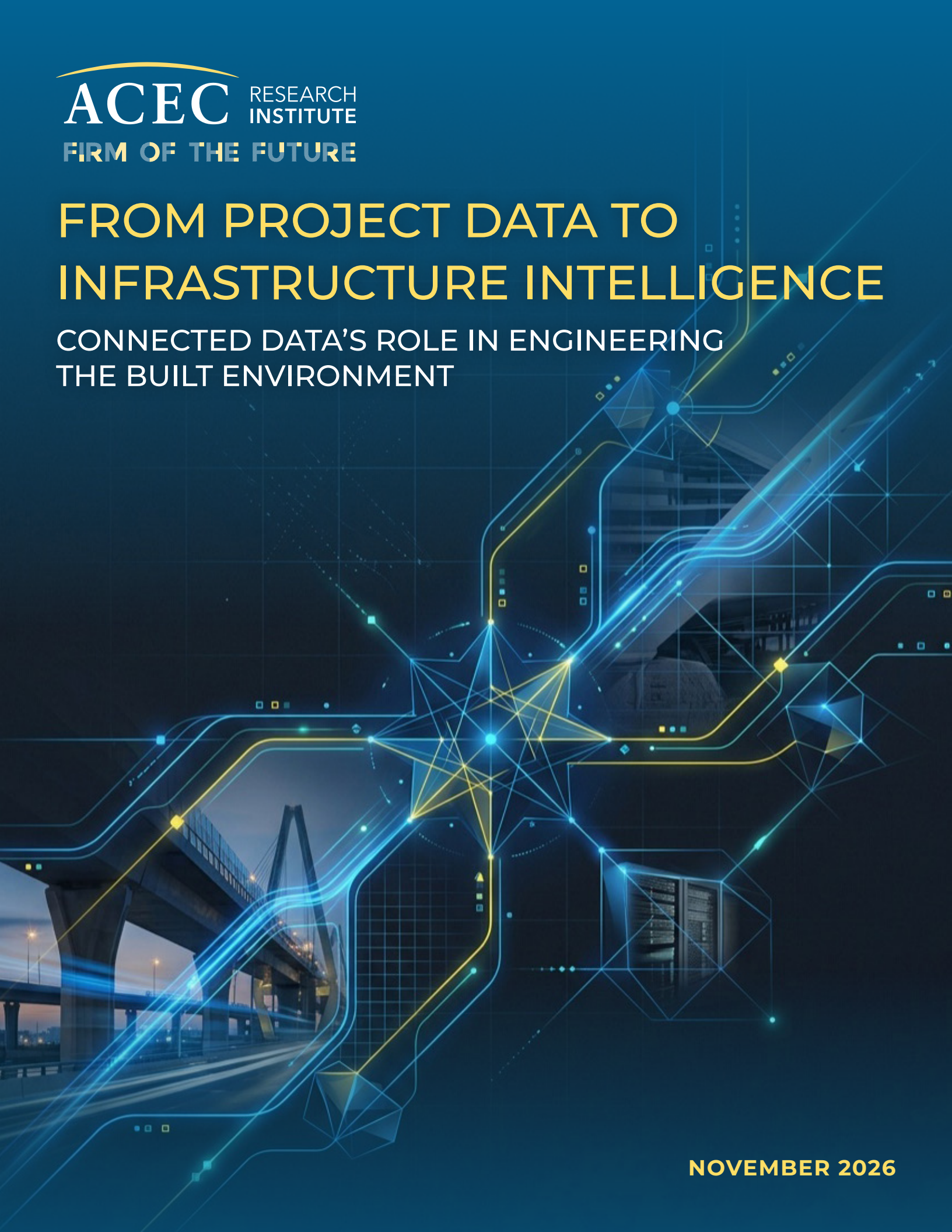
ACEC RESEARCH INSTITUTE

FIRM OF THE FUTURE

FROM PROJECT DATA TO INFRASTRUCTURE INTELLIGENCE

CONNECTED DATA'S ROLE IN ENGINEERING THE BUILT ENVIRONMENT



NOVEMBER 2026

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FOREWORD

The ACEC Research Institute's Connected Data Study examines a growing industry challenge: engineering organizations have more data than ever, yet much of it remains fragmented across projects, disciplines, and systems. Too often, time is spent finding, translating, or recreating data before it can support a decision. That challenge does not end when a project is delivered. Project data must remain accessible, retain its intent, and continue to support decisions for decades.

Friction is not inevitable. Major capital projects are inherently complex, spanning multiple organizations, while the software applications used by project participants are rarely homogeneous. Proprietary formats and vendor restrictions can make exchanging data difficult or impossible. Data should move across a diverse software environment without losing meaning.

This is why an ecosystem built on open standards and interoperability matters. It lets organizations use diverse software applications while maintaining meaning and context across the asset lifecycle, helping to reduce rework, preserve knowledge, identify problems sooner, and make better-informed decisions. Over time, connected data becomes a strategic asset that grows more valuable with reuse.

The value of connected data becomes even more consequential in the age of artificial intelligence. AI can find, analyze, and apply information at scale, but only if it can access it. Without well-governed connected data, AI may go deep on what is readily available while missing data more critical to a project, especially as assets evolve. This interdependence means that AI strategy and data strategy must advance together.

Progress will depend on engineering firms, owners, contractors, and software providers improving how data is governed, exchanged, and, ultimately, connected. Use this report to assess where data may be losing context or usefulness in your environment, compare your experience with the report's findings, and identify where greater openness, interoperability, and governance could help.

The goal is not more data or a uniform software environment. The goal is to reduce friction, giving engineers more time to apply their judgment, creativity, and expertise to the complex challenges infrastructure must solve.

DONNA HUEY
VICE PRESIDENT, MARKET DEVELOPMENT, AMERICAS
BENTLEY SYSTEMS



INTRODUCTION

Engineering firms and infrastructure owners generate enormous amounts of data. Data are created during planning and design, exchanged among engineering disciplines and project partners, used during construction, transferred to infrastructure owners, and generated throughout the operation and maintenance of assets.

Yet much of the data that has been digitized is not yet truly connected.

Project data may reside in different software applications, file structures, models, databases, and organizational systems. Data created for one purpose may need to be reformatted, reconstructed, validated, or manually re-entered before it can be used for another. Context and meaning can be lost as data moves between disciplines, organizations, or project phases. Data that were valuable when originally created may become difficult to locate, interpret, trust, or reuse years later.

The significance of connected data is becoming increasingly apparent for the engineering industry.

Engineering firms and infrastructure owners are increasingly adopting digital-delivery approaches while simultaneously exploring artificial intelligence, automation, digital twins, advanced analytics, and other technologies that depend on accessible and reliable data. Infrastructure owners are also seeking greater value from data across the lifecycle of their assets, extending beyond individual planning, design, or construction projects.

These developments raise a fundamental question: How effectively can data retain its structure, context, meaning, relationships, and usefulness as it moves across the infrastructure ecosystem?

Defining Connected Data

For purposes of this research, connected data refers to project data and information related to infrastructure assets that can be accessed, shared, and used across systems, disciplines, project phases, or organizations while retaining the structure and context necessary to support its intended use. Connected data emphasizes interoperability, the ability for information to move between and be used across different systems and applications, rather than requiring all data to reside in a single system.

Interoperability is fundamental to this definition. Infrastructure delivery involves multiple organizations using different technologies, and infrastructure assets may remain in service far longer than any individual software platform. Connected data therefore does not require all participants to use the same system or technology. It requires data to retain its meaning, provenance, and change history as it moves among different systems, applications, organizations, and phases of the infrastructure lifecycle.

This makes openness an important characteristic of connected data. Open standards and interoperable approaches can help data remain accessible and usable as technologies, project participants, and organizational needs change. The objective is not technological uniformity. It is to preserve the value of data across a diverse and changing infrastructure ecosystem.

Connected data may include information related to planning, design, construction, operation, maintenance, and management of infrastructure assets. For the purpose of this research, it does not include general corporate or administrative data, such as human resources, finance, or other internal business information.

This definition is intentionally broader than the use of any individual technology. Building Information Modeling (BIM), Geographic Information Systems (GIS), common data environments (CDEs), digital twins, APIs, asset-management systems, and other technologies can contribute to a connected data environment, but the presence of any one of them does not necessarily make data connected. The central issue is whether data remain open and interoperable as they are shared, exchanged, and ultimately reused.

Why Connected Data Matters

The value of connected data extends beyond improving the efficiency of individual projects. Infrastructure is planned, designed, built, operated, maintained, and ultimately renewed over decades. During that time, data may pass among numerous engineering firms, contractors, public agencies, technology providers, software applications, and organizational systems.

For data to retain value across that lifecycle, it must be able to move among these different environments without losing the structure, context, meaning, and relationships necessary for future reuse. Interoperability and openness are therefore not simply technical considerations, they are fundamental to whether infrastructure data can remain useful over time.

This is particularly important because infrastructure delivery does not occur within a uniform software environment. Different organizations and disciplines use different applications, platforms, data structures, and workflows. These will also change many times during the life of an infrastructure asset. Connected data therefore cannot depend on every participant using the same software. It depends on data being sufficiently interoperable and open to remain accessible and usable as systems, organizations, and project participants change.

The research shows that this remains a significant challenge. Thirty-nine percent of engineering-firm respondents report significant difficulty maintaining data continuity, context, or usability when moving data between different software applications. Other breakdowns occur when data move between firms and contractors, between engineering firms and clients or owners, across disciplines, and from completed projects into future work. These challenges demonstrate that digitizing data is not the same as creating data that can move reliably across the infrastructure ecosystem.

The implications extend beyond project delivery. Better-connected data can reduce rework, improve quality and decision-making, preserve organizational knowledge, support more effective handoffs to infrastructure owners, and enable greater use of automation and artificial intelligence. Over time, connected data can also allow data generated during operations and maintenance to inform future planning and design, creating a more continuous infrastructure data lifecycle.

About This Research

The ACEC Research Institute undertook this study to better understand the current state and future implications of connected data within engineering firms and infrastructure owners.

The research examines connected data from both the engineering firm and infrastructure owner perspectives. It considers not only the technologies firms use, but also the organizational practices, governance structures, workforce capabilities, client relationships, and business considerations that influence whether data can remain useful as it moves.

The study explores several fundamental questions:

HOW MATURE ARE ENGINEERING FIRMS' CURRENT CONNECTED DATA CAPABILITIES, AND WHERE DOES DATA MOST FREQUENTLY LOSE CONTINUITY OR USABILITY?

WHAT VALUE ARE FIRMS CURRENTLY REALIZING FROM CONNECTED DATA, AND WHERE DO THEY SEE THE GREATEST POTENTIAL FOR FUTURE VALUE?

WHAT ORGANIZATIONAL, TECHNICAL, WORKFORCE, CLIENT, AND CONTRACTUAL BARRIERS LIMIT GREATER INTEROPERABILITY?

HOW ARE INFRASTRUCTURE OWNERS INFLUENCING DIGITAL-DELIVERY REQUIREMENTS, AND HOW DO OWNER AND ENGINEERING-FIRM PERSPECTIVES COMPARE?

HOW IS ARTIFICIAL INTELLIGENCE CHANGING THE IMPORTANCE OF FIRMS' UNDERLYING DATA ENVIRONMENTS?

WHAT CAPABILITIES WILL FIRMS NEED AS CONNECTED DATA BECOMES MORE IMPORTANT?

HOW COULD CONNECTED DATA AFFECT PROJECT DELIVERY, SERVICES, CONTRACTS, PRICING, AND BUSINESS MODELS?

HOW DO ENGINEERING FIRMS EXPECT CONNECTED DATA TO CHANGE THE INDUSTRY OVER THE NEXT FIVE TO TEN YEARS?

The study combines qualitative research with engineering firms and public infrastructure owners and a quantitative survey of ACEC member engineering firms. The qualitative research provides depth and helps illuminate how connected data challenges appear across the infrastructure lifecycle, while the survey provides a broader assessment of engineering firms' current practices, experiences, and expectations.

EXECUTIVE SUMMARY

Engineering firms have made substantial progress digitizing project data, but the next stage of digital transformation is increasingly about what happens to that data after it is created.

This research finds an engineering industry in transition from data that has been digitized to data that retain the structure, context, meaning, relationships, and usability necessary to move across systems, disciplines, organizations, projects, and phases of the infrastructure lifecycle.

That transition depends fundamentally on interoperability. Infrastructure is delivered through a diverse ecosystem of engineering firms, owners, contractors, technology providers, software applications, and organizational systems. Connected data does not require all participants to use the same technology. It requires data to remain usable as they move among different technologies and organizations and as those technologies and organizations change over time.

The research finds that many of the foundations for connected data are already in place. Employees generally can access the project data they need, and many firms have established common structures, naming conventions, and digital environments for managing project data. More advanced capabilities are considerably less developed. Data do not always move readily between applications, relationships and dependencies can be lost, governance remains uneven, and data exchanged across organizational boundaries frequently require additional work before they can be used.

Firms' own assessments reflect some of this progress. Thirty-nine percent of firms rate their overall connected data capabilities as Excellent or Very Good and another 36 percent rate them Good. However, the more detailed findings reveal important limitations even among firms that consider themselves relatively advanced. The industry's challenge is increasingly not whether data exist digitally, but whether they can remain useful when their system, user, organization, project, or purpose changes.

The research also indicates that connected data are becoming more strategically important. Respondents expect connected data to affect AI, workforce capabilities, client relationships, project delivery, contracts, competitive positioning, and potentially the economics of engineering services. The strongest future expectation is that data generated during infrastructure operations and maintenance will increasingly feed back into future planning and design, pointing toward a more continuous data lifecycle rather than a sequence of disconnected projects.

The major findings include:

Digitalization Has Advanced Further Than Interoperability and Connectivity

Engineering firms have established many of the foundations necessary for connected data. Eighty-eight percent report that employees can readily access the project data they need, 78 percent use consistent structures and naming conventions, and 76 percent can readily discover data from previous projects.

More advanced capabilities are less common. Sixty-one percent report that data can move among software applications without significant reconstruction or re-entry, 65 percent say relationships and dependencies among data are preserved, and 44 percent say changes in one dataset or model automatically identify or trigger impacts elsewhere.

The limitations become especially apparent when data must cross technology boundaries. Moving data between different software applications is the most frequently identified area of significant difficulty maintaining continuity, context, or usability, cited by 39 percent of respondents. Only 16 percent of firms currently use open data or exchange standards, 23 percent use APIs to connect systems or applications, and 21 percent use automated data integration between systems.

The pattern suggests that firms have progressed further in making digital data accessible and organized than in making them interoperable across systems and continuously usable across purposes. This distinction is particularly important for infrastructure, where assets may remain in service for decades while the technologies and organizations associated with them change repeatedly.

The Cost of Disconnected Data Often Appears as Routine Friction

The research did not find that disconnected data routinely create catastrophic problems. Instead, much of the cost appears in repeated points of friction embedded throughout normal engineering work.

Thirty-nine percent say searching for, validating, or verifying project data moderately reduces employee productivity, while nine percent say the impact is significant or extreme. The impact is particularly pronounced among firms with less mature connected data environments: 23 percent of firms rating their capabilities Fair or Poor report a significant or extreme productivity impact, compared with six percent of firms rating their capabilities Excellent or Very Good and four percent rating them Good.

External data create additional friction. Fifty-five percent of respondents say their firms sometimes need to substantially rework, remodel, convert, or recreate data received from clients, partners, contractors, or other external organizations, while 19 percent say this occurs often or very often.

Individually, these problems may appear manageable. Collectively, they represent recurring labor devoted to making existing data usable again.

Connected Data Is as Much an Organizational Challenge as a Technology Challenge

The most common barriers to greater use of connected data are not primarily software or technology problems.

