Trimble

PREMIER PARTNER

SmartMarket Brief

Dodge Construction Network

Connected Construction: The Engineers' Perspective

Introduction

ABOUT THIS SMARTMARKET BRIEF

As the digital transformation of the construction industry continues, digital workflows that connect internal functions within a company and ones that connect the company to the project team are increasingly important. Engineers are unique in their relationship to the rest of the project team, which can vary from project to project or from firm to firm, so understanding their perspective on digital workflows is critical.

This report provides that unique perspective. It reveals that, currently, engineers are engaged users of internal digital workflows, but their engagement is much lower for multicompany ones. The report also dives more deeply into the specific design processes for which engineers employ digital workflows and which of those processes offer the greatest potential for improvement on their projects.

Engineers using digital workflows are experiencing critical benefits as a result, such as improved productivity, better decision-making and faster delivery on their projects, all of which are likely to drive them to use these workflows more in the future.

Dodge wishes to thank Trimble Construction for sponsoring this research.

CONTENTS

A MESSAGE FROM TRIMBLE

Trimble is a company that is committed to transforming the way the construction world works. I am encouraged by the findings of this report; transformation to digital workflows within engineering is underway, and the benefits it brings to our industry are understood.

The improved efficiencies engineers are driving through connected data workflows within their own organizations are now a reality for the whole construction supply chain. The use of digital workflows across multiple companies and project partners is how our industry will transform. The challenge for engineering businesses is to drive that change and differentiate themselves.

With digital workflows deeply integrated into design and project management processes, the ability to predict and mitigate risks is game-changing. The insight that improved data and processes bring enables errors to be easily identified and resolved, leading to improved delivery and enhanced profitability.

Naturally, we are a community of problem solvers. The ability to re-engineer business processes using technology, both internally and across all interfaces with the wider construction industry, will put engineering businesses in a good position to deal with the challenges facing construction globally.

Jari Heino
Vice President & General Manager
Trimble Structures Solutions

Key Findings

INTRODUCTION

Engineers are using digital workflows frequently and reaping their benefits. Currently, they are more focused on internal digital workflows than on multicompany ones. However, as the overall benefits of using these workflows drive adoption across the design and construction industry, their internal expertise will likely pay dividends as they find expectations grow for external digital connections with the rest of the project team.

ENGINEERS ARE HIGHLY ENGAGED WITH INTERNAL DIGITAL WORKFLOWS

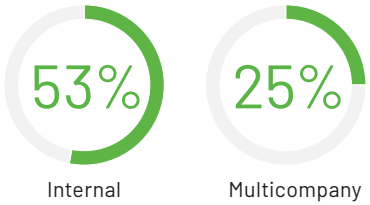
Over half (53%) of engineers already use internal digital workflows for 50% or more of their project data. Many (59%) believe that they are highly successful at converting their traditional processes into internal digital workflows.

This proficiency with internal digital workflows is particularly pronounced among large companies, where 69% are using internal digital workflows for the majority of their project data, and 75% find that they are successful at converting their data.

However, engineers at large and small companies both report far less engagement with multicompany workflows. Only 25% overall report using them for the majority of their project data.

As other critical project stakeholders like architects, owners and contractors increasingly utilize multicompany workflows, it is likely that engineers will do so as well, and that their experience with internal workflows will help with that process.

Use of Digital Workflows for 50% or More of Project Data



ENGINEERS USING DIGITAL WORKFLOWS EXPERIENCE IMPROVED PROJECT OUTCOMES AND KEY BENEFITS

Nearly all (89%) of the engineers who use digital workflows report that they experience improved project outcomes as a result, with the top outcomes they experience including faster delivery and improved quality.

They also experience critical process and business benefits, including increased efficiency of internal processes and better-informed decision-making.

In addition to increased efficiency of internal and multicompany processes, many of the benefits reported by 40% or more help improve their productivity, including reduced changes during construction and increased labor productivity.

Benefits Frequently Experienced by Engineers From Using Digital Workflows

Top Improved Project Outcomes	Top Benefits
Faster Delivery (62%)	Increased Efficiency of Internal Processes (64%)
Improved Quality (59%)	Better-Informed Decision-Making (56%)
Increased Profitability (42%)	Increased Efficiency of Multicompany Processes (44%)

Key Findings

IMPROVING PROJECTS BY IMPROVING PROCESSES

The study also featured a deep dive into the impact of specific design processes on projects, how engaged engineers are with digital workflows to conduct them, and how those workflows can help improve these processes.

- The use of digital workflows allows engineers to have more visibility into how their processes may affect their projects, which provides them with the opportunity to make the most effective changes to improve their projects.
- The processes that engineers believe have the biggest impact on their projects include construction documentation, structural analysis and calculations, and conceptual and schematic design.
- Engineers are planning to invest in digital workflows for these processes. Over two thirds (69%) of those not yet using digital workflows for them plan to invest in them in the future, and, even more tellingly, 83% of those already using digital workflows for these processes plan to continue their investment in them. This reveals that engineers are just beginning to tap the potential of digital workflows for these processes, and that they recognize the value they are already getting enough to want to invest more in the future.
- The top planned investments are for digital workflows that support the design development and construction documentation processes.

INCREASING THE USE OF DIGITAL WORKFLOWS BY ENGINEERS

The findings suggest that use of digital workflows by engineers is likely to increase in the future, although the drivers for wider use of internal ones are currently stronger than those for multicompany ones.

- The top benefit that would encourage those with little/no use of digital workflows to invest in them is increased efficiency of internal processes. It is also the most widely reported benefit among users.
- The top business benefit that would encourage wider use among engineers with little/no current use of these workflows is the ability to do more with the same resources. This suggests improving productivity is a key driver, and many widely reported benefits by users also drive better productivity.
- Over 70% of engineers with little/no current use of internal digital workflows believe that their competitors are using them, and 34% assume that that use is intensive.
- In contrast, while over two thirds of engineers with little/no current use of multicompany workflows believe that their competitors are using them, only 15% assume a similar level of intensity of use.
- Nearly half of the engineers with little/no use of internal digital workflows also believe they will be of high importance to the industry in the next five years.

All of these factors suggest that use of internal digital workflows could grow sharply among engineers in the near future, with a more moderate growth likely for multicompany workflows.

Plan to Invest in at Least One Specific Design Digital Workflow

Those Using Individual Workflows Already

Those With Little/No Use of Individual Workflows

Non/Low Users of Digital Workflows Who Believe Digital Workflows Will Be of High Importance to the Design and Construction Industry in the Future

Internal Digital Workflows

Multicompany Digital Workflows

Use of Digital Workflows

ENGAGEMENT WITH TECHNOLOGY FOR CONDUCTING DIGITAL WORKFLOWS

In order to be able to implement digital workflows, companies need to have invested in some degree of integration across the various software solutions they deploy. The more connected these solutions are, the more companies can implement workflows that efficiently share data across different departments and with different members of the project team.

Therefore, engineers were asked to identify the degree of integration they have among their software solutions. Their responses are shown in the chart at upper right.

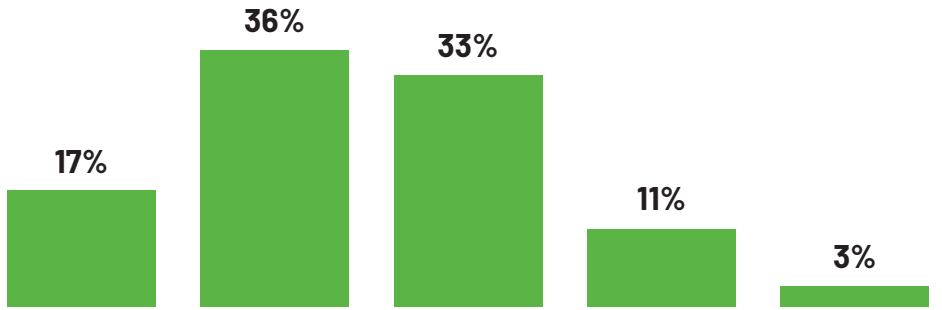
Over half of the engineers have a high/very high level of engagement with the integration of these technologies, and most of the rest are at least deploying software for most tasks. Only 14% still rely on manual processes for many functions. In fact, among all the types of organizations participating in the study, engineers are second only to owners in their technology engagement, which demonstrates that they are particularly well-positioned to adopt digital workflows.

VARIATION BY SIZE OF COMPANY

80% of engineers from large companies report high/very high engagement with digital technologies, with one quarter (25%) reporting that they use a single, connected construction management solution for most processes. In contrast, 30% of small engineers report low/no engagement, relying often on manual processes and back-office software. MIdsize firms fall in between, with 46% reporting high/very high engagement and 11% low engagement. These findings suggest that, while engineers are digitally sophisticated overall, smaller companies are likely to lag in the adoption of digital workflows.

Level of Engagement by Engineers With Technology for Conducting Digital Workflows

Dodge Data & Analytics, 2022



High/Very High Engagement With Technology for Conducting Digital Workflows

Dodge Data & Analytics, 2022

Use of Digital Workflows (CONTINUED)

NUMBER OF SOFTWARE SOLUTIONS USED TO CONDUCT DIGITAL WORKFLOWS

Engineers were asked how many separate software solutions they currently use for digital workflows. They were also asked whether that number had increased, decreased or stayed about the same over the last two years.

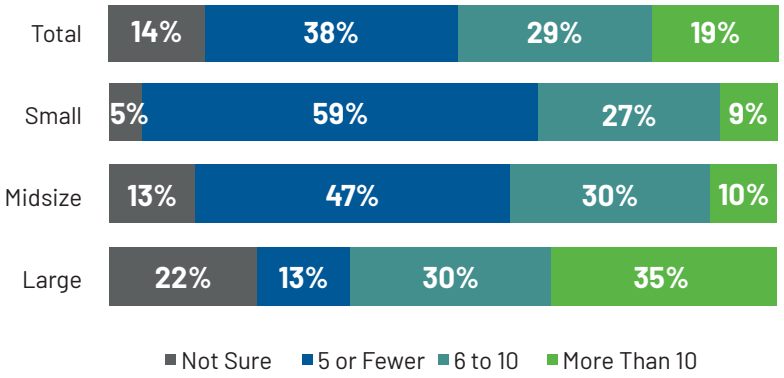
Most engineers use between one to 10 pieces of software, with a notable share (14%) who are not sure about the number. As the chart at right reveals, the use of software varies by firm size. Over half (59%) of engineers from small firms use five or fewer types of software solutions, while nearly two thirds of engineers from large companies (65%) use six or more. This likely is due to the greater digital sophistication of larger companies evident in their engagement with digital technologies (see page 4).

However, smaller companies also have fewer systems to integrate. This may provide an opportunity for them to expand their digital footprint strategically, seeking solutions that can be better integrated with digital workflows as they increase their engagement with technology.

