction.com

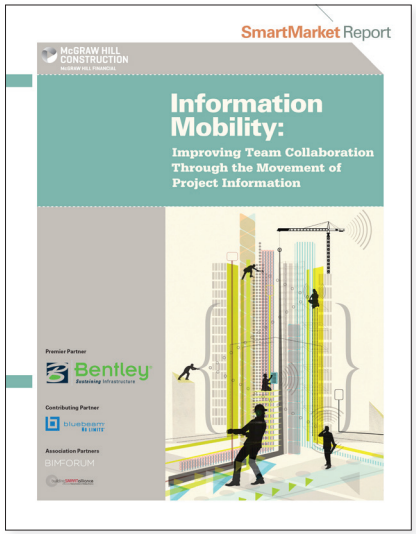
DODGE DATA & ANALYTICS

Industry Insights









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