Forty-four percent of respondents identify insufficient staff or resources dedicated to connected data initiatives as a barrier, 43 percent identify lack of time or competing project priorities, and 36 percent identify insufficient internal skills or expertise.

Technology still matters. Legacy systems and data, lack of interoperability, lack of common standards, proprietary formats, and limited API access all create constraints. But about nine out of ten firms identify at least one barrier, and the typical firm identifies six. The challenge is multidimensional, involving organizational capacity, technology, employees, clients, contracts, risk, and incentives.

Governance shows a similar pattern. Seventy-one percent of firms have standard data or file structures and 69 percent have standard naming conventions. More advanced governance practices are much less common: 23 percent have data-quality or validation procedures, 19 percent have defined authoritative data sources, 15 percent have designated data owners or stewards, and 14 percent have metadata or classification standards.

As data is reused more widely and becomes an input to automated processes and AI, these governance gaps become increasingly consequential.

The Value Proposition Is Expanding Beyond Efficiency

Connected data already creates value by improving existing engineering work. Among firms reporting Good or better connected data capabilities, 56 percent identify improved project-delivery efficiency as a leading current benefit, followed by QA/QC and earlier problem identification and improved client service (49% each), reduced rework and errors (45%), and preservation and reuse of organizational knowledge (43%).

Looking ahead, firms continue to expect these benefits while identifying opportunities associated with AI (38%), greater engineering automation (31%), project and capital planning, infrastructure lifecycle management, competitive differentiation, and new services or revenue streams.

This suggests that connected data can create value on two levels. It can make current engineering work more efficient, reliable, and reusable while simultaneously creating the data foundation for new technologies, services, and ways of delivering engineering value.

Connected Data Is an Ecosystem Challenge, Not Something Firms Can Solve Alone

Engineering firms operate within an infrastructure ecosystem in which clients, contractors, technology providers, and other participants use different systems, standards, processes, and levels of digital maturity.

Current client requirements remain heavily oriented toward traditional project delivery. Eighty-two percent of respondents say clients request or require traditional 2D/PDF deliverables most or all of the time. By comparison, 13 percent report that frequency for structured project data in addition to documents or models, 12 percent for data formatted for integration into owner systems, and 13 percent for information intended for ongoing operations and maintenance.

The qualitative interviews show that the relationship is more complex than firms being ahead and clients being behind. Some engineering firms describe client requirements as limiting more advanced approaches, while some public infrastructure owners are actively pushing engineering firms toward greater digital sophistication. Different organizations are moving at different speeds.

The infrastructure owner perspective also highlights why interoperability matters. Infrastructure assets may remain in service for decades while the software platforms, engineering firms, contractors, and technology providers associated with them change repeatedly. Infrastructure intelligence therefore cannot depend on every participant using the same technology. It depends on data remaining usable as technology changes.

This is why interoperability and openness are ecosystem issues rather than simply firm-level technology choices. Seventy-four percent of respondents believe open standards and interoperability will be essential to ensuring that infrastructure data remain accessible and usable throughout the asset lifecycle.

AI Is Increasing the Strategic Importance of Firms' Data Environments

AI and connected data are becoming increasingly interdependent.

Fifty-three percent of respondents say poorly structured or fragmented data currently limit their firm's ability to use AI effectively. Sixty-five percent say improving their firm's data environment has become more important because of AI, and 73 percent believe connected data will be essential for their firm to realize the full value of AI.

The findings do not suggest that firms must create perfect data environments before using AI. The qualitative research instead points toward parallel development: firms can deploy AI while simultaneously improving the structure, accessibility, quality, and governance of their data.

AI may, however, expose weaknesses in data environments that were previously easier for employees to work around. An experienced engineer can often recognize outdated data, interpret an inconsistent naming convention, or know which of several sources should be trusted. Automated systems may not possess that tacit organizational knowledge.

AI therefore does not reduce the importance of connected data. For most respondents, it increases it. As a result, AI strategy and data strategy are becoming increasingly difficult to separate.

Firms Expect Connected Data to Require New Capabilities Across the Organization

Only seven percent of respondents say their firms currently have sufficient capabilities across the areas examined in the study.

AI expertise is the most frequently identified capability need at 55 percent, followed by systems integration at 43 percent, digital workflow and process redesign at 42 percent, data strategy and information architecture at 38 percent, and data governance at 36 percent.

Firms expect to build these capabilities through multiple approaches, but developing their existing workforce is the dominant choice. Among firms identifying additional capability needs, 79 percent expect to train or develop existing employees. Forty-nine percent expect to hire employees with needed expertise, 46 percent anticipate using outside consultants or specialists, and 38 percent expect to partner with technology providers.

These findings suggest that connected data capabilities will not remain confined to technology specialists. As data, automation, and AI become more embedded in project delivery, a broader portion of the engineering workforce will need to work effectively within increasingly connected data environments.

Connected Data Could Improve the Economics and Structure of Project Delivery

Respondents anticipate business implications extending well beyond technology.

Eighty-two percent believe traditional project deliverables and milestones will need to evolve as model- and data-based delivery increases. Seventy-five percent believe connected data will allow firms to create more client value with fewer labor hours, while 72 percent believe traditional hourly pricing makes it difficult for firms to capture the value created through connected data.

Data themselves are also becoming part of the commercial relationship. Eighty-one percent expect data ownership and reuse rights to become increasingly important contractual issues, 73 percent believe proprietary data, tools, or digital capabilities will become increasingly important sources of competitive advantage, and 71 percent anticipate opportunities for recurring or lifecycle-based services beyond traditional project delivery.

The study does not establish which new business or pricing models will emerge. It does indicate that many firms expect the underlying conditions of project delivery to change. If firms can create greater value with fewer labor hours and data can continue creating value after an individual project ends, traditional relationships among labor, deliverables, ownership, and compensation may increasingly be tested.

The Long-Term Opportunity Is a Continuous Data Lifecycle

The strongest future expectation in the survey concerns what happens after infrastructure enters operation.

Eighty-five percent of respondents believe data generated during operations and maintenance will increasingly feed back into future planning and design decisions. Eighty-two percent believe traditional project deliverables and milestones will need to evolve, and 81 percent expect data ownership and reuse rights to become increasingly important.

Respondents also see connected data becoming competitively consequential. Seventy-five percent believe firms with mature, connected data capabilities will have a significant competitive advantage, while 65 percent believe those capabilities will become a prerequisite for competing for many engineering projects. Two-thirds, 66 percent, believe connected data will fundamentally change how engineering projects are delivered.

Achieving that future will require data to remain useful as it crosses organizational and technological boundaries. Seventy-four percent believe open standards and interoperability will be essential to ensuring that infrastructure data remain accessible and usable throughout the asset lifecycle.

Taken together, the research points toward a broader transition in how engineering firms think about data. Project data have traditionally been created primarily to support a particular phase, deliverable, or assignment. Connected data creates the possibility of supporting decisions as an asset moves through design, construction, operations, maintenance, and eventually future planning and investment.

> The next transition for the engineering industry is not simply from paper to digital or from digital files to connected data. It is from project data that exists to infrastructure intelligence that becomes increasingly valuable.

RESPONDENT AND FIRM PROFILE

The survey included 251 respondents from ACEC member engineering firms. Participating firms represent a broad range of firm sizes, geographic regions, client orientations, and engineering markets. Respondents themselves were predominantly firm leaders, providing a senior-level perspective on firms' current connected-data capabilities, challenges, and future expectations.

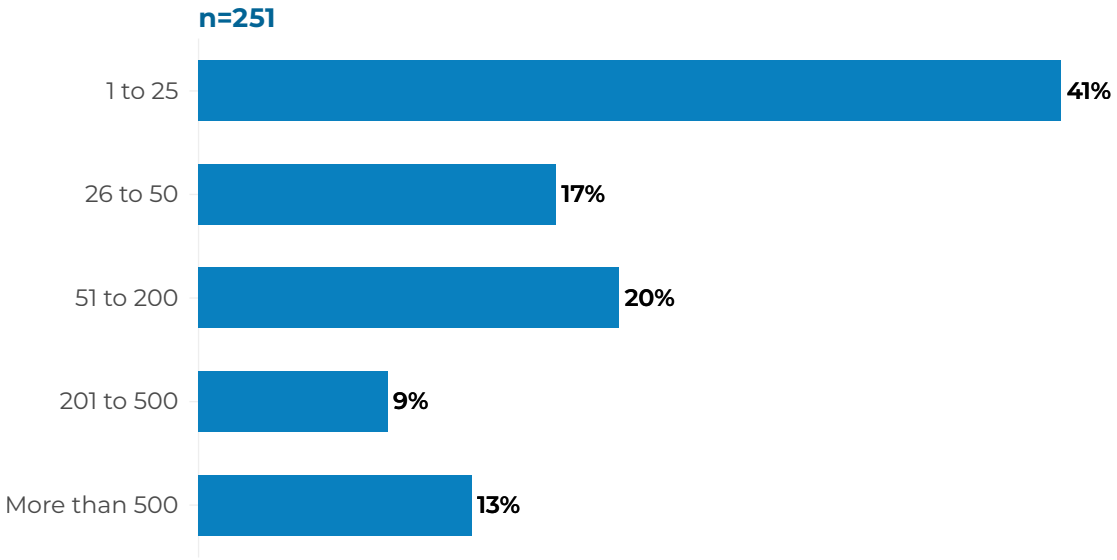
Firms of All Sizes Participated

The sample includes substantial representation from both smaller and larger engineering firms. Forty-one percent of respondents work for firms with 1–25 full-time equivalent employees (FTEs), making this the largest individual firm-size group. Seventeen percent represent firms with 26–50 FTEs, and 20 percent represent firms with 51–200 FTEs.

Larger firms are also well represented. Nine percent of respondents work for firms with 201–500 FTEs, while 13 percent represent firms with more than 500 FTEs.

FIGURE 1

Firm Size of Respondents' Organizations



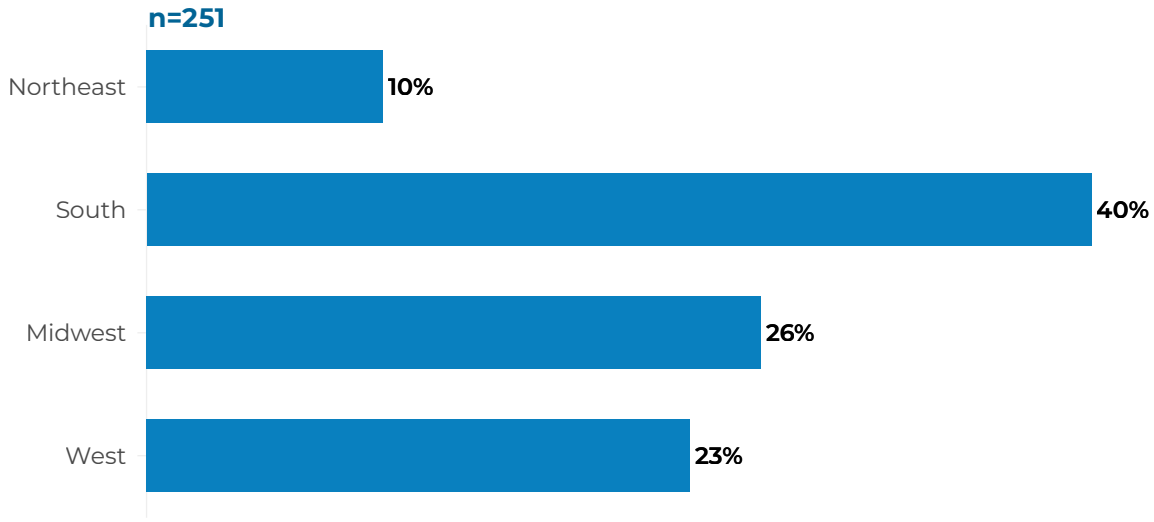
This distribution is particularly important for interpreting the findings that follow. As the report demonstrates, firms of different sizes sometimes assess their overall connected-data maturity similarly, but their underlying technologies, governance structures, capability needs, and approaches to AI can differ considerably.

Respondents Represent Firms Across the United States

Participating firms are geographically diverse. Forty percent are headquartered in the South, 26 percent in the Midwest, 23 percent in the West, and 10 percent in the Northeast.

FIGURE 2

Geographic Distribution of Respondents' Firms



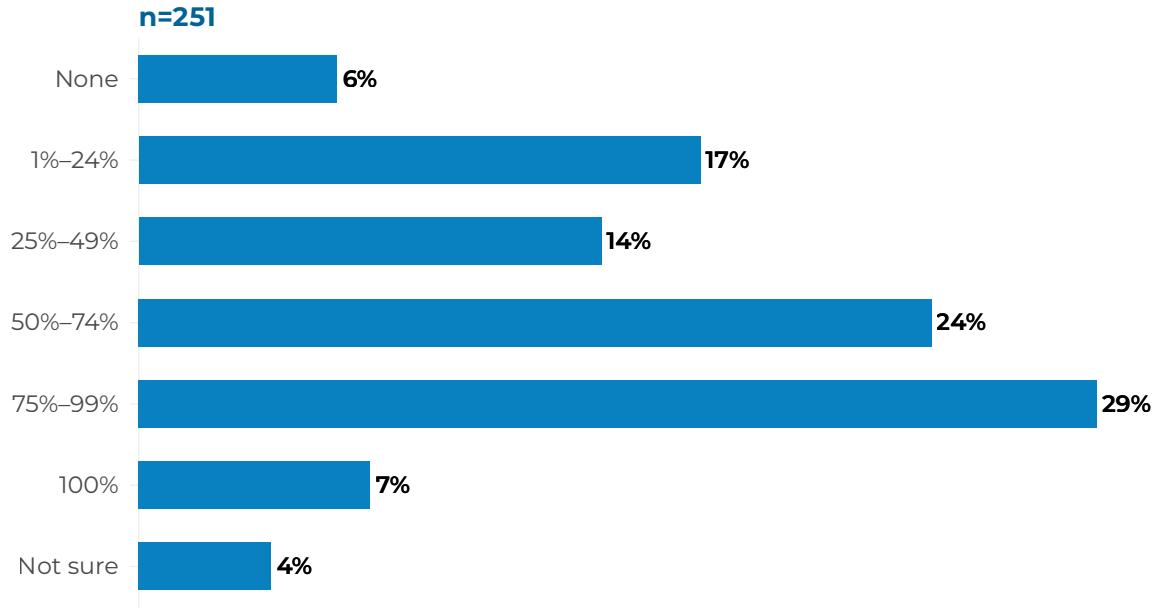
The Sample Includes Both Public- and Private-Sector-Oriented Firms

Respondents also represent firms with substantially different mixes of public- and private-sector work. Twenty-nine percent report that 75 percent–99 percent of their firm's annual revenue comes from public-sector clients, while 24 percent report that public clients account for 50 percent–74 percent of revenue. Seven percent report that all of their firm's revenue comes from public-sector clients.

At the other end of the spectrum, 17 percent report that public-sector clients account for one percent–24 percent of annual revenue, 14 percent report 25 percent–49 percent, and six percent report no public-sector revenue. Four percent are not sure.

FIGURE 3

Percentage of Firm Revenue from Public-Sector Clients



This mix provides an opportunity to examine whether connected data experiences differ between firms that primarily serve public clients and those that primarily serve private clients. However, an important relationship within the sample should be considered when interpreting those comparisons: public-sector orientation and firm size are not independent of one another.

The percentage of revenue derived from public clients generally increases with firm size. Among firms with 1–25 FTEs, 40 percent receive a majority of their revenue from public clients. Among firms with more than 200 FTEs, the percentage increases to 68 percent. Conversely, 15 percent of firms with 1–25 FTEs report no public-sector revenue, compared with none of the firms with more than 200 FTEs.