About half (48%) of engineers report that they have increased the number of software solutions they use in the last three years. Not surprisingly, more small firms reported no change in the number of software tools used over this time frame than did large firms (51% versus 22%). However, the share of engineers from large companies who reported increasing (48%) and decreasing (18%) the number of solutions they deploy is larger than among small companies, which may suggest that some large companies are seeking more unified solutions as the next step in their progress toward digital transformation.

Number of Software Solutions Engineers Use to Conduct Digital Workflows

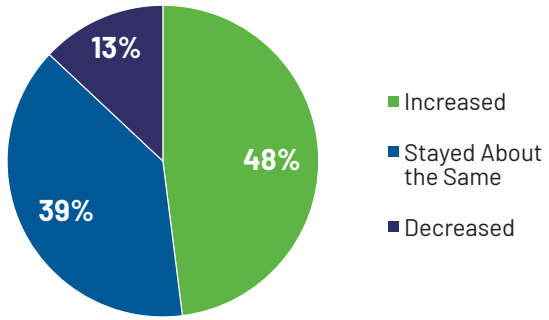
Dodge Data & Analytics, 2022



Size by Annual Revenue: Small: Under $10M **Midsize:** $10M to Less Than $100M **Large:**$100 M or More

Change Since 2019 in Number of Software Systems Used for Digital Workflows

Dodge Data & Analytics, 2022



Use of Digital Workflows (CONTINUED)

USE OF INTERNAL AND MULTICOMPANY DIGITAL WORKFLOWS

Respondents were asked about their use of two different categories of digital workflows:

Internal Digital Workflows: Those that allow them to share data and participate in processes between divisions within their own organization.

Multicompany Digital Workflows: Those that allow them to share data and participate in processes across the companies that make up the project team.

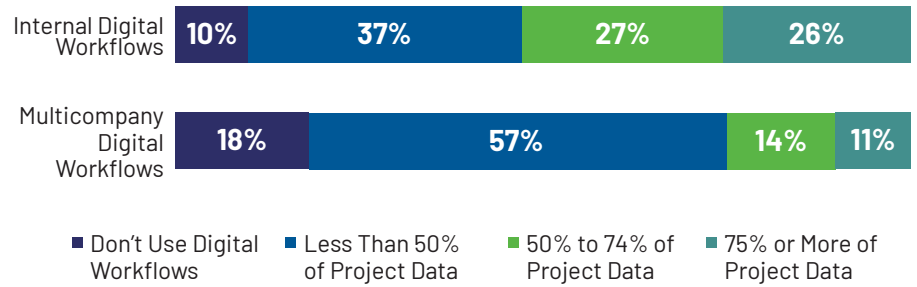
As the chart at upper right reveals, internal digital workflows are more widely used by engineers than multicompany ones. However, it is notable that the share using external digital workflows at all is only slightly lower than those using internal digital workflow (82% versus 90%). The most significant differences are in the share of project data exchanged by these workflows, with 53% digitally sharing half or more of their project data internally, but only 25% doing so externally.

VARIATION BY SIZE OF COMPANY

Engineers from large and midsize companies far more frequently report utilizing internal digital workflows for 50% or more of their project data than do small companies. However, it is notable that there is little difference between small, midsize and large firms in the share who exchange the majority of their project data externally, which suggests that small and large companies both may experience the same pressure to participate in digital workflows from their project partners, but not have the same push internally.

Engineers' Use of Digital Workflows to Exchange Data Internally Versus Externally With the Project Team

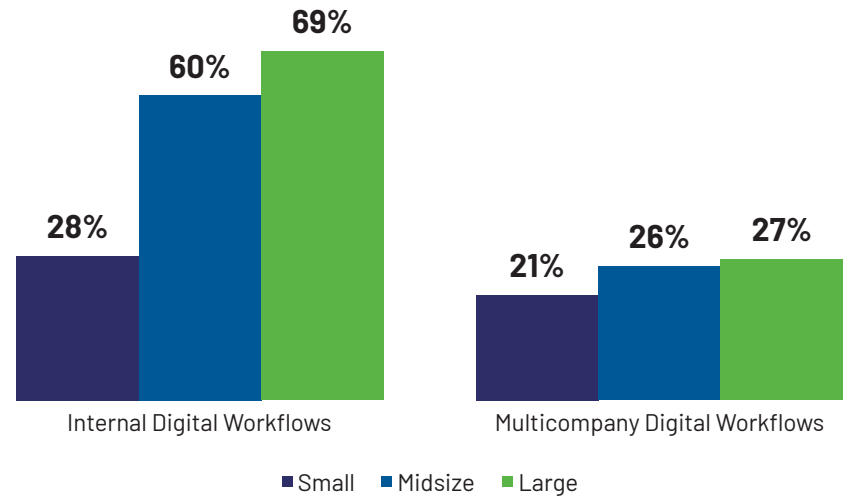
Dodge Data & Analytics, 2022



Use of Digital Workflows to Share 50% or More of Project Data

(by Size of Company)

Dodge Data & Analytics, 2022



Use of Digital Workflows (CONTINUED)

SUCCESS AT CONVERTING TRADITIONAL WORKFLOWS TO DIGITAL ONES

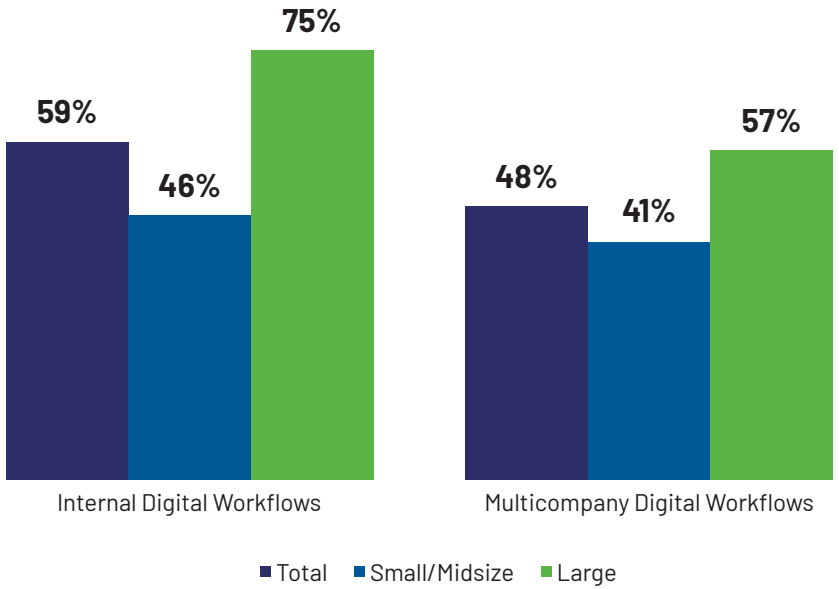
Engineers who use digital workflows were asked to rate their success at digitizing traditional processes. Notably, respondents from over half of the firms that have implemented internal digital workflows believe that their organization is highly successful at doing so, and nearly half of those implementing multicompany digital workflows rate themselves as highly.

This confidence in their ability to convert workflows bodes well for wider digital implementation by engineers. In fact, engineers are more optimistic about their ability to convert multicompany processes than are owners, GCs/CMs or specialty trade contractors. It is possible that engineers are generally more inclined to solve problems through technology than most of the other types of companies, which may help account for their confidence in their ability to deploy multicompany digital workflows.

As the chart at right reveals, respondents from large companies are more confident in their abilities to make these conversions than are those from small/midsize companies, although it is notable that over 40% of the respondents in small/midsize companies share that confidence.

Percentage of Engineers Using Digital Workflows Who Believe That They Are Highly Successful in Transforming Traditional Processes Into Digital Workflows

Dodge Data & Analytics, 2022



Connectedness With Stakeholders

INTERNAL FUNCTIONS MOST FREQUENTLY CONNECTED BY DIGITAL WORKFLOWS

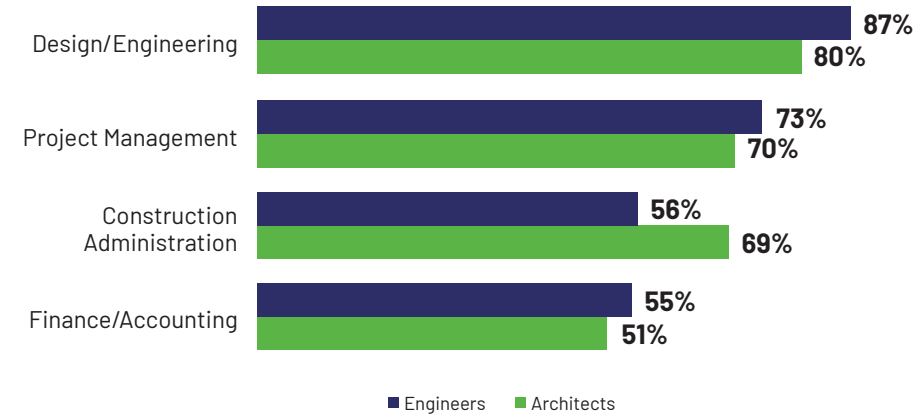
75% of engineers use internal digital workflows to share 25% or more of their project data across their organizations. These engineers were asked which departments at their firms frequently use digital workflows to exchange information with other functions. The chart at right shows the departments most frequently connected by these workflows and compares their responses to those of the architects who participated in the study.

- By far the most connected functions at engineering firms are the design/engineering and project management functions. Most of the engineers using internal digital workflows select each of these. This reveals that digital workflows are well-integrated into design and project management processes for engineers.
- Over half of engineers also use digital workflows to share information from their construction administration and finance/accounting departments. Each of these are also critical functions directly related to project management, so it is not surprising that they are frequent users of digital workflows. However engineers lag behind architects in the use of digital workflows for construction administration.
- Notably, there are no significant differences between small, midsize and large engineering firms in the degree to which they report that these four departments are connected via digital workflows, which demonstrates a common need for connection for these functions at most engineering firms.

Internal Departments Most Frequently Connected by Digital Workflows

(According to Engineers and Architects)

Dodge Data & Analytics, 2022



Connectedness With Stakeholders (CONTINUED)

INTERNAL FUNCTIONS LESS FREQUENTLY CONNECTED BY DIGITAL WORKFLOWS

The chart at right shows five internal departments where connection is less common, with fewer than half of the engineers reporting that they are frequently connected to other departments at their firm. The chart highlights the differences in the responses of large firms compared with smaller ones.