This relationship is important when interpreting differences elsewhere in the report between firms primarily serving public and private clients. Some differences associated with client orientation may also reflect underlying differences in firm size. The survey's bivariate crosstabs cannot determine how much of a particular difference is independently attributable to client mix versus firm size. Accordingly, public/private differences should be interpreted alongside the corresponding firm-size patterns rather than assumed to result from client orientation alone.

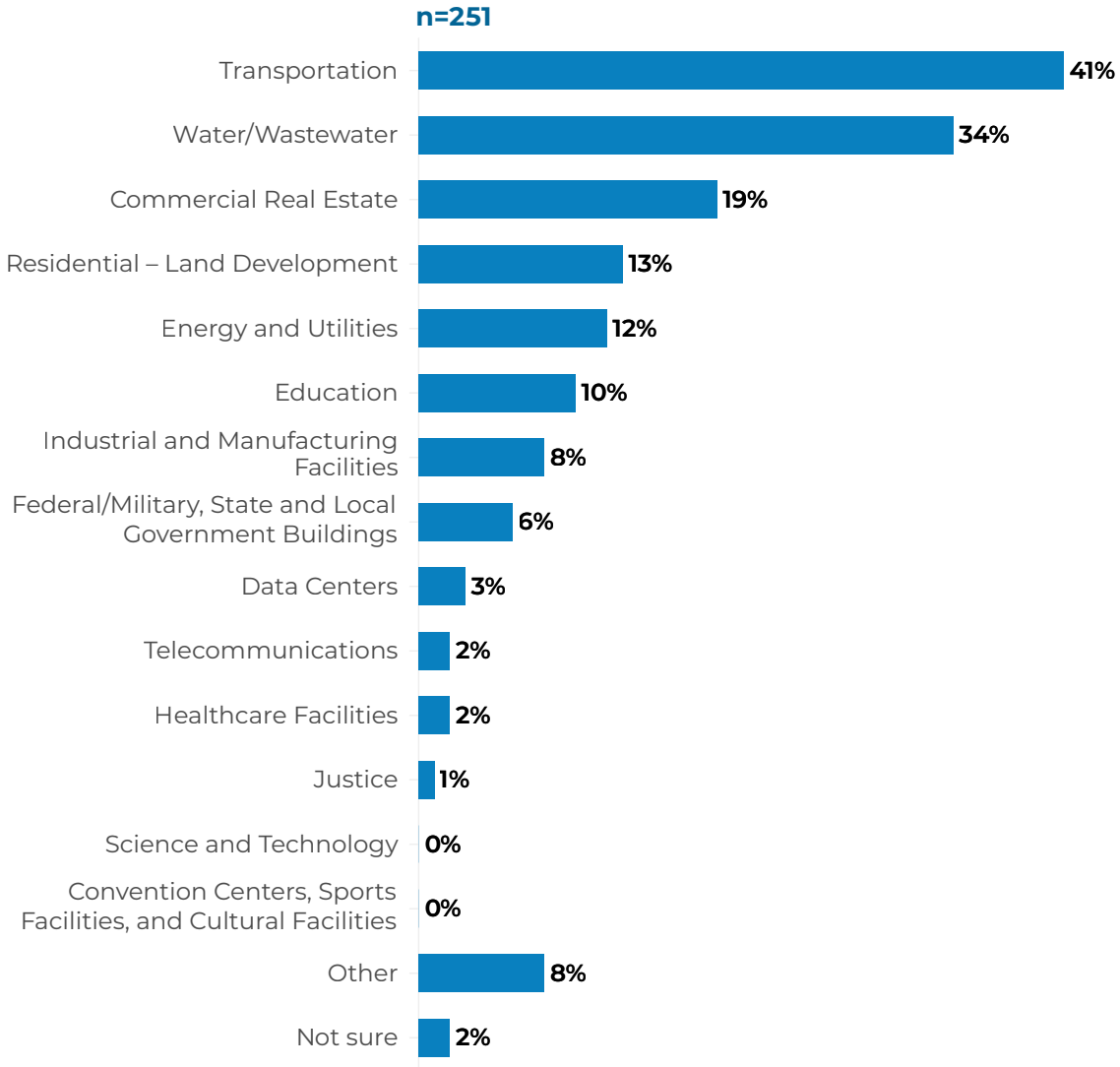
Transportation and Water/Wastewater Are the Most Common Major Markets

Respondents were asked to identify the one or two sectors generating the largest share of their firm's revenue. Transportation is the most frequently identified sector, selected by 41 percent of respondents, followed by Water/Wastewater at 34 percent.

Commercial Real Estate is identified by 19 percent, Residential – Land Development by 13 percent, Energy and Utilities by 12 percent, and Education by 10 percent. Each of the remaining sectors is identified by fewer than 10 percent of respondents.

FIGURE 4

Sectors Generating the Largest Share of Firms' Revenue



The market mix also varies by firm size. Transportation is identified as a major revenue-generating sector by 30 percent of firms with 1–25 FTEs compared with 60 percent of firms with more than 200 FTEs. Water/Wastewater similarly increases from 25 percent among firms with 1–25 FTEs to 47 percent among firms with more than 200 FTEs. By contrast, Commercial Real Estate declines from 22 percent among the smallest firms to nine percent among firms with more than 200 FTEs, while Residential – Land Development declines from 20 percent to two percent.

These differences provide additional context for the relationship between firm size and client orientation. Larger firms in the sample are more heavily represented in markets such as Transportation and Water/Wastewater, where public-sector clients play a substantial role.

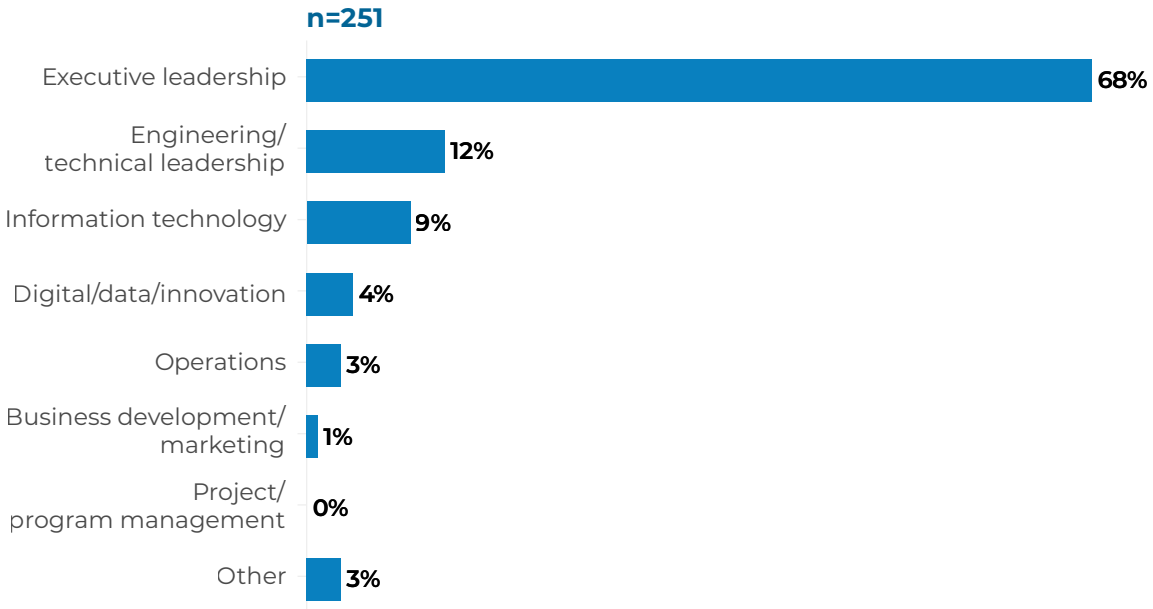
Respondents Are Predominantly Firm Leaders

The survey reached a senior group of respondents. Sixty-eight percent identify their primary role as executive leadership, while another 12 percent are in engineering or technical leadership.

Nine percent work primarily in information technology, four percent in digital, data, or innovation roles, three percent in operations, one percent in business development or marketing, and three percent selected other.

FIGURE 5

Primary Role of Survey Respondents



The respondent profile is useful when interpreting the findings throughout the report. The survey primarily reflects the perspectives of individuals with broad organizational responsibility rather than only those directly responsible for implementing connected data technologies. At the same time, the sample includes engineering, technology, data, innovation, and operational perspectives that provide more direct visibility into firms' technical environments.

THE CURRENT STATE OF CONNECTED DATA

Engineering firms have made considerable progress digitizing project data and making those data available across their organizations. However, the survey findings suggest an important distinction between having digital data and having truly connected data. Basic capabilities such as accessing project data and applying consistent data structures are widespread. More advanced capabilities that allow data to move across different systems, preserve relationships and dependencies, or automatically trigger downstream impacts are considerably less common.

This distinction is important because connected data maturity is not simply a question of whether a firm uses digital tools. It reflects the extent to which data remain accessible, structured, contextualized, interoperable, and usable as they move across systems, disciplines, projects, organizations, and phases of the infrastructure lifecycle.

These distinctions matter because limitations in connected data do not remain confined to a firm's technology environment. When data cannot move reliably between systems or retain their context and relationships, employees may spend additional time locating, validating, converting, recreating, or manually re-entering data. These points of friction can contribute to inefficiency and rework, make coordination and quality control more difficult, and increase the possibility that decisions are made using incomplete, outdated, or incorrectly interpreted data.

Conversely, better-connected data can reduce these sources of friction and support earlier identification of problems, improved QA/QC, better multidisciplinary coordination, reduced rework and errors, and more informed decision-making. The importance of connectivity therefore lies not simply in moving data more efficiently, but in helping engineering professionals use the right data, with the necessary context, when making project and infrastructure decisions.

Most Firms Assess Their Overall Connected Data Capabilities Positively

When asked to assess their firm's overall ability to connect and use data across projects, disciplines, systems, and project lifecycle phases, 39 percent of respondents rated their firm as Excellent or Very Good. Another 36 percent rated their firm as Good, while 25 percent rated their capabilities as Fair or Poor.

These results provide a broad measure of how firms perceive their own connected data capabilities. They should not, however, be interpreted as a comprehensive measure of connected data maturity. Respondents may apply different standards when assessing what it means to connect and use data, and a broad self-assessment cannot capture all the capabilities associated with interoperability, governance, automation, and lifecycle data use.

The more detailed findings throughout this study therefore provide a more complete picture of connected data maturity and help explain the limitations of the broad self-assessment.

Overall self-assessments vary relatively little by firm size. The percentage rating their capabilities Excellent or Very Good ranges from 34 percent to 44 percent across the firm-size groups examined.

That relative consistency is notable because much larger differences emerge when respondents are asked about specific technologies, practices, and capabilities. Firms of different sizes may therefore assess their overall connected data capabilities similarly even when the environments underlying those assessments differ substantially.

Access to Data Is Stronger Than Advanced Connectivity

The more specific measures provide a clearer picture of where firms' connected data environments are relatively mature and where important limitations remain. Eighty-eight percent of respondents agreed that employees can readily access the project data they need. Seventy-eight percent said their firms use consistent data structures and naming conventions, and 76 percent said employees can readily discover relevant data from previous projects.

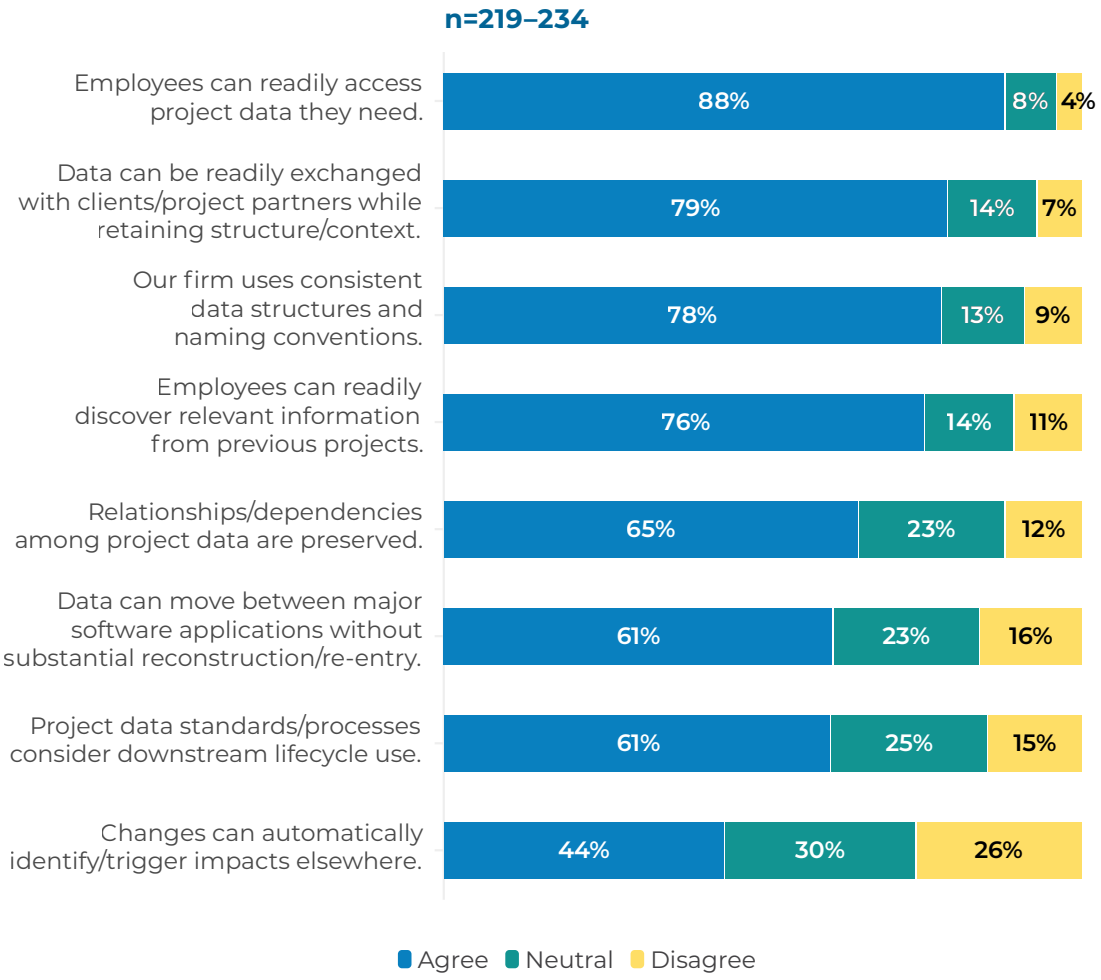
Data exchange with external organizations also appears relatively well established. Seventy-nine percent agreed that data can be readily exchanged with clients and project partners while retaining its structure and context.

The results become less positive as the capabilities move from access and organization toward deeper integration. Sixty-five percent agreed that relationships and dependencies among project data are preserved. Sixty-one percent said data can move between major software applications without substantial reconstruction or re-entry, and 61 percent said their project-data standards and processes consider downstream lifecycle use.

The least common capability was also the most advanced: only 44 percent agreed that changes can automatically identify or trigger impacts elsewhere.

FIGURE 6

Characteristics of Firms' Current Data Environments



Taken together, these results reveal an important progression. Firms are generally strongest at making data accessible and applying consistency to how they are organized. They are less advanced at enabling data to move among software applications and preserving relationships and dependencies. The greatest gap appears when connectivity requires systems to recognize and respond to those relationships automatically.

This progression illustrates why digital maturity and connected data maturity are not synonymous. A firm may have accessible, well-organized digital data, yet still struggle to preserve context, continuity, and usability as that data moves across systems, organizations, and lifecycle phases.

This pattern closely reflects what emerged during the qualitative research. Interviews with engineering firms and public infrastructure owners suggested that the industry has accumulated enormous quantities of digital data, but that accessibility alone does not make data connected. Data becomes progressively more valuable as it becomes discoverable, standardized, connected, relational, and ultimately capable of supporting automated or predictive workflows. Connecting data can improve project efficiency, reduce delays, mitigate risk, and diminish rework.

The quantitative findings provide broader evidence for that distinction. The engineering industry has progressed substantially beyond simply creating digital data, but many firms have not yet reached the point where project data behaves as an integrated, relational data environment.

Current Practices Reflect a Mix of Established and Emerging Capabilities

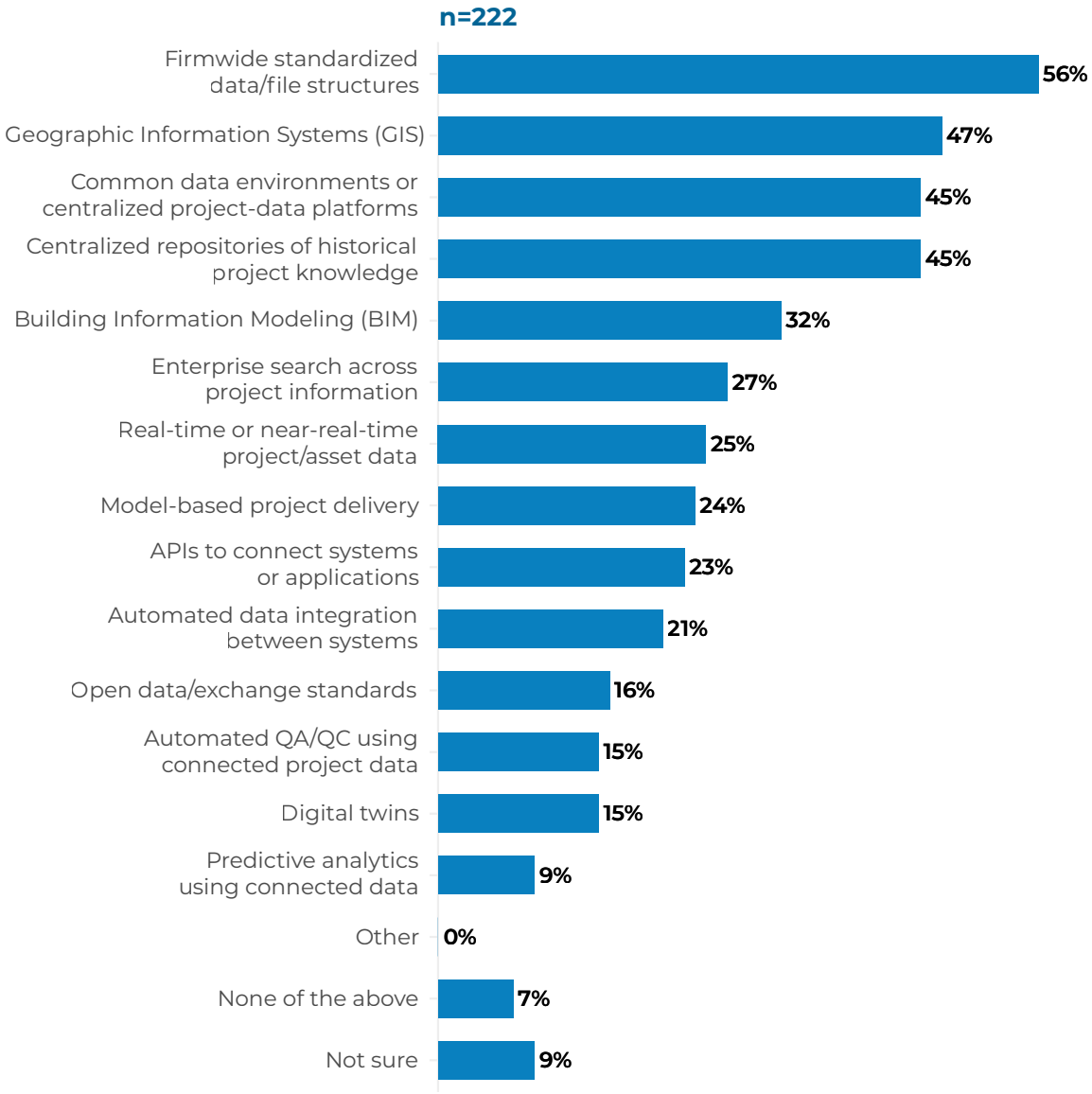
The technologies and practices firms currently use reinforce this picture. The most common connected data practice is firmwide standardized data/file structures, used by 56 percent of respondents. Nearly half use Geographic Information Systems (47%), common data environments or centralized project-data platforms (45%), and centralized repositories of historical project knowledge (45%).

Although related measures elsewhere in the survey show higher percentages for consistent data structures and naming conventions, these questions measure different concepts. This item specifically asks whether firms currently use standardized data/file structures on a firmwide basis.

Technologies that more directly enable integration, automation, or advanced analytics are less common. Twenty-three percent use APIs to connect systems or applications, 21 percent use automated data integration between systems, 16 percent use open data or exchange standards, 15 percent use automated QA/QC using connected project data, and 15 percent use digital twins. Only nine percent currently use predictive analytics based on connected data.

FIGURE 7

Connected Data Practices and Capabilities Currently Used



Firm size begins to matter much more when the analysis moves from overall self-assessment to specific capabilities. For example, common data environments or centralized project-data platforms are used by 36 percent of firms with 1–25 FTEs compared with 71 percent of firms with more than 200 FTEs. BIM is used by 15 percent compared with 61 percent, GIS by 25 percent compared with 82 percent, APIs by six percent compared with 63 percent, and enterprise search across project information by 11 percent compared with 57 percent, respectively.

This creates an important distinction that recurs throughout the research. Firms of different sizes do not assess their overall connected data capabilities very differently, yet the technologies, systems, governance structures, and advanced capabilities underlying those assessments can differ substantially. Broad perceptions of maturity therefore should be interpreted alongside the specific capabilities that make connected data possible.

The Industry Is Between Digitalization and Full Connectivity

Taken together, the findings place the engineering industry between widespread digitalization and full data connectivity. Most firms have established important foundations: project data are generally accessible, many firms use standardized structures, and substantial numbers have adopted technologies that make data easier to share and reuse.

The larger challenge is interoperability. Data must be able to move across applications, organizations, projects, and lifecycle phases while retaining their structure, context, relationships, and usability. The findings show that these more advanced capabilities remain considerably less developed.

> The industry's next challenge is therefore not simply creating more digital data or adopting more technology. It is creating data environments in which the value of those data can survive movement across a diverse and changing infrastructure ecosystem.

WHERE CONNECTIVITY BREAKS DOWN

Even firms with relatively mature digital environments experience points where data lose continuity, context, or usability. These breakdowns occur when data cross boundaries: between software applications, across projects, among organizations and disciplines, and over time.

The survey findings indicate that technology boundaries are the most common trouble spot, reinforcing the importance of interoperability in a connected data environment.

Software Interoperability and Historical Data Are the Most Common Trouble Spots

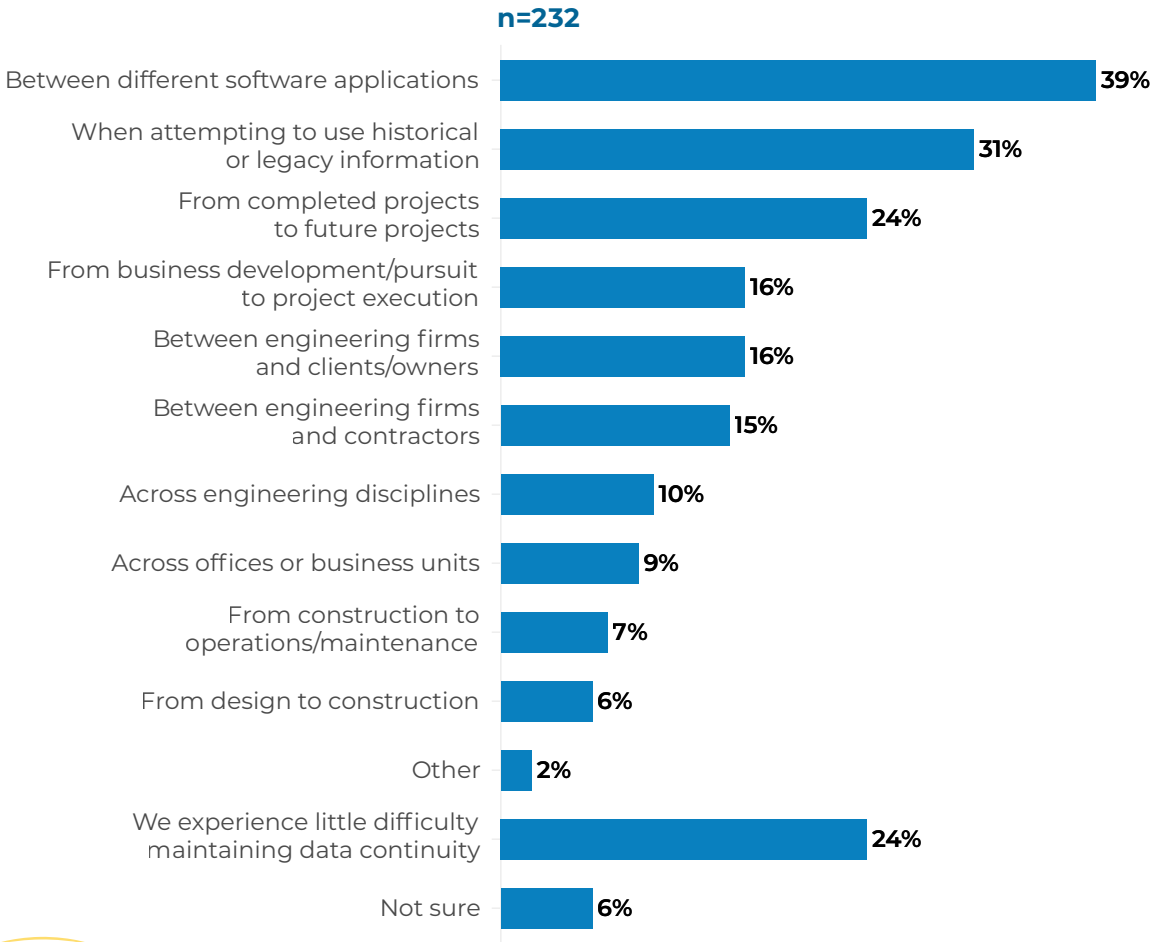
The most frequently identified difficulty is moving data between different software applications, cited by 39 percent of respondents. The second most common challenge involves historical or legacy information, identified by 31 percent, followed by moving information from completed projects to future projects at 24 percent.

Other organizational and project boundaries create difficulties for smaller shares of firms. Sixteen percent report significant difficulty between engineering firms and clients or owners, 15 percent between engineering firms and contractors, 10 percent maintaining data continuity across engineering disciplines, and nine percent identify problems across offices or business units.

Perhaps more surprising are the relatively low percentages associated with two major lifecycle transitions. Only six percent identify design-to-construction as an area of significant difficulty, and seven percent identify construction-to-operations and maintenance.

FIGURE 8

Areas Where Firms Experience Significant Difficulty Maintaining Data Continuity, Context, or Usability



These results reinforce an important finding from the qualitative research. Interviews with engineering firms and public infrastructure owners identified handoffs as recurring points where data can lose context or usefulness. The quantitative findings show that engineering firms experience this problem most broadly when data cross software boundaries and when previously created data must be reused over time.

This is an important distinction. Interoperability is not simply the ability to transfer a file from one application to another. Data must retain enough structure, context, and meaning to remain usable after the transfer. The prominence of software interoperability in the survey suggests that this continuity remains difficult even within an increasingly digital engineering environment.

The quantitative results suggest that engineering firms experience this problem most broadly through software interoperability and the reuse of data over time. The comparatively low percentages for design-to-construction and construction-to-operations should not be interpreted as evidence that those transitions are unimportant. Rather, they indicate that relatively few engineering-firm respondents identify them as significant difficulties within their own firms.

These relatively low percentages should also be interpreted in the context of current client-delivery practices. Traditional 2D/PDF deliverables remain much more common than structured data or data formatted for integration into owner systems. As a result, firms may have fewer opportunities to encounter difficulties associated with more advanced data exchange across organizational boundaries.

That distinction between simply transferring files and retaining structure, context, and meaning to remain useful after transfer is particularly important for construction-to-operations. Public owners interviewed during the qualitative research repeatedly described difficulty moving project data into the systems used to operate and maintain infrastructure. As-built data may be available but not structured so that it can automatically populate asset-management systems, sometimes requiring data to be manually re-entered or interpreted later. Engineering firms and owners may therefore experience different portions of the same data lifecycle, giving them different perspectives on where continuity is most likely to break down.

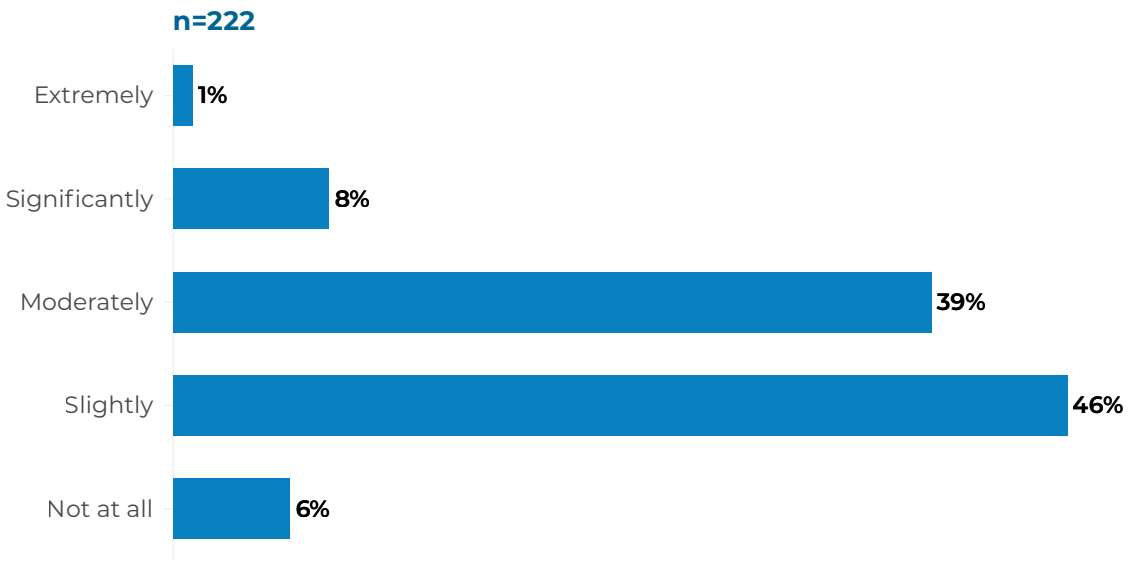
Fragmentation Also Affects Employee Productivity

Disconnected data do not need to result in a major project failure to impose a cost. Employees can lose productive time simply locating information, determining whether it is current and authoritative, or validating it before use.

When asked how much searching for, validating, or verifying project data reduces employee productivity, 39 percent of respondents said it has a moderate impact. Another eight percent described the impact as significant and one percent as extreme. At the other end of the spectrum, six percent said it does not reduce productivity at all, while 46 percent described the impact as slight.

FIGURE 9

Extent to Which Searching for, Validating, or Verifying Project Data Reduces Employee Productivity



The distribution is important. The survey does not suggest that searching for and validating information creates severe productivity losses for most firms. Only nine percent characterize the impact as significant or extreme. Instead, the more common experience is a moderate or slight productivity burden.

The relationship with firms' overall self-assessment is also notable. Twenty-three percent of firms rating their connected data capabilities Fair or Poor report a significant or extreme productivity impact, compared with six percent of firms rating their capabilities Excellent or Very Good and four percent rating them Good. While the broad maturity measure does not capture all dimensions of connected data, this relationship provides additional evidence that firms perceiving themselves as more mature also experience less of the day-to-day friction associated with finding and validating data.