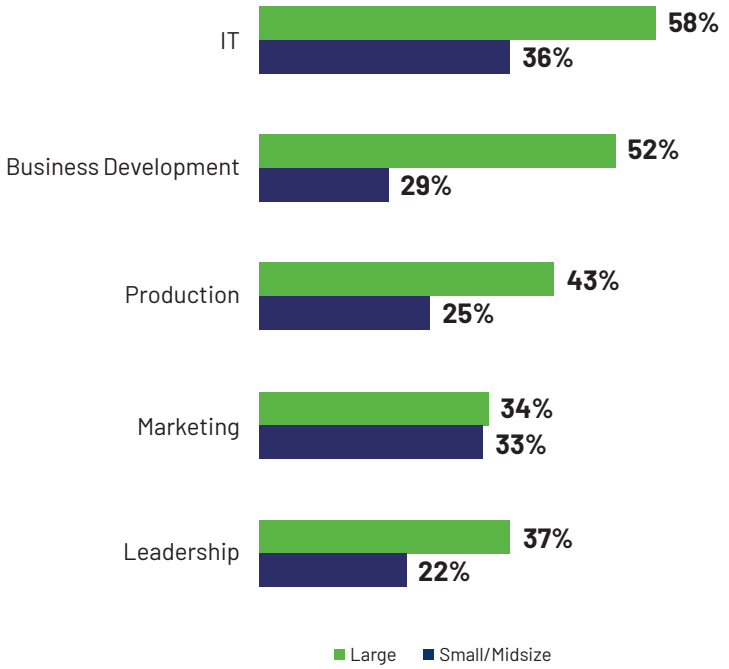
Over half of the large firms report that their IT and business development departments are connected via digital workflows, but far fewer midsize and small companies have these departments digitally plugged into their organizations.

- Business development benefits directly from access to previous project data, and IT can be more efficiently managed through digital workflows, so the frequency with which they are reported connected by respondents at larger firms makes sense.
- Their low levels of connection at smaller companies, though,suggests that many of these firms are still focused primarily on functions related directly to design but not yet on other important departments.

Production, marketing and leadership are connected at fewer than half of the engineering firms, regardless of size, although production and leadership are far less frequently connected at small/midsize companies than at large ones.

Internal Departments Less Frequently Connected by Digital Workflows at Engineers (by Size of Company)

Dodge Data & Analytics, 2022



Connectedness With Stakeholders (CONTINUED)

MOST FREQUENT COMPANIES THAT ENGINEERS CONNECTED WITH VIA DIGITAL WORKFLOWS

54% of engineers use multicompany digital workflows to share 25% or more of their project data with external project stakeholders. Those engineers were asked to identify the external stakeholders with which they frequently use digital workflows to exchange information. The findings are shown in the chart at right for large, midsize and small engineering firms.

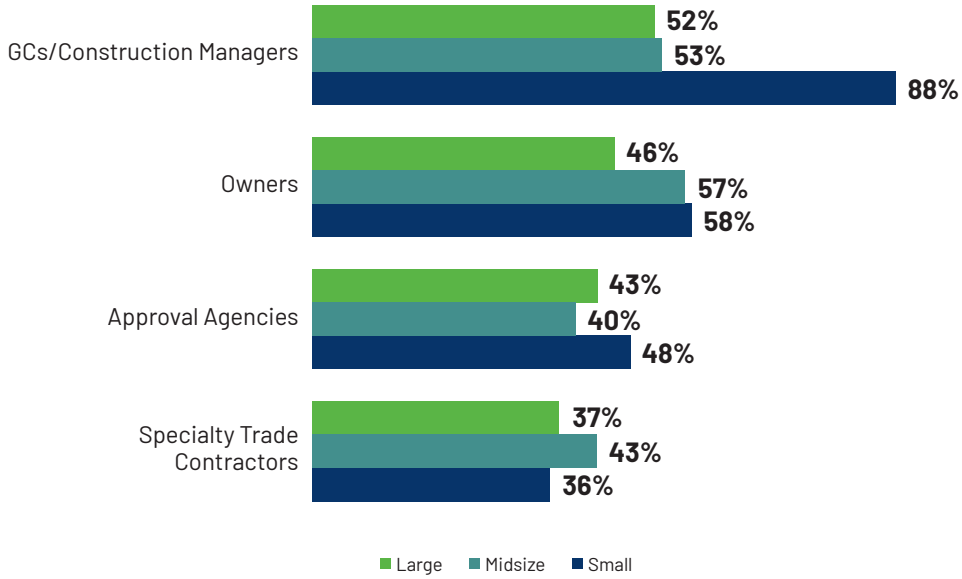
Overall, the highest percentage (64%) of engineers report being connected via digital workflows with the GCs/CMs. However, that high percentage is largely driven by the responses of engineers from small firms. In fact, engineers at midsize firms report a higher share who are connected to the owner than to the GCs/CMs. These findings demonstrate that the size of company influences the stakeholders with whom they most frequently interact.

It is also possible that small firms are more frequently influenced by the GCs/CMs to use digital tools than are midsize and large firms. They generally use fewer digital tools than larger engineering firms, so they may be adopting the contractor's software on some of their projects.

Fewer engineers report using digital workflows with specialty trade contractors than with any of the other types of organizations. This is likely influenced by the lower level of engagement the trades have with digital workflows compared with other stakeholders.

External Organizations That Engineers Are Connected With Via Digital Workflows

Dodge Data & Analytics, 2022



Connectedness With Stakeholders (CONTINUED)

SATISFACTION WITH CONNECTION TO OTHER STAKEHOLDERS

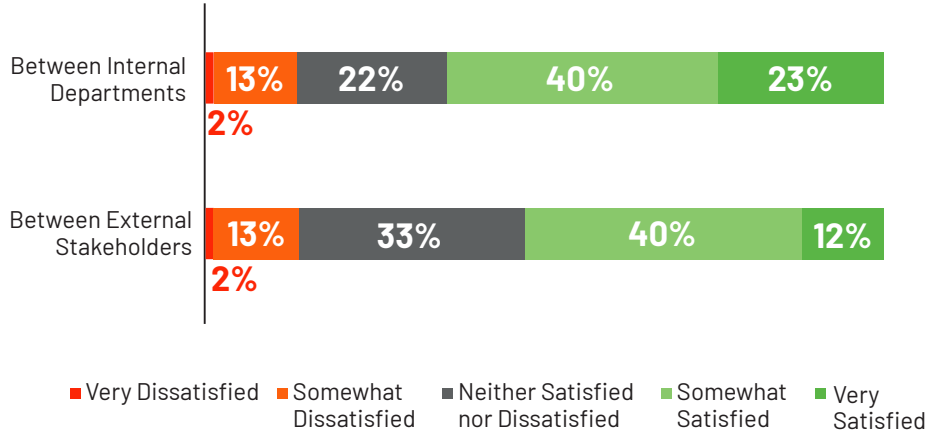
All engineers with a moderate or higher use of internal and multicompany digital workflows were asked about the degree to which they are satisfied with their connection to other project stakeholders, both internal and external.

The majority of engineers using digital workflows report that they are satisfied with these connections between internal departments (63%) and between external stakeholders (52%). A much larger percentage, though, report being very satisfied with their internal connections than with their external ones. Even though the difference falls into the neutral category rather than into the small share who report being dissatisfied (15%), it still suggests that many engineers see a lot of room for improvement in their connections with external project stakeholders.

There are no significant differences by size in the responses from small, midsize or large companies, which suggests that experiences among those using digital workflows are similar, regardless of the size of the company (and the resources they can invest in these workflows).

Engineers' Satisfaction With the Level of Connection to Other Stakeholders

Dodge Data & Analytics, 2022



Connectedness With Stakeholders (CONTINUED)

MOST FREQUENT CONNECTIVITY BREAKDOWNS BETWEEN COMPANIES

Engineers who use multicompany workflows to connect with external stakeholders were asked to select the external stakeholders with whom they find that connectivity most frequently breaks down.

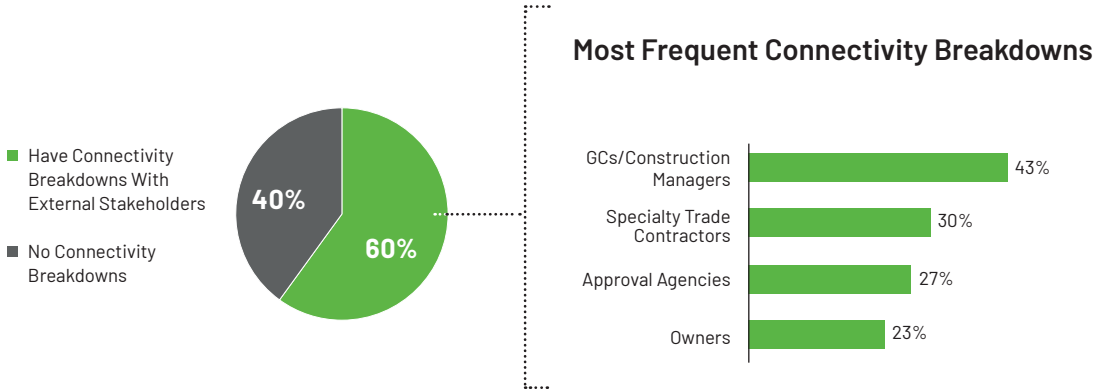
A few conclusions can be drawn from their responses, which are shown in the chart at right.

- Despite the majority being at least somewhat satisfied with their connection with external stakeholders (see page 11), even more (60%) report that they experience connectivity breakdowns. This suggests that for many, these breakdowns are considered a mundane part of doing business.
- The external stakeholders with the biggest connectivity issues for engineers are the GCs/CMs. This is a common finding among many of the other company types, along with the frequency of connecting to GCs/CMs. It suggests that improving the digital connections with GCs/CMs may be the most important way to improve the digital flow of information on projects.
- Despite frequent connections with owners (see page 10), fewer engineers (23%) report connectivity breakdowns with them than with other types of organizations.