That finding is consistent with an important observation from the qualitative interviews: The cost of fragmented data frequently appears as hidden labor rather than as a discrete expense. Participants described employees searching for documents, reconciling versions, reformatting data, rebuilding models, re-entering data, and reconstructing prior project knowledge. Individually, these activities may not appear transformational. Repeated across projects and employees, however, they represent friction within the engineering workflow.

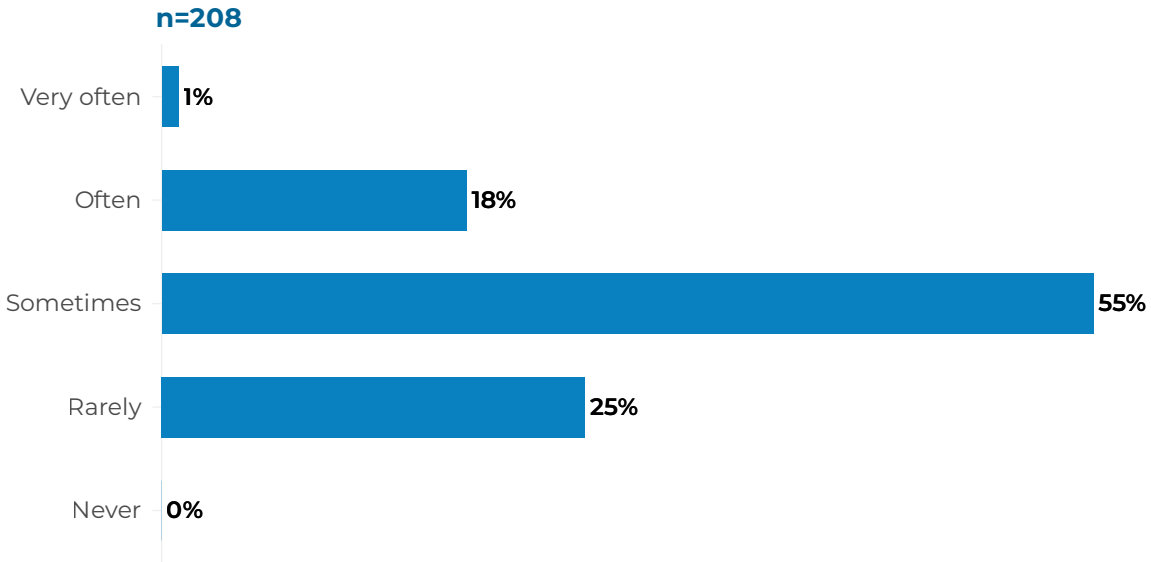
Data Received from Project Partners Frequently Requires Additional Work

External handoffs create another source of friction. When firms receive data from project partners, it is often not immediately usable in the form received.

More than half of respondents, 55 percent, said their firms sometimes need to substantially rework, remodel, convert, or recreate data received from external project partners before their teams can use it effectively. Another 18 percent said this occurs often and one percent said it occurs very often. By comparison, 25 percent said it happens rarely and none said it never occurs. These findings are not necessarily inconsistent with firms' generally positive assessments of their ability to exchange data externally. Data may be successfully exchanged between organizations while still requiring conversion, restructuring, or other substantial work before the recipient can use them.

FIGURE 10

Frequency With Which Firms Must Substantially Rework, Remodel, Convert, or Recreate Data Received From External Project Partners



Again, the dominant pattern is not one of constant failure. Only 19 percent report that substantial rework occurs often or very often. The more significant finding is how uncommon seamless exchange appears to be: no firms say they never need to substantially rework external data before using it.

The qualitative interviews help explain why. Infrastructure projects operate across heterogeneous technology environments, with disciplines, clients, contractors, and other partners using different software, data structures, standards, and vendor ecosystems. The need to recreate or substantially modify externally received data illustrates an important dimension of interoperability. Data may technically be exchanged between organizations without being immediately usable by the recipient. True connectivity therefore requires more than successful transmission. It requires sufficient compatibility, structure, and context for data to support their intended downstream use.

The Problem Is Often Lost Usability, Not Missing Data

Taken together, the findings show that connectivity most often breaks down when data must cross a boundary. Software applications are the most prominent boundary, but difficulties also emerge across organizations, projects, and time.

These breakdowns rarely appear as a single catastrophic failure. More often, they create recurring friction: data must be located, interpreted, validated, converted, reconstructed, or recreated before they can be used. That distinction helps explain why interoperability matters. The objective is not simply to move more data. It is to allow data to cross boundaries without repeatedly losing the context and usability that give them value.

> Making data flow more easily is only part of the solution. Firms also need confidence that the data being connected are organized consistently, sufficiently documented, authoritative, and appropriate for their intended use. That makes data governance and quality fundamental to connected data.

DATA GOVERNANCE AND QUALITY

Connecting data creates value only when firms can trust the data being connected. The survey findings indicate that engineering firms have made considerable progress establishing basic standards for how project data are organized, but more formal data-governance practices remain much less common.

This creates an important maturity gap. Many firms have rules for files and data structures. Far fewer have established the ownership, stewardship, validation, metadata, and enforcement mechanisms needed to manage project data consistently as a strategic organizational asset.

Basic Standards Are Common, but Formal Governance Is Not

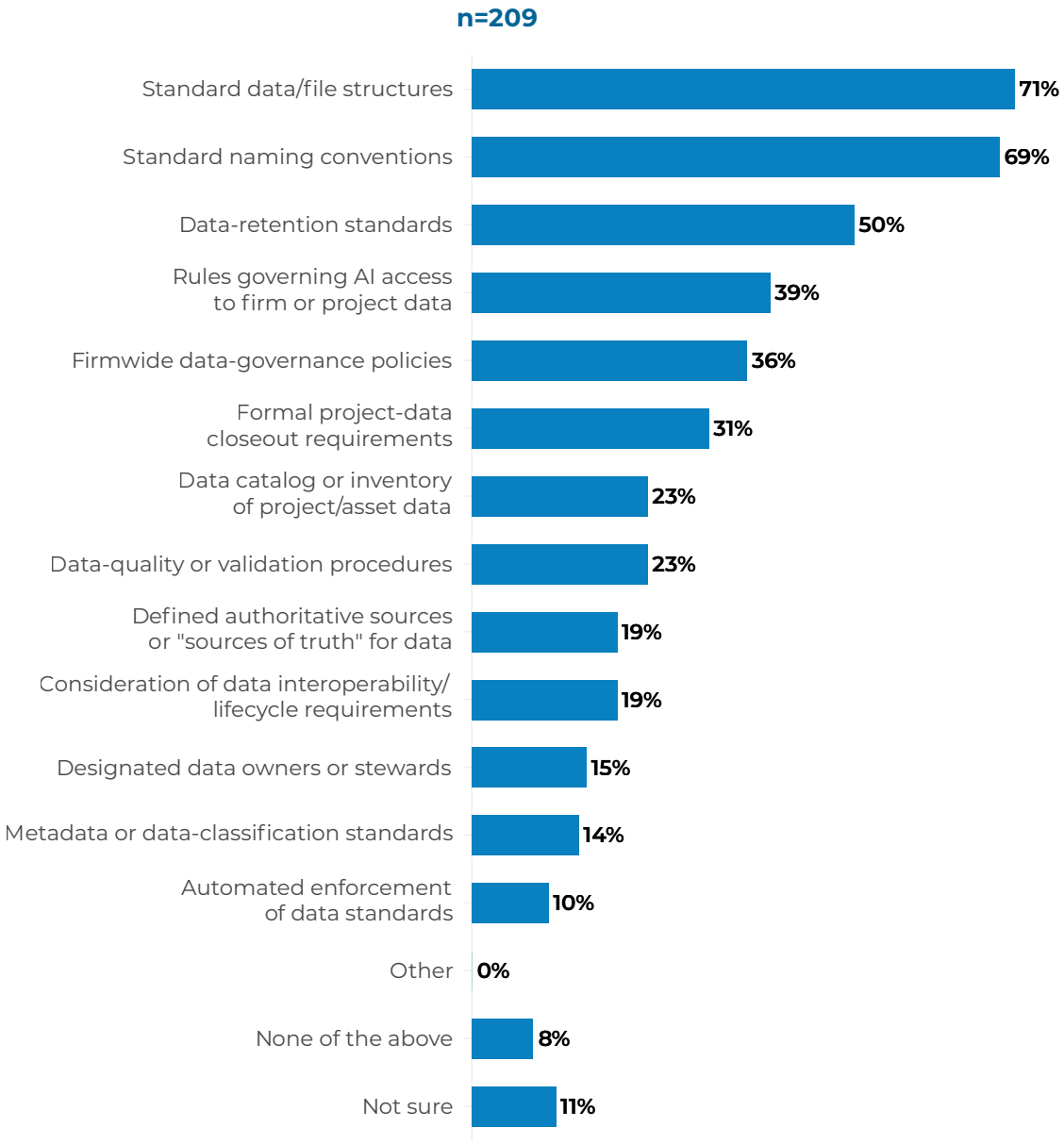
The most widely adopted governance practices focus on standardization. Seventy-one percent of respondents report having standard data or file structures, while 69 percent have standard naming conventions. Data-retention standards are also relatively common, reported by 50 percent.

Adoption falls considerably for more formal governance practices. Thirty-six percent have firmwide data-governance policies, and 31 percent have formal project-data closeout requirements. Only 23 percent report having data-quality or validation procedures, while another 23 percent have a data catalog or inventory.

Practices that establish explicit responsibility and authority over data are even less common. Nineteen percent have defined authoritative sources, 15 percent have designated data owners or stewards, and 14 percent have metadata or classification standards. Automated enforcement of data standards is reported by only 10 percent of respondents.

FIGURE 11

Data Governance Practices Currently in Place



The contrast between the most and least common practices is substantial. Standard data/file structures are reported by 71 percent of respondents, compared with only 15 percent who have designated data owners or stewards and 10 percent who have automated enforcement of data standards. This suggests that many firms have established conventions for organizing data without yet developing the more comprehensive governance systems needed to define who is responsible for data, which data are authoritative, how quality is assured, and whether standards are consistently followed.

The qualitative interviews pointed to the same distinction. Participants described governance not simply as a set of policies, but as an operating capability involving authoritative sources, ownership, stewardship, standards, validation, retention, and accountability.

Larger Firms Have Built More Formal Governance Infrastructure

Firm size is particularly important in this area. While larger and smaller firms did not differ substantially in their overall self-assessment of connected data maturity, their governance practices differ considerably.

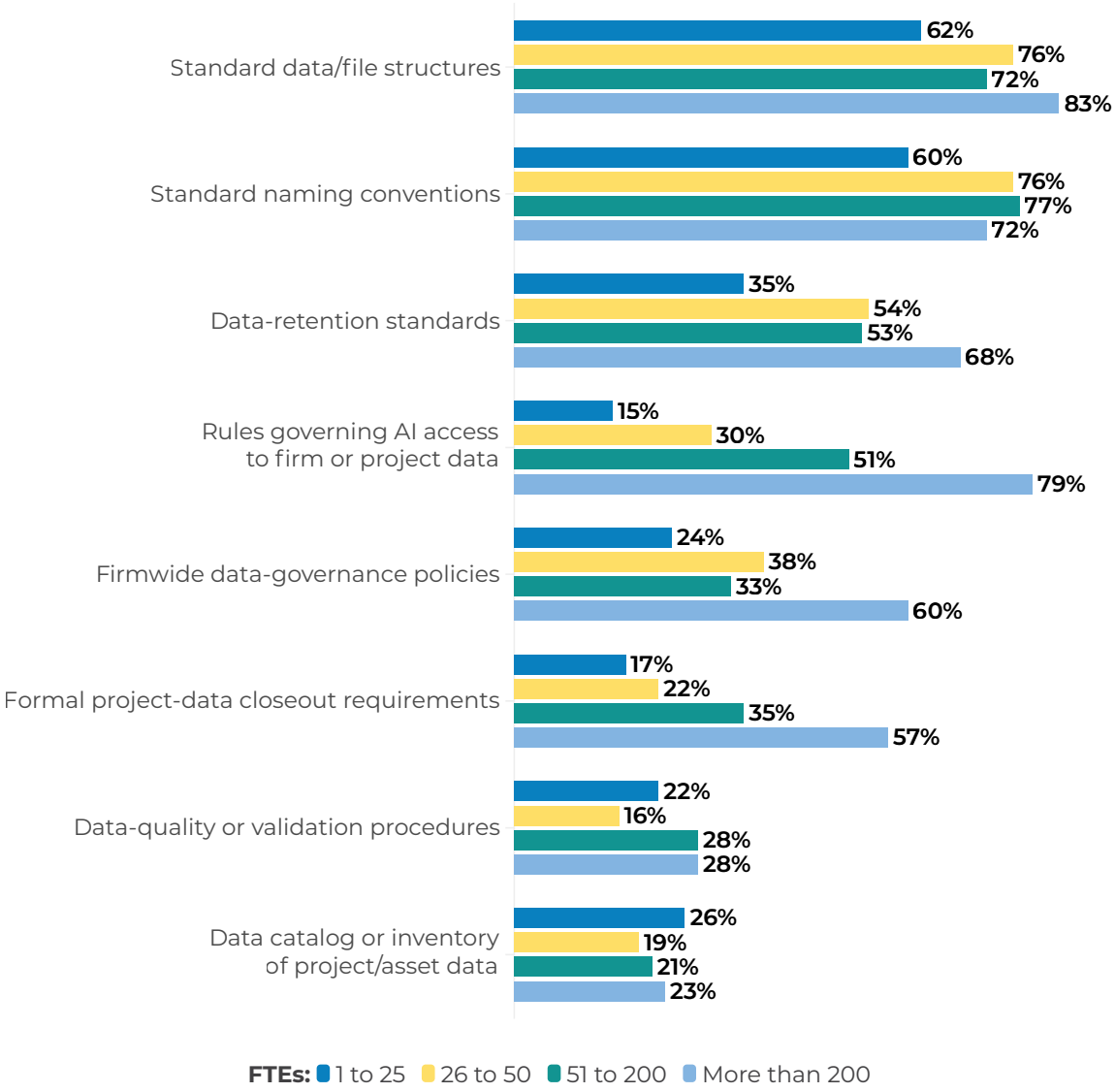
For example, firmwide data-governance policies are in place at 24 percent of firms with 1–25 FTEs compared with 60 percent of firms with more than 200 FTEs. Formal project-data closeout requirements increase from 17 percent among the smallest firms to 57 percent among the largest, while data-retention standards increase from 35 percent to 68 percent.

A similar pattern appears in how firms approach technology decisions. Ten percent of firms with 1–25 FTEs report having requirements to consider interoperability and lifecycle needs when implementing technology, compared with 38 percent of firms with more than 200 FTEs.

The largest difference involves AI. Rules governing AI access to project data are reported by 15 percent of firms with 1–25 FTEs compared with 79 percent of firms with more than 200 FTEs.

FIGURE 12

Selected Data Governance Practices by Firm Size



These differences suggest that scale may matter less for whether a firm recognizes the importance of connected data than for its ability to institutionalize the practices required to manage it. Larger firms have more employees, projects, offices, systems, and data to coordinate, which may create greater need for formal governance. They may also have greater capacity to dedicate personnel and resources to those functions.

The survey does not establish why these differences exist. What it does show is that similarly positive assessments of overall connected data capability can rest on substantially different organizational foundations.

Data Quality Problems Remain Part of the Connected Data Challenge

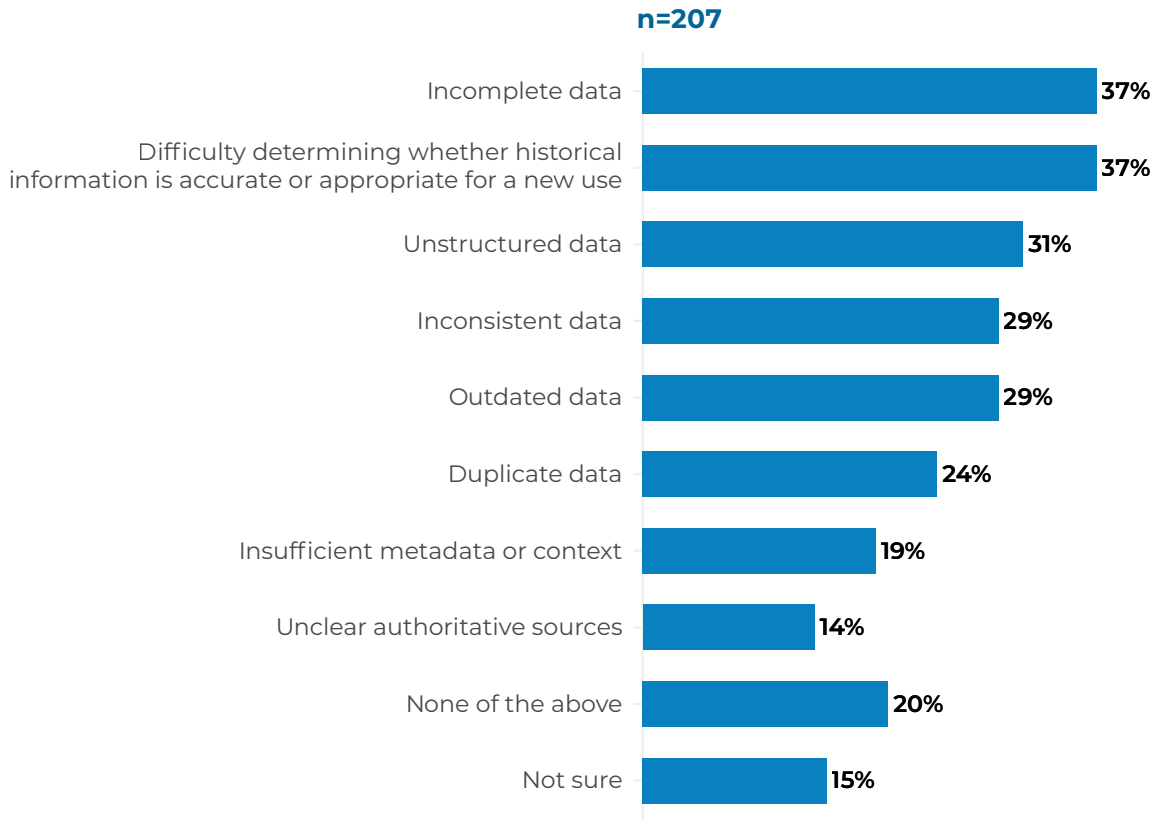
Governance becomes particularly important because firms continue to encounter problems with the quality and consistency of project data. The survey results suggest that no single data-quality issue dominates. Instead, firms face several different problems that can make existing data difficult to connect or reuse.

The most commonly identified issues are incomplete data and difficulty determining whether historical data are accurate or appropriate for a new use, both cited by 37 percent of respondents. Unstructured data follow at 31 percent, while 29 percent identify inconsistent data and outdated data.

Other issues are somewhat less common. Twenty-four percent report duplicate data as a significant limitation, 19 percent cite insufficient metadata or context, and 14 percent identify unclear authoritative sources. At the same time, only 20 percent of respondents report that none of the listed data-quality issues significantly limit their firm's ability to connect or reuse data.

FIGURE 13

Data-Quality Issues That Significantly Limit Firms' Ability to Connect/ Reuse Data



The prominence of historical data is particularly noteworthy because it reinforces a finding from the previous section. Thirty-one percent of respondents identified using historical or legacy data as an area where their firm experiences significant difficulty maintaining data continuity, context, or usability. The figure above helps explain part of that challenge: even when historical data can be located, firms may still need to determine whether it is sufficiently accurate, current, and appropriate to support a new use.

The results also illustrate why greater connectivity alone cannot solve the industry's data challenges. For example, 37 percent of firms report significant limitations from incomplete data, 31 percent from unstructured data, and 29 percent from inconsistent data. Making those data more readily accessible does not necessarily make them more useful. In some circumstances, greater connectivity could simply allow deficient data to travel more easily through the organization or project ecosystem.

This was a recurring concern during the qualitative research. Participants emphasized that connecting unreliable data does not solve the underlying problem. Data need sufficient structure, context, quality, and governance to remain trustworthy when they are reused by another employee, organization, software application, or automated process.

That issue becomes increasingly consequential as firms move toward AI and automation. Data that were once interpreted by an engineer within the context of a particular project may eventually be accessed automatically by systems that depend on consistent structure and reliable underlying data. Governance therefore becomes part of the infrastructure required for more advanced connected data capabilities, rather than simply an administrative function.

Governance Is Becoming a Strategic Capability

The findings suggest a progression similar to the broader connected data maturity pattern identified earlier in the report. Firms have made the greatest progress on practices that organize data for current use, particularly standardized structures and naming conventions. They have made less progress on practices that allow data to be governed consistently across projects, systems, time, and organizational boundaries.

This matters because the potential uses of project data are expanding. Data originally created to complete a project may later support another project, populate an owner's asset-management system, inform an AI application, enable an automated workflow, or contribute to a new digital service. The qualitative research found that both engineering firms and public owners increasingly view data as an asset whose usefulness can extend well beyond the purpose for which it was originally created.

As that transition occurs, firms will need more than standards governing where files are stored or how they are named. They will increasingly need mechanisms for establishing quality, authority, ownership, stewardship, and appropriate reuse.

> The more valuable data become beyond the project on which they were created, the more important it becomes to manage them as an enduring organizational asset.

THE VALUE OF CONNECTED DATA

The survey findings indicate that connected data already creates tangible value for engineering firms, particularly through improvements to project delivery, quality, client service, and the reuse of organizational knowledge. Looking ahead, firms continue to expect these core benefits, but their expectations also extend into areas such as AI, automation, lifecycle management, and new sources of competitive value.

The pattern suggests that the value proposition for connected data is broadening. Today, firms most often associate connected data with making existing work better. Over the next three to five years, they also see it as an enabling capability for new ways of working.

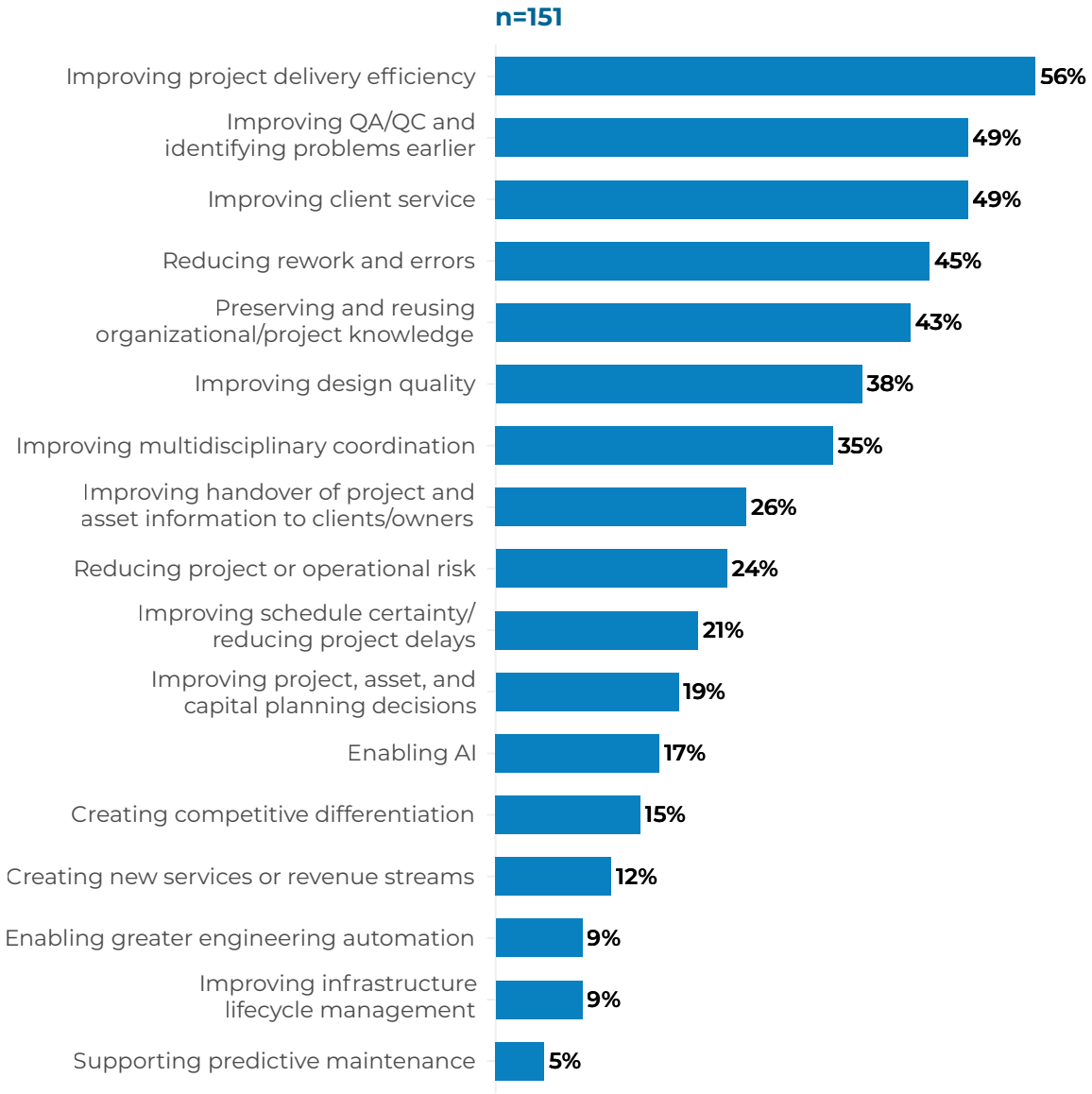
Current Value Is Concentrated in Project Delivery and Quality

Respondents whose firms rated their overall connected data capabilities as Good, Very Good, or Excellent were asked to identify the greatest benefits their firms currently realize from connected data. Among the respondents who answered the question, 56 percent selected improved project-delivery efficiency, making it the most frequently identified current benefit.

Improving QA/QC and identifying problems earlier and improving client service followed at 49 percent each. Forty-five percent identified reducing rework and errors, while 43 percent selected preserving and reusing organizational or project knowledge. Improving design quality was selected by 38 percent, and 35 percent identified improved multidisciplinary coordination.

FIGURE 14

Greatest Benefits Firms Currently Realize from Connected Data



The results indicate that firms already realizing value from connected data tend to experience that value close to the core engineering and project-delivery process. Five of the six most frequently selected benefits involve efficiency, quality, rework, knowledge, or client service.

By comparison, benefits associated with more advanced or emerging applications are currently less widespread. Seventeen percent identify enabling AI as one of the greatest benefits they currently realize, 15 percent identify competitive differentiation, and 12 percent identify creating new services or revenue streams. Only nine percent identify greater engineering automation, while another nine percent identify improved infrastructure lifecycle management.

The distinction is important. Connected data is not simply a future concept for engineering firms. More mature firms are already realizing meaningful operational benefits. However, the benefits currently experienced most widely are primarily improvements to existing project delivery rather than fundamentally new business models or technology-enabled services.

The qualitative interviews provide additional context. Participants described connected data as a way to reduce duplicated work, identify problems earlier, improve QA/QC, retain organizational knowledge, and make better decisions with data that already exist. They also emphasized that the value often comes from eliminating relatively small points of friction that recur throughout a project rather than from one dramatic improvement.

Firms Expect the Value Proposition to Broaden

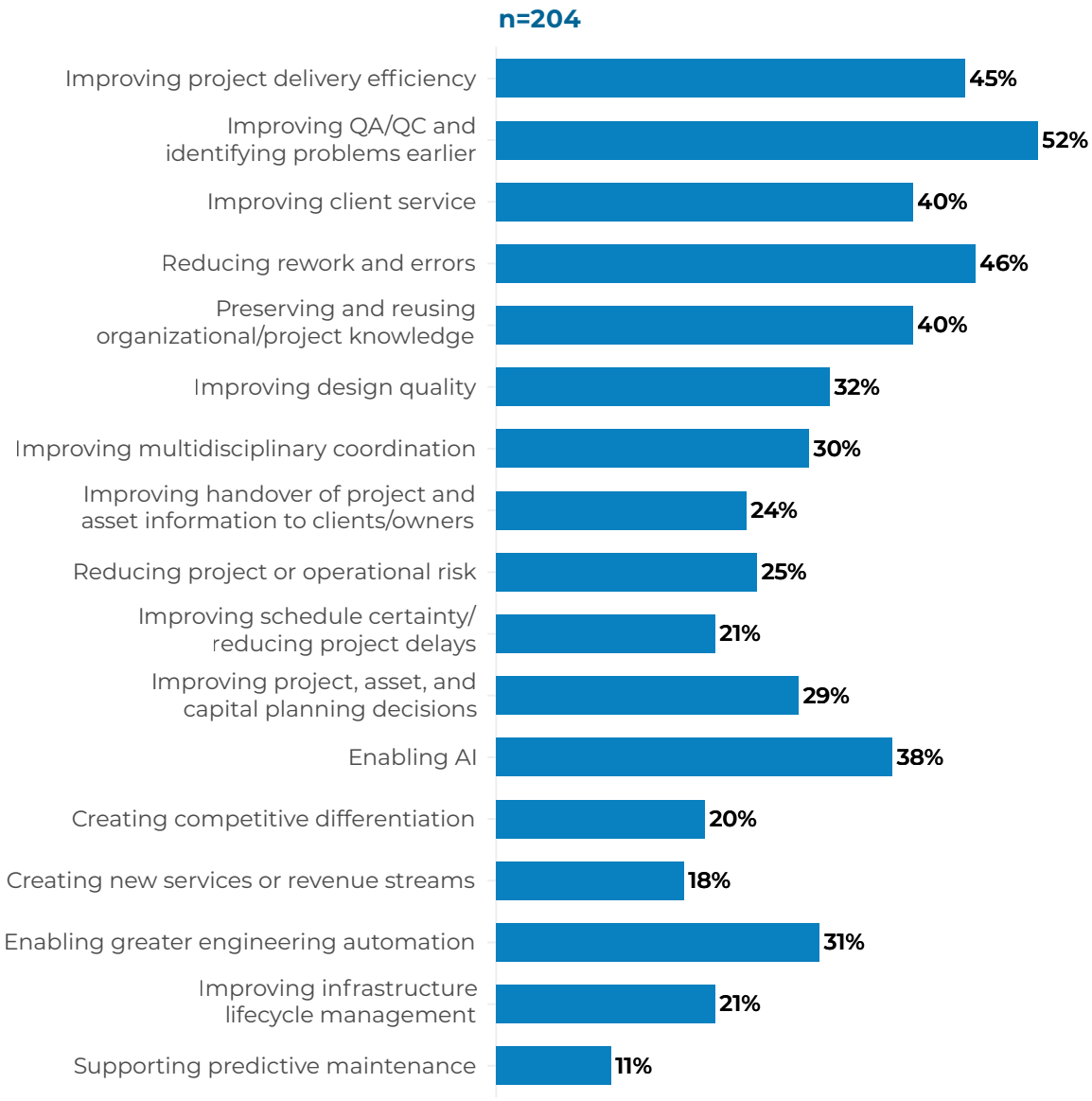
When all respondents were asked where connected data has the greatest potential to create value over the next three to five years, many of the traditional project-delivery benefits remained prominent. Improving QA/QC and identifying problems earlier was selected by 52 percent, reducing rework and errors by 46 percent, and improving project-delivery efficiency by 45 percent.