Experience Frequent Connectivity Breakdowns With External Stakeholders

(According to Engineers Connected to Each Who Experience Breakdowns With Multiple Types of Organizations)

Dodge Data & Analytics, 2022



Connectedness With Stakeholders (CONTINUED)

TOP WAYS TO IMPROVE SATISFACTION WITH CONNECTEDNESS WITH STAKEHOLDERS

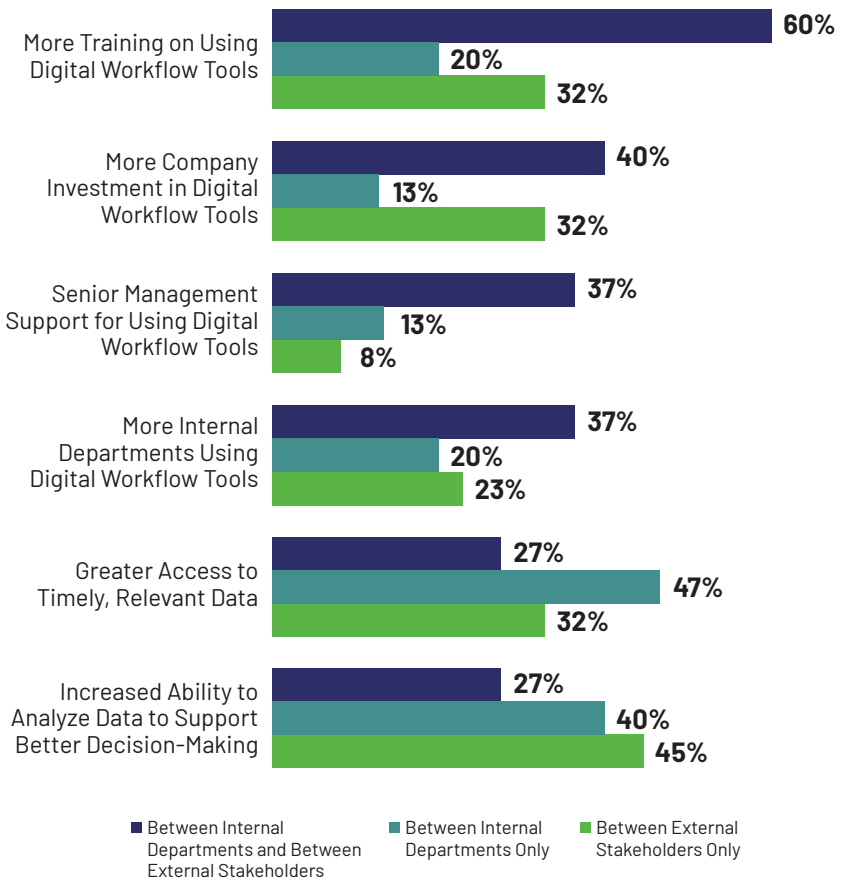
Engineers using digital workflows who do not report being satisfied with the level of connectedness that they have with other project stakeholders (see page 11) were asked to select the top three ways that they could improve their satisfaction level from the list of six options shown in the chart at right.

This question was asked of three distinct groups: those who only report dissatisfaction with their connection to internal stakeholders, those who only report dissatisfaction with their connection to external stakeholders and those who report dissatisfaction with both. All three groups are represented separately in the chart.

- Those facing internal and external connectivity most frequently select more training on using digital workflow tools as the top means to improve their satisfaction. Clearly, more industry knowledge is needed across the board.
- However, to specifically address issues with internal workflows, the most important areas of improvement needed are greater access to timely, relevant data and Increased ability to analyze data. The usefulness of the data shared is thus the primary consideration for internal digital workflows.
- Increased ability to analyze data is also the most important factor for those seeking to improve their satisfaction with their connection to external stakeholders. Again, this suggests that for many of these workflow users, they are not yet seeing the full extent of the value they believe they can achieve from the data they can access.

Top Ways to Improve Satisfaction With Engineers' Connectedness to Other Stakeholders

Dodge Data & Analytics, 2022



Use of Digital Workflows for Specific Activities

INTRODUCTION

This section examines engineers' use of digital workflows for nine design processes. The findings in this section address the following about these processes:

- **Root Causes of Problems:** The ability of architects to identify root causes of project errors and/or delays associated with these processes.
- **Severity of Problems:** The degree of negative impact that these errors/delays have on their projects.
- **Use of Digital Workflows:** The frequency with which digital workflows are used for each process.
- **Investing in Digital Workflows:** The processes in which firms are most frequently planning to make digital workflow-related investments.

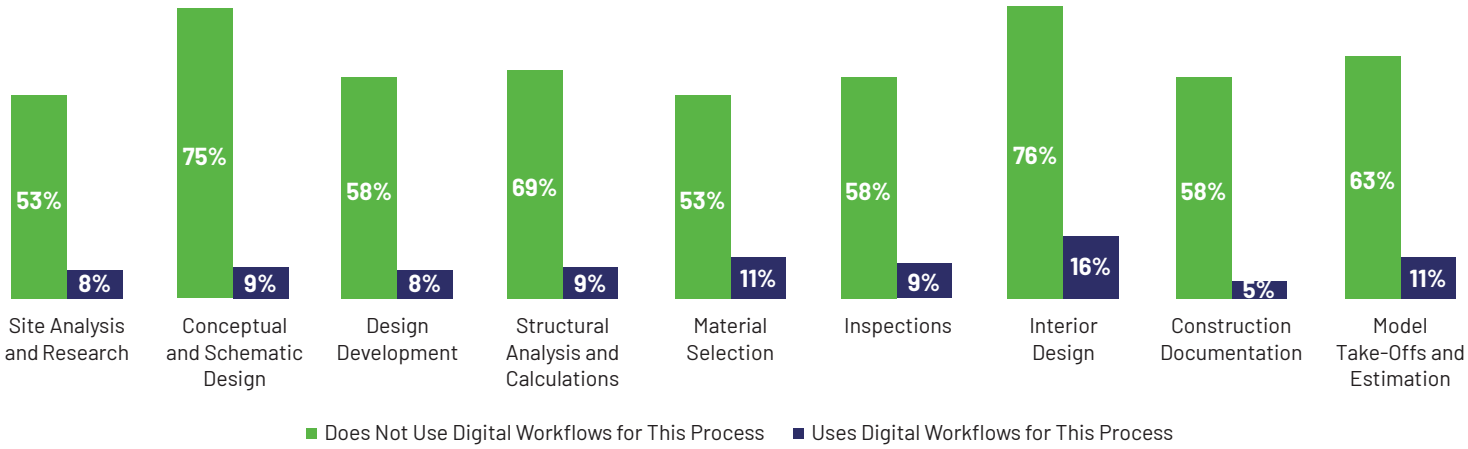
ABILITY TO LINK ROOT CAUSES OF ERRORS/ DELAYS TO SPECIFIC PROCESSES

The chart below contrasts the share of engineers who are not able to link the root causes of the errors/delays they experience on projects to specific workflows by their use of digital workflows, and it reveals a striking pattern. Those using digital processes consistently have far more visibility into how those processes impact their projects.

This visibility is a critical benefit of the use of workflows. All of these are common processes conducted by engineers, and challenges created by these processes are likely to be evident on multiple projects. Being able to understand the root causes is the first, essential step in being able to change processes in order to avoid these issues in the future. This may be one of the most significant ways that the use of digital workflows improves project performance.

Engineers Who Never Trace Root Causes Back to Issues With Conducting These Design Processes

Dodge Data & Analytics, 2022



Use of Digital Workflows for Specific Activities (CONTINUED)

FREQUENCY AND IMPACT OF ISSUES ASSOCIATED WITH DESIGN PROCESSES

Engineers were asked to rate the frequency which errors/delays on projects can be linked back to specific processes. Those who found them to be the root causes of these issues were asked to rate their severity.

Those ratings were converted to a 100-point scale index, and they are shown in the table at right. They are also shown graphically on the following page.

- There is a wide range across the responses for the frequency with which they are identified as the root causes of issues, with the frequency scores ranging from 26 for interior design to 45 for construction documentation.
- However, once they are determined to be a root cause of errors/delays, the issues they cause are widely recognized as having a high impact. The impact scores fall in a much narrower, more intensive range than do the frequency scores, from 68 for material selection and inspections to 75 for conceptual and schematic design. Even interior design, which is not noted with great frequency, has a relatively high impact score of 73.
- Despite this, a few processes stand out for their frequency and impact, and appear to be the ones for which improvements would have the greatest benefits to projects in general:

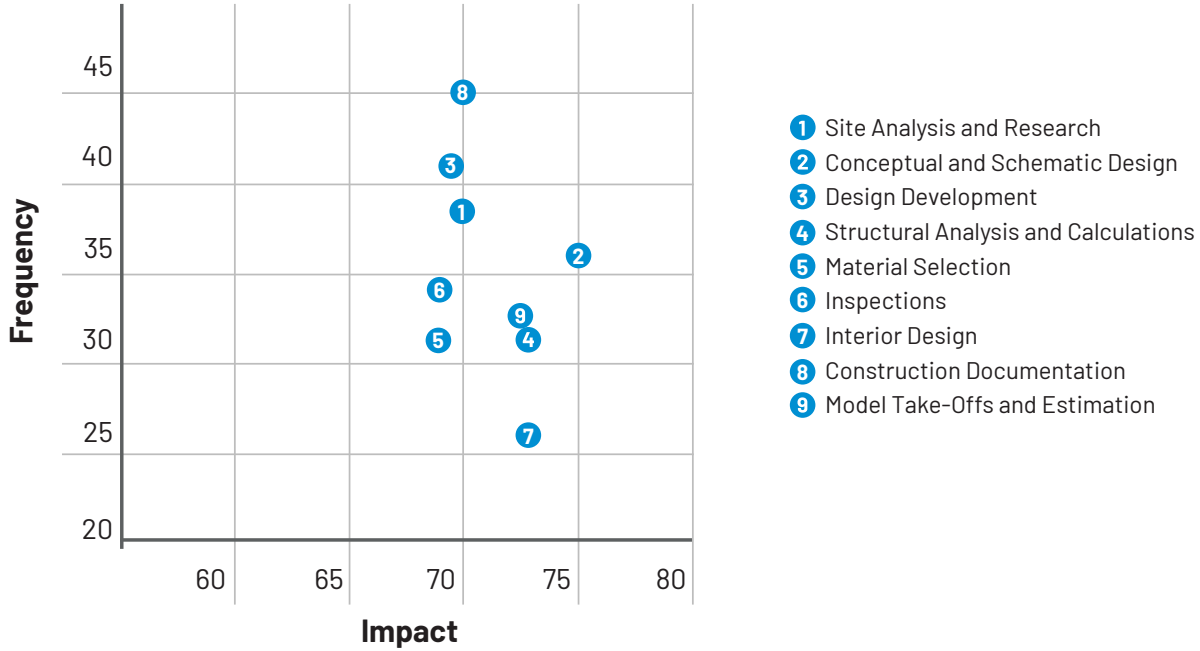
	Frequency Index: Processes Identified as Root Causes for Errors/ Delays	**Impact Index:** Degree of Negative Impact of Errors/Delays Caused by Processes
Site Analysis and Research	38	70
Conceptual and Schematic Design	36	75
Design Development	41	69
Structural Analysis and Calculations	32	73
Material Selection	32	68
Inspections	34	68
Interior Design	26	73
Construction Documentation	45	70
Model Take-Offs and Estimation	33	73

Use of Digital Workflows for Specific Activities (CONTINUED)

- Construction documentation has a combined high frequency and impact score, and thus improving this process could have a broad and deep impact.
- Conceptual and schematic design is the most notable for a high level of impact, and is cited with moderate frequency. Certainly, improving processes early in design would keep issues from cascading through the rest of the project lifecycle.
- Structural analysis and calculations also stand out as an area where process improvements could significantly enhance project performance. Since many engineers in the survey may not directly engage in this process, its high impact score is particularly notable.

Frequency and Impact of Activities Identified as Root Causes for Errors/Delays

Dodge Data & Analytics, 2022



Use of Digital Workflows for Specific Activities (CONTINUED)

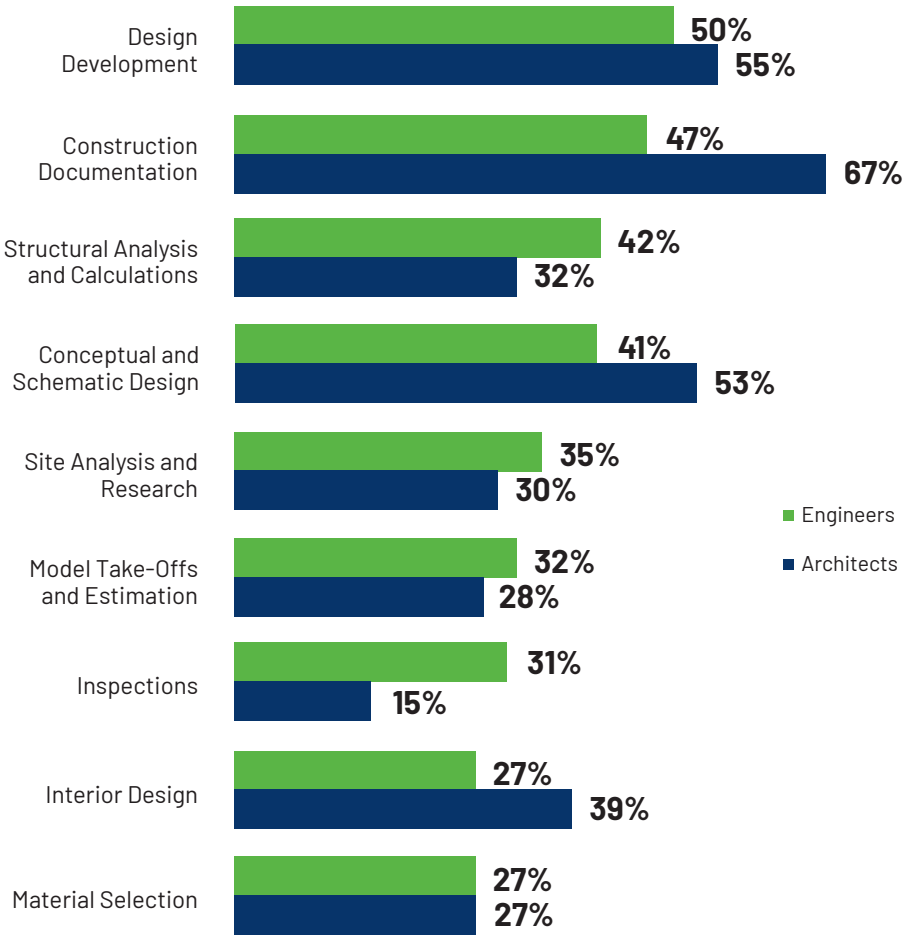
FREQUENCY OF USING DIGITAL WORKFLOWS FOR DESIGN PROCESSES

Engineers were asked about the frequency with which they use digital workflows for each specific design process shown in the chart at right. The chart shows those who use digital workflows for these processes frequently/very frequently, and compares the engineer responses with those of the architects who also participated in the study.

- Engineers most frequently use digital workflows for design processes. Three out of the top four processes for which digital workflows are used fall into this category: construction documentation, design development and conceptual and schematic design.
  - It is likely that many engineers do not engage directly in interior design, which may be why it ranks so much lower, despite being a design process.
  - Architects more frequently utilize digital workflows for construction documentation and conceptual and schematic design than do engineers.
- Analysis processes also frequently utilize digital workflows, with structural analysis and site analysis also key processes utilized by engineers.
  - Since much of this analysis often falls into the engineer's purview, it is not surprising that engineers more frequently utilize digital workflows for these activities than do architects.
- Fewer than one third of engineers utilize digital workflows for model take-offs and estimation, inspections, interior design or material selection. Notably, even fewer architects are using digital workflows for these processes, suggesting that these tools may still need to be improved for wider adoption.

Share of Engineers Using Digital Workflows for Processes Frequently/Very Frequently

Dodge Data & Analytics, 2022



Use of Digital Workflows for Specific Activities (CONTINUED)

PLANNED INVESTMENTS IN DIGITAL WORKFLOWS

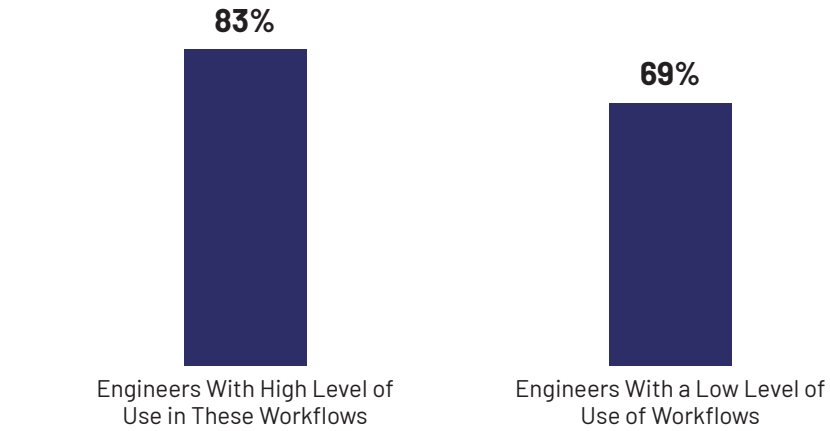
Engineers were asked about their planned investments in digital workflows for the nine design processes included in the survey.

The upper chart reveals that a high percentage of engineers intend to invest in at least one process, with those who already use these workflows even more committed to investing more in them than those who have little/no use of these specific workflows currently. This finding reveals both a high degree of interest in overall digital workflow investment, and also, more specifically, that most engineers using digital workflows are still engaged in improving and expanding upon them.

The design-related workflows—design development, construction documentation and conceptual/schematic design—have the highest share of those already using them who plan to invest more. They are also a top area of investment for those not yet using them, along with model take-offs and estimation.

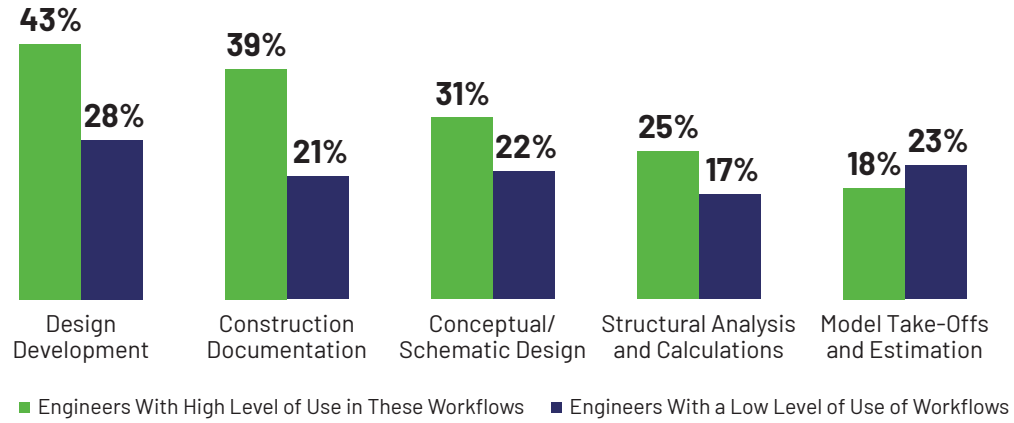
Plan to Invest in Digital Workflows

Dodge Data & Analytics, 2022



Top Processes for Planned Investments

Dodge Data & Analytics, 2022



Benefits

FREQUENTLY EXPERIENCED BENEFITS

The engineers who use digital workflows were asked to select the benefits they most frequently experience as a result from the list of nine options at right.

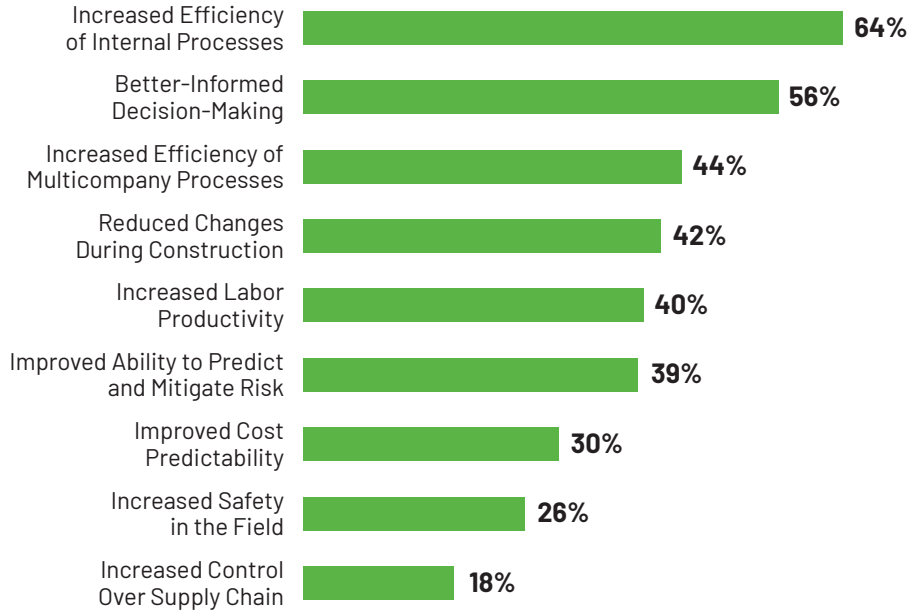
- Two benefits are more widely experienced by engineers than any others: increased efficiency of internal processes and better-informed decision-making. These are the two most common benefits experienced by architects, owners and contractors as well. It is likely that better-informed decision-making is the direct result of better understanding of how processes impact project outcomes (see page 14).
- A cluster of four benefits are experienced by around 40% of engineers. Three of these directly impact productivity on projects, including increased labor productivity (40%), increased efficiency of multicompany processes (44%) and reduced changes during construction (42%). These productivity gains can help address the staffing challenges faced by many design firms currently.

VARIATION BY SIZE OF COMPANY

More respondents from large engineering firms than small ones report that use of digital workflows gives them an improved ability to predict and mitigate risk (47% versus 26%) and increased control over the supply chain (30% versus 8%). It is possible that these benefits are more likely to accrue to those who use digital workflows more widely, as larger companies do (see page 6).