At the same time, several emerging applications become much more prominent in the future-value results. Thirty-eight percent identify enabling AI as an area with significant potential, and 31 percent identify greater engineering automation. Twenty-nine percent identify improved project, asset, and capital-planning decisions, while 21 percent identify improved infrastructure lifecycle management. Competitive differentiation is selected by 20 percent, and 18 percent identify creating new services or revenue streams.

FIGURE 15

Areas Where Connected Data Has the Greatest Potential to Create Value Over the Next Three to Five Years

(In Same Order as Figure 14 for Ease of Comparison)



Preserving and reusing organizational or project knowledge and improving client service also remain important, each selected by 40 percent of respondents. These results suggest that firms do not expect emerging applications to replace the operational value of connected data. Rather, the range of potential applications is expanding.

The overall pattern is informative. Current value is concentrated most heavily in project delivery, quality, client service, rework reduction, and knowledge reuse. The future results retain those benefits while also placing AI and engineering automation among the more frequently identified opportunities.

Connected Data Is Becoming an Enabler for AI and Automation

The emergence of AI and automation in the future-value results is particularly significant. Enabling AI is identified by 38 percent of respondents as one of the areas where connected data has the greatest potential to create value over the next three to five years. Greater engineering automation is identified by 31 percent.

These findings suggest that firms increasingly see connected data not simply as a data-management objective, but as infrastructure required for other technologies to deliver value.

That relationship emerged repeatedly in the qualitative interviews. Participants generally did not view connected data as a prerequisite that must be fully solved before firms can pursue AI. Instead, they described the two as mutually reinforcing. AI can help firms organize, analyze, and extract value from data, while better structured and better connected data improve the reliability and usefulness of AI applications.

The implication is important. A firm's investments in data structure, governance, interoperability, and knowledge preservation may generate benefits beyond the immediate connected data use case. They can also create a stronger foundation for technologies that depend on accessible, contextualized, and trustworthy data.

The report will return to this relationship in greater detail in the section on connected data and AI.

The Longer-Term Opportunity Extends Beyond Individual Projects

The future-value findings also begin to shift the focus beyond the delivery of an individual project. Twenty-nine percent of respondents identify improved project, asset, and capital-planning decisions as one of the greatest potential sources of value, while 21 percent identify infrastructure lifecycle management.

These percentages remain below those associated with QA/QC, rework reduction, and project-delivery efficiency. They nevertheless point toward a broader conception of what engineering data can support.

Public owners interviewed during the qualitative phase were particularly important in identifying this longer-term value. Owners described opportunities to carry useful data from planning and design into construction, operations, maintenance, asset management, and future capital planning. They also described the reverse flow: data generated during operation and maintenance can improve future planning and design decisions.

That lifecycle perspective changes the potential value of project data. Data created during design may have value well after the design assignment is complete, provided that their structure, context, and usability survive the transition to subsequent systems and organizations.

This helps explain why preserving and reusing organizational or project knowledge remains one of the more frequently identified future benefits at 40 percent. Connected data can allow data created for one purpose to contribute to decisions that occur later, whether on the same asset, on a future project, or elsewhere within the firm.

Operational Value May Be the Foundation for Strategic Value

Taken together, the findings suggest that the value of connected data is developing in layers. The strongest evidence today is operational: firms use connected data to improve project-delivery efficiency, QA/QC, client service, reduce rework and errors, and preserve knowledge.

The future opportunity is broader. Firms continue to expect those operational benefits, but they also see connected data supporting AI, automation, planning, lifecycle management, competitive differentiation, and new services or revenue streams.

The survey does not indicate that these more strategic applications have displaced traditional project-delivery benefits. Improving QA/QC and identifying problems earlier remains the most frequently selected future opportunity at 52 percent, while reducing rework and errors is selected by 46 percent and improving project-delivery efficiency by 45 percent.

Instead, the findings suggest that connected data may create strategic value because it first creates a better data environment for engineering work. Reliable, reusable, contextualized data can help firms reduce rework, identify problems earlier, improve quality and coordination, and make better use of existing knowledge. The same data environment can also become the foundation for tomorrow's automation, AI applications, lifecycle services, and new ways of creating value for clients.

Realizing the broader potential of connected data will require firms to overcome more than technical limitations. Resources, skills, organizational priorities, change management, and external constraints all influence how quickly firms can move from potential value to broader adoption.

BARRIERS TO GREATER CONNECTIVITY

The survey findings suggest that the principal barriers to greater use of connected data are not purely technological. Firms certainly face interoperability, legacy-system, cybersecurity, and standards challenges, but the most frequently identified obstacles involve organizational capacity: insufficient resources, competing priorities, internal skills, and employee adoption.

This distinction matters because it changes the nature of the challenge. Greater connectivity will require continued technology investment, but technology alone is unlikely to move firms substantially forward if they lack the people, time, expertise, and organizational commitment needed to implement it.

Resources and Competing Priorities Are the Most Common Barriers

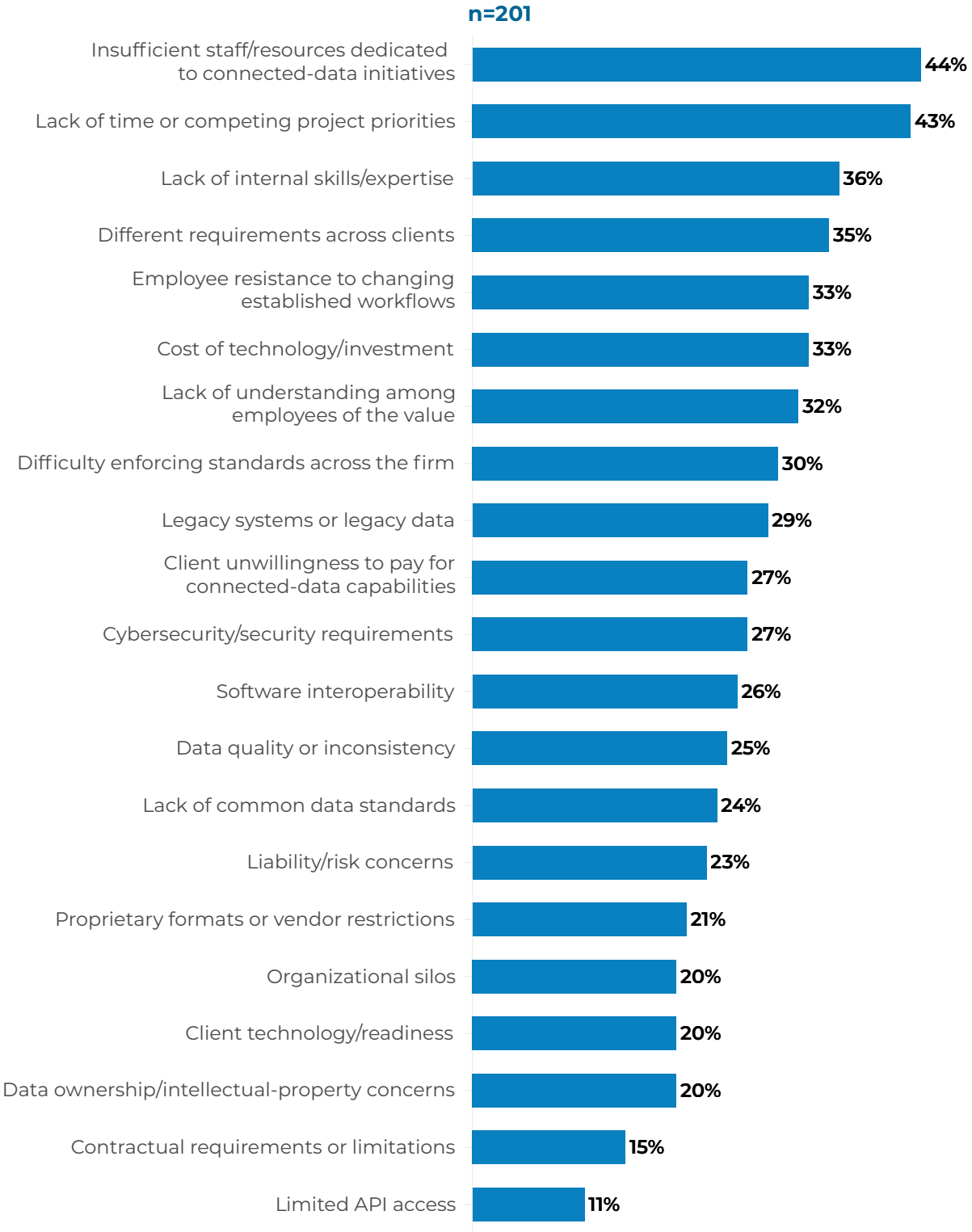
When respondents were asked which factors limit their firm's ability to make greater use of connected data, 44 percent identified insufficient staff or resources dedicated to connected data initiatives, making it the most frequently cited barrier. Nearly as many, 43 percent, identified lack of time or competing project priorities.

Internal capabilities and organizational change followed closely. Thirty-six percent identified lack of internal skills or expertise, 33 percent cited employee resistance to changing established workflows, and 32 percent identified a lack of understanding among employees about the value or benefits of connected data.

Cost is also an important consideration, with 33 percent identifying the cost of technology or investment as a barrier. However, the fact that insufficient dedicated resources and competing priorities rank above technology cost suggests that the challenge is not simply finding money to purchase new systems. Firms also need the organizational capacity to implement and sustain change.

FIGURE 16

Factors Limiting Firms' Ability to Make Greater Use of Connected Data



Technology-related barriers remain significant. Twenty-nine percent identify legacy systems or legacy data, 26 percent software interoperability, and 24 percent lack of common data standards. Twenty-one percent identify proprietary formats or vendor restrictions, while 11 percent cite limited API access.

External and risk-related factors also contribute. Different requirements across clients are identified by 35 percent of respondents, client unwillingness to pay for connected data capabilities by 27 percent, cybersecurity or security requirements by 27 percent, and liability or risk concerns by 23 percent. Client technology or readiness and data ownership or intellectual-property concerns are each identified by 20 percent.

The breadth of these results is important. Although there is no single barrier that a majority of firms identify, about nine out of ten firms cite at least one barrier. In fact, the number of barriers cited by the typical firm is six. Firms face a combination of organizational, technical, client, contractual, and risk-related constraints. Interoperability therefore cannot be separated entirely from the broader organizational environment in which it must be achieved.

This aligns closely with the qualitative interviews. Participants frequently described connected data initiatives as competing with immediate project-delivery demands. Even when firms recognized the potential value, implementation required employees to develop standards, restructure workflows, clean or organize existing data, coordinate across departments, and change established practices. Those activities require resources today even when much of the value may be realized later.

Connected Data Competes with the Immediate Demands of Project Delivery

The prominence of time and resource constraints points to a fundamental implementation problem for engineering firms. Project-based organizations are structured to deliver work for clients, and employees' time is closely connected to project schedules, utilization, and revenue.

Connected data initiatives may require work whose benefits extend across many future projects rather than being captured by the project currently paying for the employee's time. Creating reusable data structures, developing governance practices, improving interoperability, documenting data for future use, or redesigning workflows can therefore compete with immediate project demands.

This tension also emerged during the qualitative interviews. Participants described situations in which one project team or lifecycle participant incurs the effort required to structure, classify, or prepare data, while much of the benefit accrues later to another project, another department, another organization, or an infrastructure owner.

The survey findings provide quantitative evidence of the organizational consequences of that tension. Forty-four percent of respondents identify insufficient dedicated staff or resources as a barrier, and 43 percent identify lack of time or competing project priorities.

This suggests that the business case for connected data cannot focus solely on the ultimate value created. Firms must also address who has the time, responsibility, and resources to do the work required to create that value.

Change Management Is Part of the Connected Data Challenge

The findings also indicate that greater connectivity requires changes in how people work. Thirty-three percent of respondents identify employee resistance to changing established workflows as a barrier. Similarly, 32 percent identify lack of understanding among employees about the value or benefits of connected data as a barrier.

These findings help explain why technology deployment alone may produce limited results. New platforms and standards can be introduced centrally, but their effectiveness ultimately depends on whether employees consistently use them, enter data in the required ways, follow new processes, and understand why those practices matter.

The challenge becomes more complex because the benefits may not be immediately visible to the person being asked to change. An employee may be asked to provide additional structure, metadata, or documentation so that someone else can find and reuse the data months or years later. An engineering team may be asked to alter a familiar workflow to improve interoperability with another system or lifecycle phase.

In that sense, connected data adoption is partly a change-management problem. Firms need not only technical standards but also sufficient understanding, incentives, training, accountability, and leadership support to make those standards part of normal project delivery.

External Requirements Add Another Layer of Complexity

Although the largest barriers are primarily internal, firms do not control the entire environment in which project data are created and exchanged. Different requirements across clients are identified as a barrier by 35 percent of respondents.

That finding is particularly significant for engineering firms serving multiple infrastructure owners. A firm may develop its own standards and connected data practices but still need to adapt to different client systems, formats, deliverable requirements, and levels of digital maturity.

The qualitative research showed that this relationship works in both directions. Engineering firms sometimes described clients as slowing adoption through inconsistent requirements, traditional deliverables, or limited technology capabilities. Public owners, however, sometimes described themselves as moving aggressively toward more connected approaches and expecting engineering firms to help them implement those changes.

The result is not a simple divide between technologically advanced firms and less advanced clients. It is an uneven ecosystem in which different organizations are moving at different speeds, using different systems, and operating under different requirements.

That finding deserves deeper examination because engineering firms cannot achieve lifecycle connectivity entirely within their own organizational boundaries.

> Connected data is ultimately an ecosystem challenge. Even a highly capable engineering firm depends on clients, contractors, technology providers, and other project participants to preserve the usefulness of data as they move across organizational and technological boundaries.

CLIENTS, OWNERS, AND THE DIGITAL-DELIVERY ECOSYSTEM

Engineering firms can improve their own data environments, governance practices, and technical capabilities, but connected data ultimately extends beyond the boundaries of any single organization. Project data move among engineering firms, public and private owners, contractors, technology platforms, and eventually the organizations responsible for operating and maintaining infrastructure. Maintaining the usefulness of those data therefore depends not only on what happens within individual organizations, but also on what happens when data cross organizational and technological boundaries.

The survey findings show a substantial gap between what connected data can enable and what clients currently request, require, and are prepared to support. At the same time, the public-owner interviews demonstrate that this is not simply a story of engineering firms being more advanced than their clients. Digital maturity varies considerably across the infrastructure ecosystem, and some owners are actively pushing their engineering partners toward more sophisticated approaches.

Client Willingness to Pay Is the Most Significant Constraint

Among the client-related factors examined in the survey, unwillingness to pay additional fees for connected data capabilities stands out. Sixty-two percent of respondents said this limits their firm's ability to provide more advanced connected data deliverables or services most or all of the time.