Benefits Frequently Experienced From Engineers' Use of Digital Workflows

Dodge Data & Analytics, 2022



Benefits (CONTINUED)

IMPROVED PROJECT OUTCOMES DUE TO DIGITAL WORKFLOWS

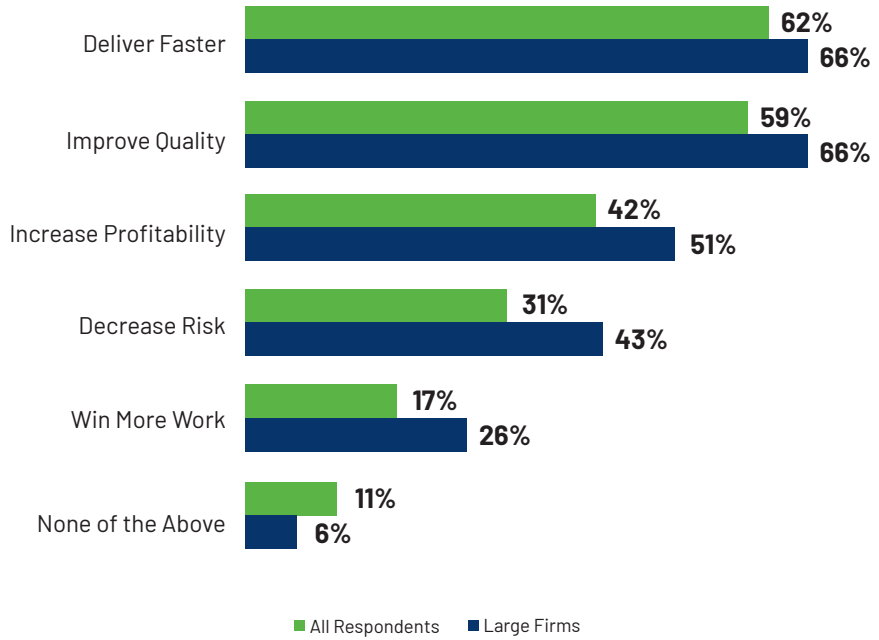
Engineers were also asked to select the most frequently improved project outcomes that they experience due to their use of digital workflows. The findings are shown in the chart at right, including the responses from all engineers and those who work at large firms.

The top benefits reported by engineers are that digital workflows help them to deliver projects faster and improve quality. These are also the top benefits for the other stakeholders included in the study. Given the process improvements (see page 19) and transparency about process impacts (see page 14) that those using digital workflows experience, it is not surprising that these would be commonly experienced benefits.

Respondents from large firms also more frequently report experiencing all five improved project outcomes than do those from smaller companies. The differences in the project improvements experienced are especially pronounced for increased profitability, decreased risk and the ability to win more work. Again, it is likely that their greater engagement with digital workflows overall (see page 6) allows larger companies to benefit more from their use.

Improved Outcomes From Use of Digital Workflows Frequently Experienced by Engineers

Dodge Data & Analytics, 2022



Benefits (CONTINUED)

EVALUATION OF THE ROI OF TECHNOLOGY INVESTMENTS

Engineers were asked if they have a method for evaluating the return on investment in technology for digital workflows.

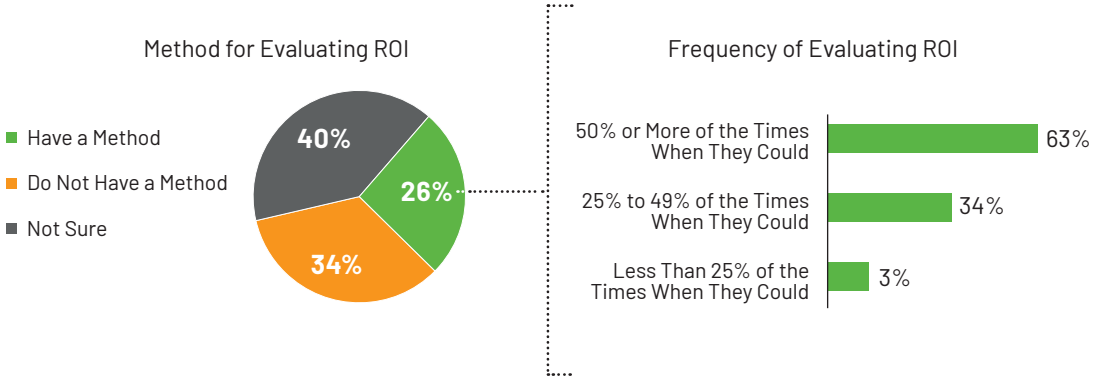
As the pie chart reveals, only about one quarter (26%) of engineers have a method for doing so. In fact, the largest percentage are not sure whether their company has a method for analyzing ROI or not. Even at large companies, only 36% report that they have a method for analyzing ROI, with 45% reporting that they are unsure. Those from small companies are the most certain, and 61% report that they do not have a method of measuring ROI.

Notably, though, those who do have a method tend to deploy it. Nearly two thirds (63%) of those with a means of measuring the ROI of technology investments report that they do so 50% or more of the times when they could. While this is just a small share of the overall respondents, it does suggest that there is sufficient data being gathered on the financial benefits of using these technologies to help many in the industry determine which investments have the greatest impact.

Evaluating the Return on Investment in Technology for Digital Workflows

(According to Engineers)

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows

TOP REASONS DIGITAL WORKFLOWS ARE NOT OR ARE RARELY USED

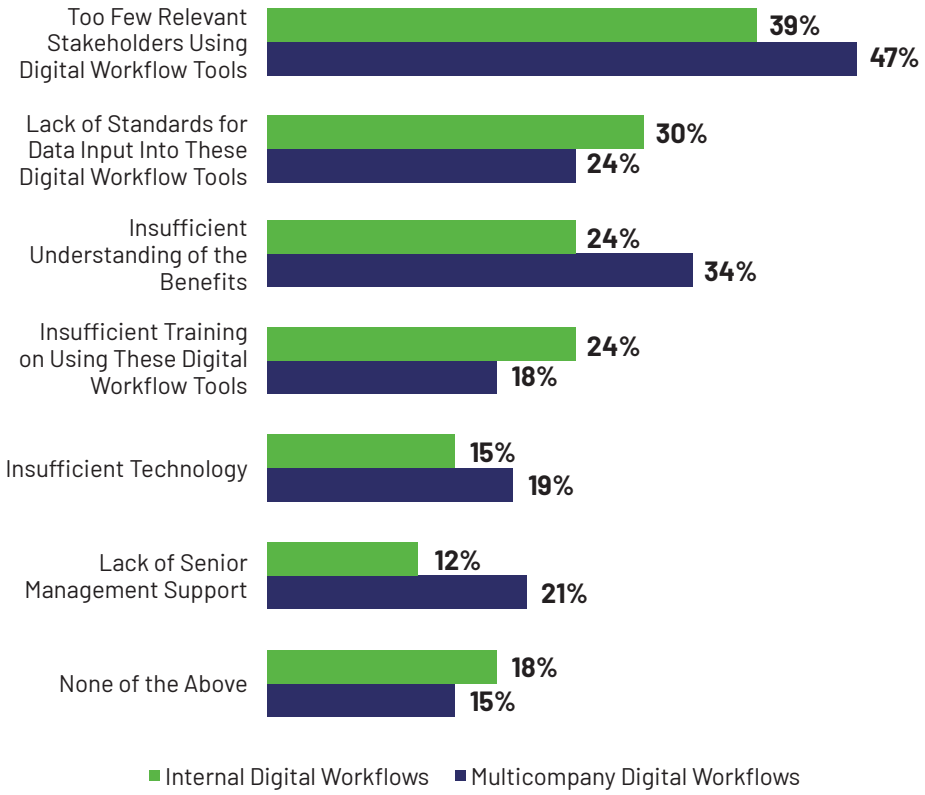
One quarter (25%) of engineers never or infrequently use digital workflows to share project data with other internal departments, and 47% have little/no engagement with multicompany digital workflows. This section of the report examines why they do not use digital workflows more frequently and the factors that could encourage them to adopt them or increase their use.

The chart at right shows the top reasons selected by engineers for their low/lack of use of digital workflows.

- The most frequently cited reason for not using both internal and multicompany workflows is that there are not enough relevant stakeholders using them. Clearly the benefits are much more apparent if a strong ecosystem already exists, but waiting for other departments or companies to take the lead could ultimately disadvantage those lagging in their adoption of digital tools.
- Lack of standards for data input is the second most frequently cited reason for not using internal digital workflows and the third for multicompany ones. This reveals a strong need in the industry for data standards to increase the benefits of digital tool adoption.
- The second biggest deterrent to the use of multicompany digital workflows is an insufficient understanding of the benefits of using them. Most companies have developed standard practices for exchanging data that they rely on, but as firms struggle to find sufficient staff for their projects, the status quo may not be sufficient to keep them competitive. Knowing the productivity benefits reported by users (see page 19) could help drive use of these workflows in the larger industry.

Top Reasons for Little/No Use of Digital Workflows by Engineers

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

PROCESS-RELATED BENEFITS MOST LIKELY TO INCREASE USE OF DIGITAL WORKFLOWS

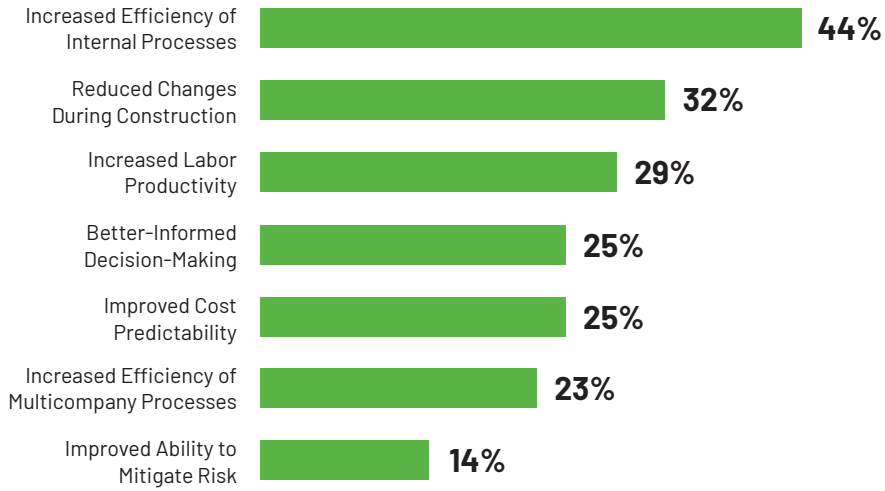
Engineers whose firms infrequently/never use digital workflows were asked to select the top three process-related benefits that would encourage them to increase their use of these workflows from the list of seven possible benefits shown in the chart at right.

The most influential benefits correspond directly with the benefits that users most frequently report experiencing. This suggests that more information about what engineers using these workflows experience could help drive greater engagement with them among non-users.

- The most influential process benefit is increased efficiency of internal processes, and it is also the most widely experienced benefit by those using digital workflows, reported by nearly two thirds (64%).
- The second most influential benefit is having reduced changes during construction, and this benefit was reported by 42% of those using digital workflows. Again, this bodes well for wider utilization.
- Increased labor productivity is considered influential by 29%, and it is reported as benefit by 40% of users.
- Better-informed decision-making is another top benefit reported by over half of users, and the ability to achieve it would encourage wider use among 25% of the non-users.

Process-Related Benefits That Would Encourage Engineers to Increase Use of Digital Workflows (Selected in Top Three)

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

IMPROVED PROJECT OUTCOMES MOST LIKELY TO INCREASE USE OF DIGITAL WORKFLOWS

Engineers whose firms rarely or never use digital workflows were asked to select the top three project outcomes that would encourage them to adopt or more widely use these workflows from the list of options shown in the chart at right.

Over half of the current users of digital workflows reported improved project quality (see page 20), and not only is this the second most compelling benefit on its own, but it is also likely to lead to increased client satisfaction, which ranks first. This is especially true if it is combined with faster project delivery, which is reported by an even higher percentage of users (62%) and is considered influential on its own by over one third of the low/non-users.

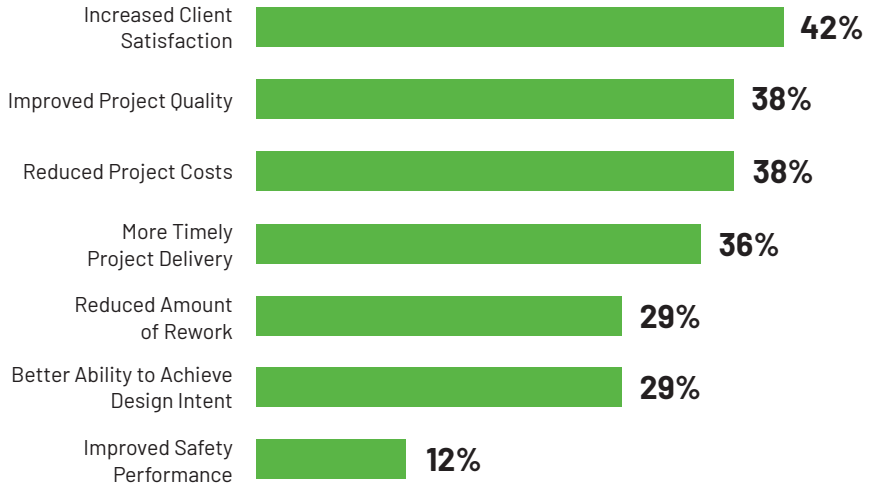
Reducing project cost is also considered an influential benefit by over one third of low/non-users. While users were not asked directly about it, some of the top benefits they report experiencing are likely to lower overall project cost, including increasing the efficiency of internal and multicompany processes and reduced changes during construction.

Again, the alignment of benefits desired by non-users and benefits experienced by users bodes well for wider use in the future as the benefits of digital workflows become better established in the industry.

Improved Project Outcomes That Would Encourage Engineers to Increase Use of Digital Workflows

(Selected in Top Three)

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

BUSINESS BENEFITS MOST LIKELY TO ENCOURAGE USE OF DIGITAL WORKFLOWS

Engineers whose firms rarely/never use digital workflows were asked to select the top three business benefits that would encourage use of them from the list of options in the chart at right.

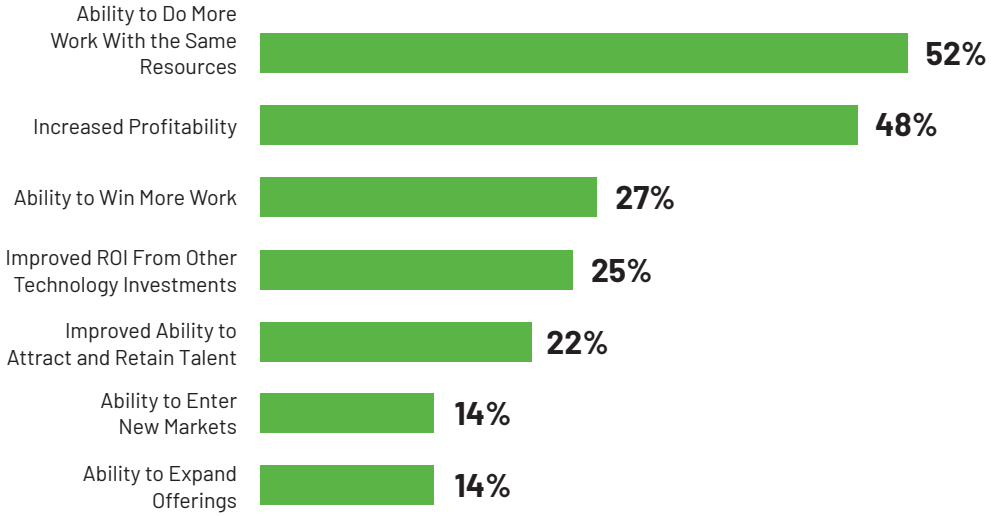
Two business benefits are widely influential for engineers.

- The ability to do more work with the same resources is the most influential. While not asked specifically about this benefit, most users (64%) report that they see increased efficiency for their internal processes from using digital workflows, 44% cite increased efficiency in their multicompany processes and 40% report improved labor productivity. If achieved, the combination of these benefits would likely allow companies to get more work done with the same resources.
- Increased profitability for their company is also an influential benefit to encourage use of digital workflows. 42% of users report that they experience increased profitability on their projects, which could certainly help increase overall profitability at their company.

The ability to deliver on the promise of the top two benefits is clearly critical to sway the low/non-users to invest in digital workflows.

Business Benefits That Would Encourage Engineers to Increase Use of Digital Workflows (Selected in Top Three)

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

USE OF DIGITAL WORKFLOWS BY COMPETITORS

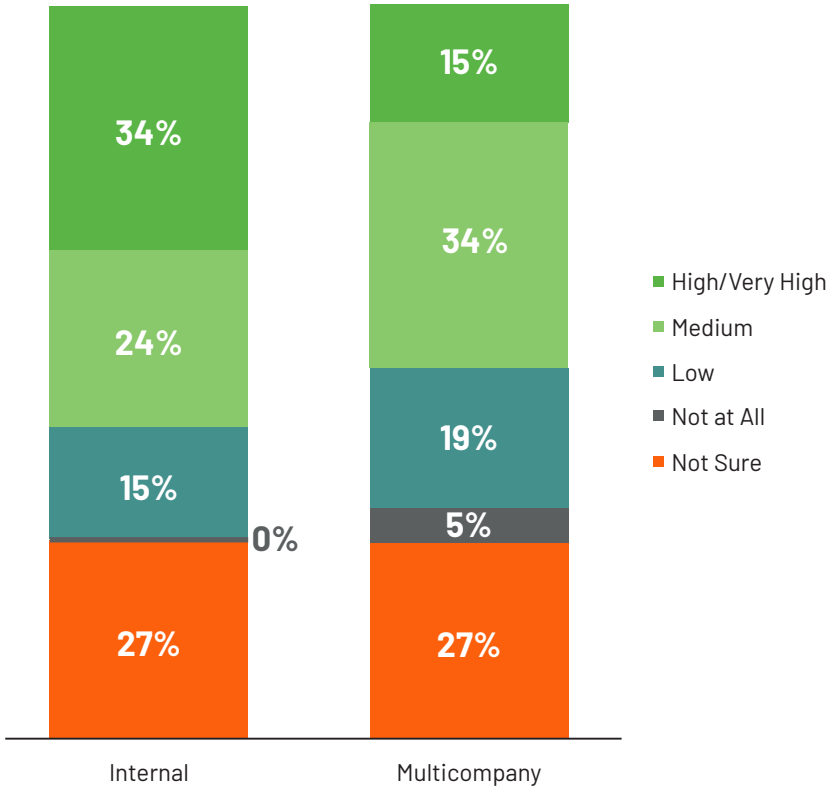
A compelling driver for technology adoption is the perception that it is necessary to stay competitive. Therefore, engineers with little to no use of digital workflows were asked about the degree to which they believe their competitors are using them.

- Around half believe that their competitors are using these workflows at a medium or higher level. For these engineers, concerns about falling behind competitors may be a driver.
- Expectations about the use of internal workflows is much higher than that about the use of multicompany workflows. This aligns with the data on usage. Engineers appear to be more aware that use is higher for internal than multicompany workflows than several other players, including architects and contractors.

Degree to Which Competitors Are Using Internal Digital Workflows

(According to Engineers Who Rarely/Never Use Digital Workflows)

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

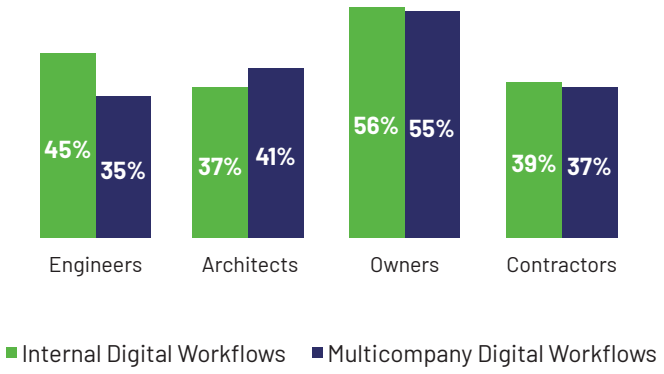
IMPORTANCE OF DIGITAL WORKFLOWS TO THE CONSTRUCTION INDUSTRY IN THE FUTURE

Another influential factor in the adoption of new technology is the perception that it is of growing importance to the industry. Therefore engineers were asked to rate the importance of internal and multicompany digital workflows to the construction industry in the next five years. The chart at right shows the engineers who rated the importance as high/very high, and it contrasts their responses with architects, owners and contractors who provided similar ratings.

- **Internal Digital Workflows:** Engineers with little/no use of digital workflows are relatively optimistic about their future importance compared with the other types of companies in the survey. This aligns with the fact that many believe their competitors are already engaged in moderate to frequent use of them (see page 26), and it provides further evidence that engineers may find staying competitive as a driver for ultimately making more technology investments.
- **Multicompany Digital Workflows:** Engineers put less stock in the importance of multicompany workflows to the industry, less than architects and especially less than owners. Fewer engineers may be facing demands from clients to offer digital workflows than architects and contractors do currently, but that demand is likely to trickle down to them.

Share of Those Who Infrequently or Never Use These Workflows Who Believe They Will Have a High Level of Future Importance for Construction Industry

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

CONTRACTUAL REQUIREMENTS FOR TECHNOLOGIES AND DIGITAL DOCUMENTATION

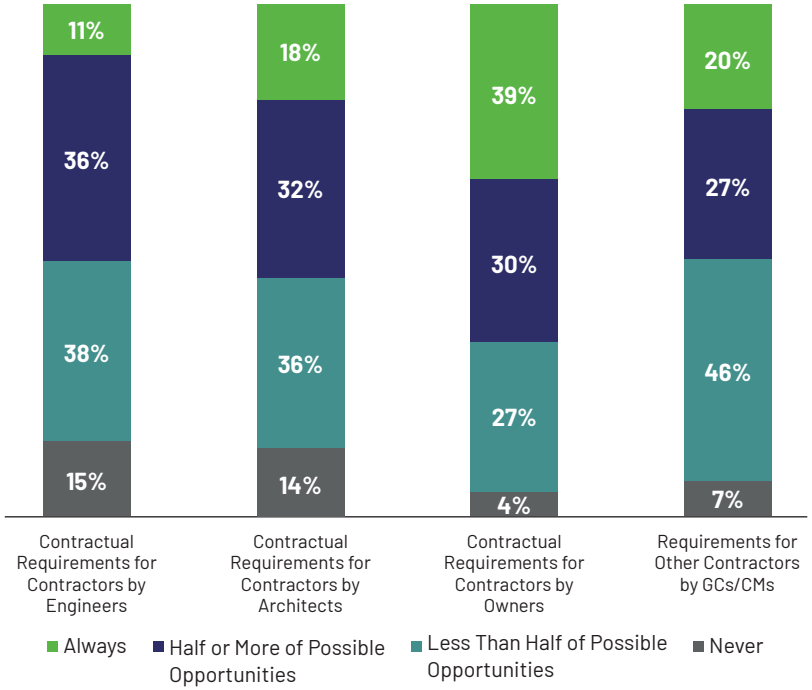
One factor that could encourage wider use of digital workflows generally is more engagement by contractors, and a top factor that could influence them is a contractual requirement for specific technologies and/or digital document and practices on their projects.

As the charts below reveal, engineers are about evenly split between those who require digital documentation and practices on about half of their projects and those who less frequently require them. They also largely agree with architects that the top reason for not requiring them is that it isn't a high enough priority, and many also cite the lack of cohesive software to track these requirements, resistance to change, and concerns about reducing the number of qualified bidders on projects.

Frequency of Other Organizations Requiring Contractors to Use Digital Documentation and Practices

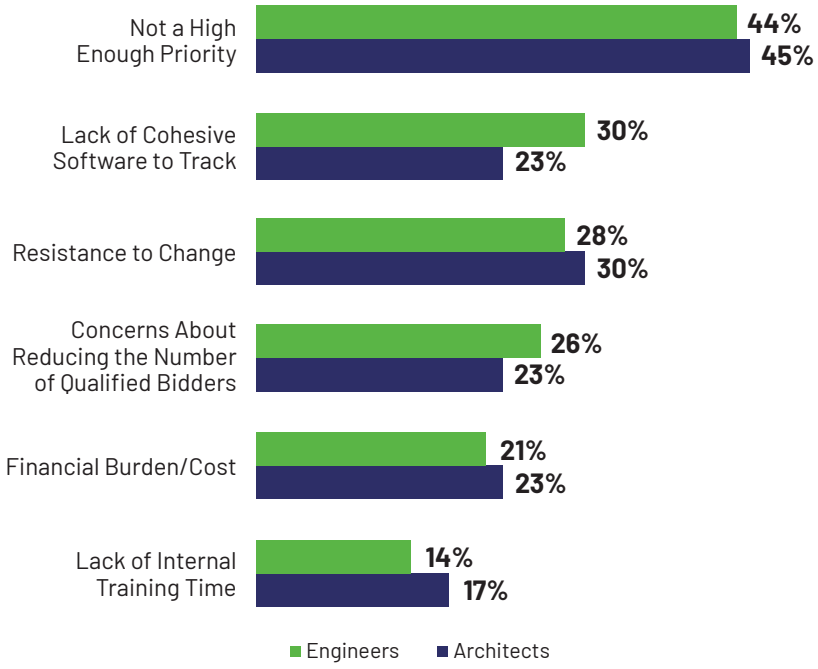
(By Type of Company)

Dodge Data & Analytics, 2022



Reasons That Organizations Do Not More Frequently Require Contractors Use Digital Documentation and Practices

Dodge Data & Analytics, 2022



Influences on Widening Use of Digital Workflows (CONTINUED)

USE OF LEAN AND INTEGRATED PROJECT DELIVERY

At the end of the survey, respondents were given the option to answer a few additional questions about Lean construction and integrated project delivery (IPD). Over one third (38%) of the engineers who participated in the study opted to answer these questions.

FAMILIARITY WITH AND USE OF LEAN CONSTRUCTION AND IPD

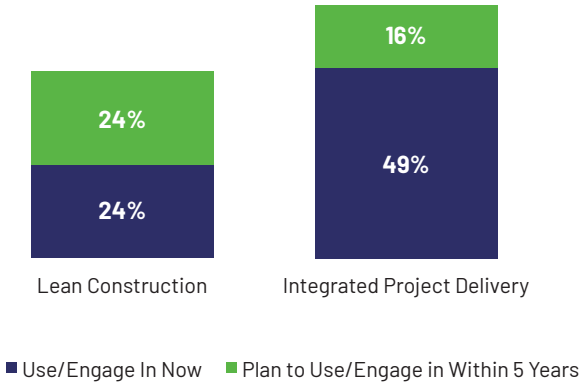
Since they chose to answer these questions, it is not surprising that 78% of them report that they are familiar with the term Lean construction and 82% with integrated project delivery.

Among this self-selected group, far more have experience with IPD (49%) in the last five years than with Lean construction (24%). These findings suggest that, while many designers know about Lean, it is still an emerging strategy among them. The use of IPD, though, is surprisingly high, even when factoring in the likelihood that many of the engineers who opted not to answer these questions probably have not engaged in an IPD project.

Expectations about use of Lean construction in the future are relatively strong, with the share who expect to adopt it equal to the share currently using it. While these predictions may be optimistic, they demonstrate that for a significant share of engineers the value of Lean is well-understood.

Current and Expected Use of Lean Construction and Integrated Project Delivery by Engineers

Dodge Data & Analytics, 2022



Expectations by those not engaged in an IPD project currently that they will be engaged in one in the future, though, are much lower, with only 16% falling in this category.

Respondents using these two methods were also asked about the benefits they experience from them. While the number of users for either method is too small for quantitative findings, it is notable that all believe that use of Lean and IPD on projects improves the exchange of project data, and over 90% find that they increase collaboration on their projects. These findings suggest that growth in these two methods will provide greater encouragement for the use of digital workflows, and that the use of digital workflows could help maximize the benefits each offers.

Methodology

In 2021, Dodge conducted an online study to gauge the perceptions and experience of engaging in connected construction in the US. The survey was fielded from April 28 to August 17. Sample was provided by Dodge Data & Analytics' Architect and Contractor Panels, engineers from the Dodge database and a list of industry contacts from Trimble.

PROFILE OF RESPONDENTS

The overall study included 954 responses:

- 240 architects
- 133 engineers
- 236 general contractors/construction managers
- 232 specialty trade contractors
- 113 building or infrastructure owners

Respondents had to work primarily on nonresidential construction projects, excluding single-family, for non-owners or have primarily nonresidential construction projects, excluding single-family, in their portfolio for owners.

ENGINEER DEMOGRAPHICS

ENGINEERING DISCIPLINES

Engineers were asked about the engineering disciplines provided by their firm and could select all that were appropriate. The top disciplines selected are:

- Civil (69%)
- Structural (51%)
- Mechanical and Plumbing (45%)
- Electrical (44%)
- HVAC (35%)
- Geotech (29%)

PROJECT TYPES

The top project types that engineers reported working on include commercial (56%), institutional (53%), transportation (43%), water/wastewater (57%), industrial (47%), energy/power (29%) and multifamily residential (23%). Civil/horizontal projects account for 50% or more of their company's US projects for 69% of the engineers.

ROLES

The engineer respondents fall into the following roles at their firms.

- Design Engineer, Project Engineer, Staff Engineer: 30%
- Principal/Executive: 20%
- Project Manager/Project Director: 18%
- BIM/CAD Manager: 7%
- Other roles selected by fewer than five respondents include construction observation/management, IT, business/project analyst and specifications writer.

SIZE OF FIRM

Three size classifications are examined in the analysis in this report for engineers, based on annual revenues.

- Small (Revenues Under $10 Million): 32%
- Midsize ($10 Million to Under $100 Million): 27%
- Large ($100 Million or More): 41%

DEFINITION OF DIGITAL WORKFLOWS

The following definition was provided in the survey: A digital workflow is an automated or integrated construction business process that uses one or more software tools to improve formerly paper-based or manual tasks.

- Internal workflows are construction business processes within just your organization, such as data transfer between the estimating and project management departments of a general contractor.
- External/multicompany workflows are construction business processes between at least two distinct organizations that serve different roles on a construction project.

Contacts & Resources

DODGE EDITORIAL TEAM

Stephen A. Jones leads Dodge Data & Analytics' Industry Insights Research division and is the primary author of this report. He is active in numerous industry organizations and frequently speaks at industry events around the world. Before Dodge, Jones was a vice president with Primavera Systems (now part of Oracle). Prior to that, he was principal and a Board of Directors member with Burt Hill, a major A/E firm (now Stantec). He holds a BA from Johns Hopkins and an MBA from Wharton.
steve.jones@construction.com

Donna Laquidara-Carr currently provides editorial direction, analysis and content for Dodge's SmartMarket Reports. Prior to this position, she worked for nearly 20 years with Dodge's editorial team, where she gained detailed insight into the construction industry. She holds a PhD from Tulane University, an MA from Boston University and a BA from Middlebury College.
donna.laquidara@construction.com

Stephen A. Jones
Senior Director
Industry Insights

Donna Laquidara-Carr
PhD, LEED AP
Research Director
Industry Insights

ADDITIONAL RESOURCES

Trimble

Trimble is an industrial technology company transforming the way the world works by delivering solutions that enable our customers to thrive. Core technologies in positioning, modeling, connectivity and data analytics connect the digital to the physical worlds to improve productivity, quality, safety, transparency and sustainability. From purpose-built products to enterprise lifecycle solutions, Trimble is transforming industries such as agriculture, construction, geospatial and transportation. For more information about Trimble (NASDAQ:TRMB), visit:

www.trimble.com

Dodge Construction Network

Dodge Data & Analytics: Main Website: www.construction.com **Dodge Construction Central:** www.construction.com/products
Market & Competitive Intelligence: www.construction.com/products/construction-market-data **Sweets:** www.construction.com/products/sweets
SmartMarket Reports: www.construction.com/toolkit/reports

■ Design and Construction Intelligence

SmartMarket Brief

www.construction.com

Dodge Data & Analytics SmartMarket Reports™

Get smart about the latest industry trends.

For more information on these and other reports, visit

www.construction.com/toolkit/reports

Dodge Construction Network™