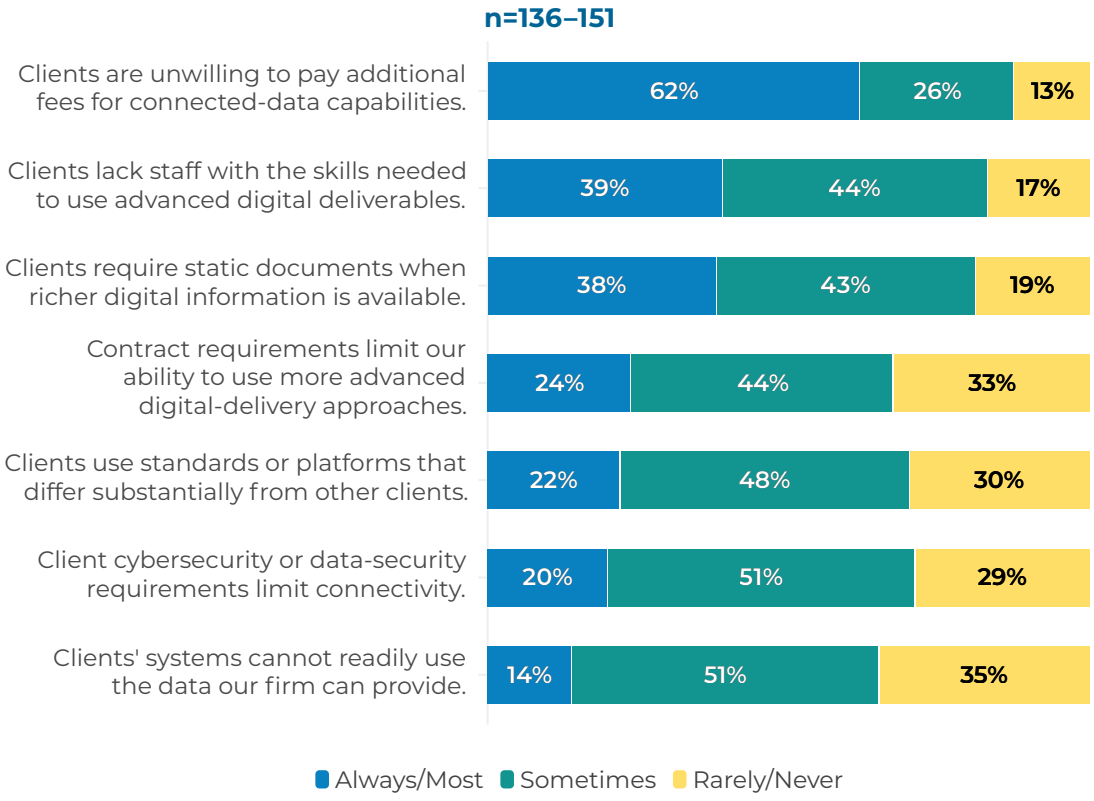
Other client limitations are less widespread but still significant. Thirty-nine percent report that clients' lack of staff with the skills needed to use advanced digital deliverables limits their firm most or all of the time, while 38 percent say the same about clients requiring static documents when richer digital data is available.

Twenty-four percent say contract requirements limit their ability to use more advanced digital delivery approaches most or all of the time. Twenty-two percent report that differing client standards or platforms create this level of constraint, and 20 percent say client cybersecurity or data-security requirements do so. By comparison, 14 percent report that clients' systems being unable to readily use the data their firms can provide is a limitation most or all of the time.

Several of these client-related constraints are more common among firms that derive a majority of their revenue from public-sector clients. Forty-seven percent of majority-public firms say clients' lack of staff with the skills needed to use advanced digital deliverables limits their firm most or all of the time, compared with 28 percent of majority-private firms. Similarly, 46 percent of majority-public firms report this level of constraint from clients requiring static documents when richer digital data is available, compared with 28 percent of majority-private firms. Contract requirements also limit advanced digital-delivery approaches most or all of the time for 29 percent of majority-public firms compared with 12 percent of majority-private firms. These differences are statistically significant.

FIGURE 17

Client-Related Factors Limiting More Advanced Connected Data Deliverables or Services



The 62 percent finding on willingness to pay is particularly important because it connects the technology discussion to the economics of project delivery. Firms may have the ability to create richer, more reusable data, but doing so can require additional effort during the project. If the client does not recognize or compensate that additional value, firms have less incentive to incur the cost.

The qualitative interviews identified this same tension from both sides of the relationship. Engineering firms described the difficulty of investing additional effort when contracts and fees remain tied to conventional deliverables. Public owners, meanwhile, described the need to demonstrate value internally and determine which additional digital requirements justify their cost.

This creates an incentive problem across the infrastructure lifecycle. The organization asked to invest in better-connected data today may not be the organization that captures most of its value later.

Traditional Deliverables Still Dominate Client Requirements

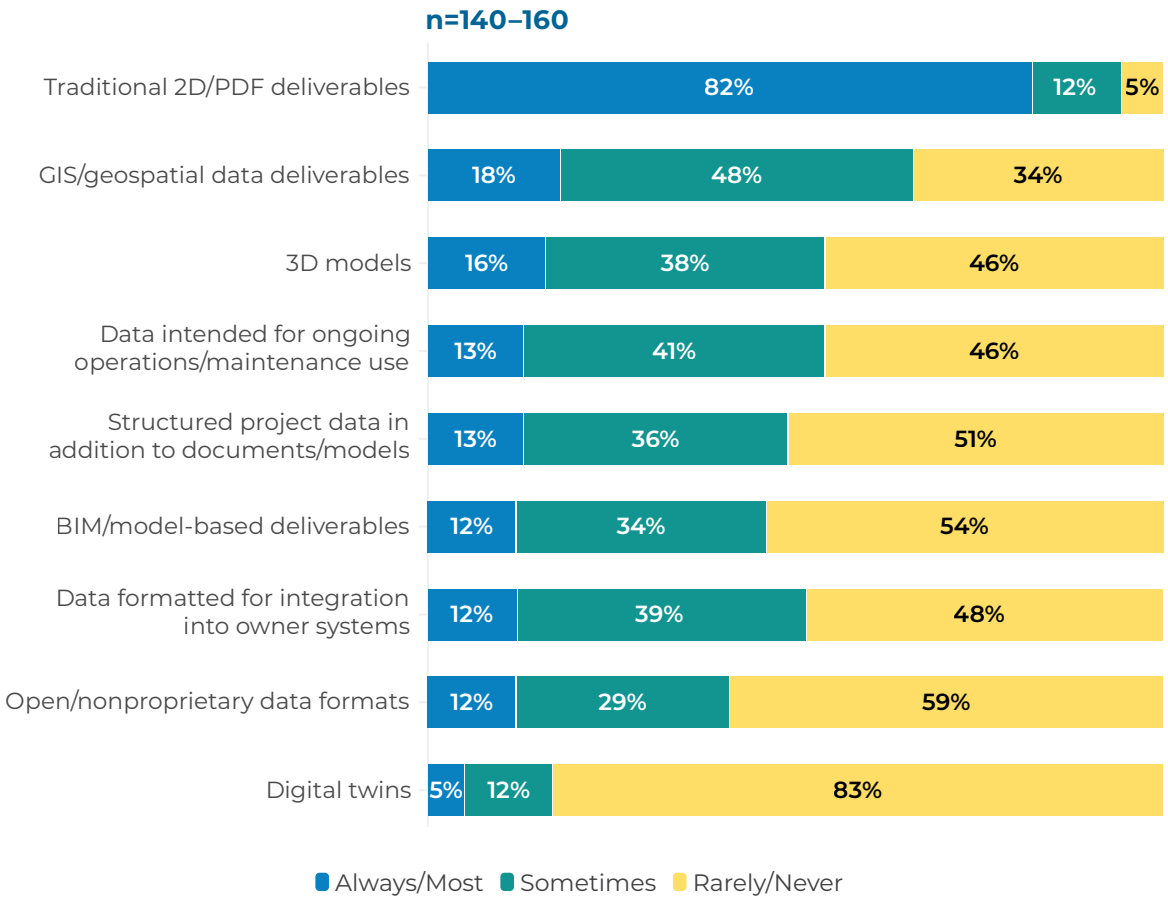
Current client requirements provide perhaps the clearest indication of how far digital delivery still has to evolve. Eighty-two percent of respondents say clients request or require traditional 2D/PDF deliverables most or all of the time.

No other deliverable examined in the survey comes close to that level. GIS or geospatial data deliverables rank second, requested or required most or all of the time by 18 percent of respondents, followed by 3D models at 16 percent. Data intended for ongoing operations and maintenance use are requested or required at this frequency by 13 percent, while structured project data in addition to documents or models are requested by 13 percent.

BIM or model-based deliverables and data formatted for integration into owner systems are each requested or required most or all of the time by 12 percent. The same is true for open or nonproprietary data formats, at 12 percent. Digital twins are requested or required most or all of the time by only five percent.

FIGURE 18

Deliverables Clients Currently Request or Require



The contrast between traditional documents and richer digital deliverables is striking. Traditional 2D/PDF deliverables are requested or required most or all of the time by 82 percent of respondents, compared with 13 percent for structured project data in addition to documents or models, 12 percent for data formatted for integration into owner systems, and 13 percent for data intended for ongoing operations and maintenance.

This helps explain why firms can become more digitally sophisticated internally without necessarily achieving full lifecycle connectivity. If contractual deliverables remain centered on documents rather than reusable data, the data environment can revert to a document-based model at precisely the point where data cross an organizational boundary.

The qualitative interviews provide an important qualification, however. Public owners frequently described PDF and traditional documentation as continuing requirements even as they pursue more sophisticated digital approaches. In many cases, richer digital data is being added alongside traditional deliverables rather than replacing them outright. The transition is therefore likely to involve parallel delivery requirements for some time.

Most Firms Are Still Responding to Client Requirements Rather Than Shaping Them

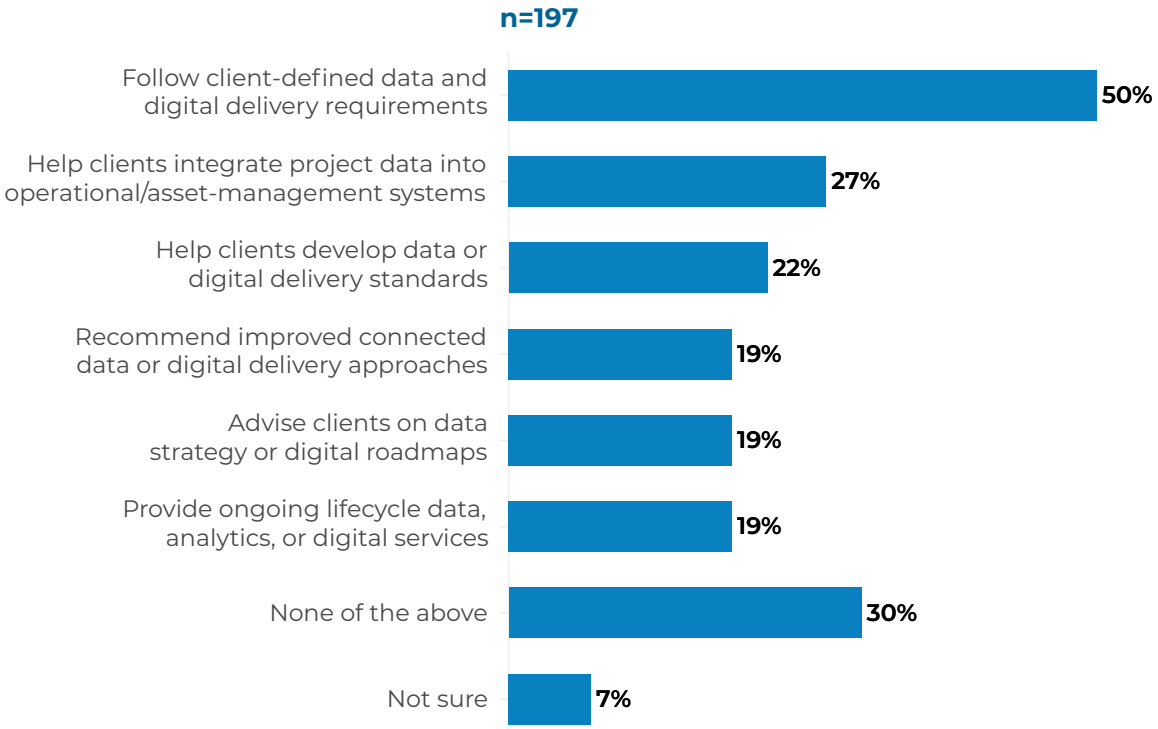
The survey also examined the role engineering firms currently play in helping clients advance their connected data capabilities. The most common activity is simply following client-defined data and digital-delivery requirements, reported by 50 percent of respondents.

More proactive roles are considerably less common. Twenty-seven percent help clients integrate project data into operational or asset-management systems, while 22 percent help clients develop data or digital-delivery standards. Nineteen percent recommend improved connected data or digital-delivery approaches, 19 percent advise clients on data strategy or digital roadmaps, and 19 percent provide ongoing lifecycle data, analytics, or digital services.

Thirty percent report that their firm performs none of the listed activities for clients.

FIGURE 19

Connected Data and Digital-Delivery Activities Firms Currently Perform for Clients



The difference between following requirements and helping define them is notable. Half of respondents report following client-defined requirements, while only about one-fifth report recommending improved approaches, developing standards, advising on data strategy, or providing ongoing lifecycle data and analytics services.

This suggests that the engineering industry's role as a digital advisor to infrastructure owners is still emerging. Firms are much more commonly implementing requirements established by clients than helping clients determine what those requirements should be.

At the same time, 27 percent already help clients integrate project data into operational or asset-management systems. That activity is particularly important because it connects project delivery to the longer infrastructure lifecycle and addresses one of the central issues raised during the owner interviews: ensuring that data created during planning, design, and construction remains useful once an asset enters operation.

Public Owners Provide an Important Counterpoint

The engineering firm survey necessarily presents the client relationship from the firm's perspective. The public-owner interviews add an important second perspective.

Owners varied considerably in their connected data maturity. Some described environments still characterized by legacy systems, inconsistent data, organizational silos, and substantial manual effort. Others were actively implementing digital-delivery standards, common data environments, digital twins, asset-information strategies, and other approaches intended to improve continuity across the infrastructure lifecycle.

This variation matters because it complicates any simple characterization of clients as a barrier to connected data. Some engineering firms may be ahead of their clients and constrained by what those clients can use or are willing to purchase. In other cases, sophisticated owners may establish requirements that push engineering firms to develop new capabilities.

The survey itself provides evidence of this unevenness. Thirty-nine percent of respondents say clients' lack of staff skills limits advanced connected data delivery most or all of the time, and 38 percent say clients' requirements for static documents do so. Yet only 14 percent say clients' systems being unable to use the data their firms can provide is a limitation most or all of the time. Client constraints therefore appear to involve more than technology alone. Skills, requirements, contracts, economics, and organizational practices all contribute.

The qualitative interviews also highlighted a structural difference between firms and owners. Engineering firms typically organize data around projects, while infrastructure owners ultimately need data to persist across assets and lifecycles that can extend for decades. An engineering firm's project may end, but the owner's need for the data does not.

That difference helps explain why owners placed particular emphasis on interoperability, open standards, asset-management integration, and data that can remain usable as software platforms change over time.

Interoperability Requires an Ecosystem, Not a Single Platform

The combined quantitative and qualitative findings reinforce an important principle underlying the study's definition of connected data: connectivity does not require every organization to use the same system.

Infrastructure delivery inherently involves multiple organizations, disciplines, applications, and technology providers. Attempting to centralize all data within a single platform is therefore neither necessary nor realistic. The more consequential issue is whether data can move among those environments while retaining enough structure, context, meaning, and relationships to remain useful.

This is why open standards and interoperability emerged so strongly in the owner interviews. Public infrastructure has a particularly long lifecycle, while individual software products, consultants, contractors, and technology providers can change many times during that lifecycle. Owners therefore have a strong interest in data that can remain accessible and usable as those technologies and participants change. Open and interoperable approaches can help preserve that continuity without requiring every organization to adopt the same technology.

For engineering firms, this means connected data strategy cannot stop at the firm's organizational boundary. Internal improvements create value, but the full potential of connected data depends on how effectively data moves between firms and the broader network of organizations responsible for designing, constructing, operating, and maintaining infrastructure.

> The future of connected data will therefore depend not simply on which organizations become most technologically advanced, but on whether the infrastructure ecosystem becomes better able to exchange and preserve useful data across organizational boundaries.

That challenge becomes even more important as firms and owners increase their use of artificial intelligence. AI can extract substantial value from large volumes of engineering and infrastructure data, but its effectiveness depends heavily on the accessibility, structure, context, and quality of the underlying data.

CONNECTED DATA AND AI

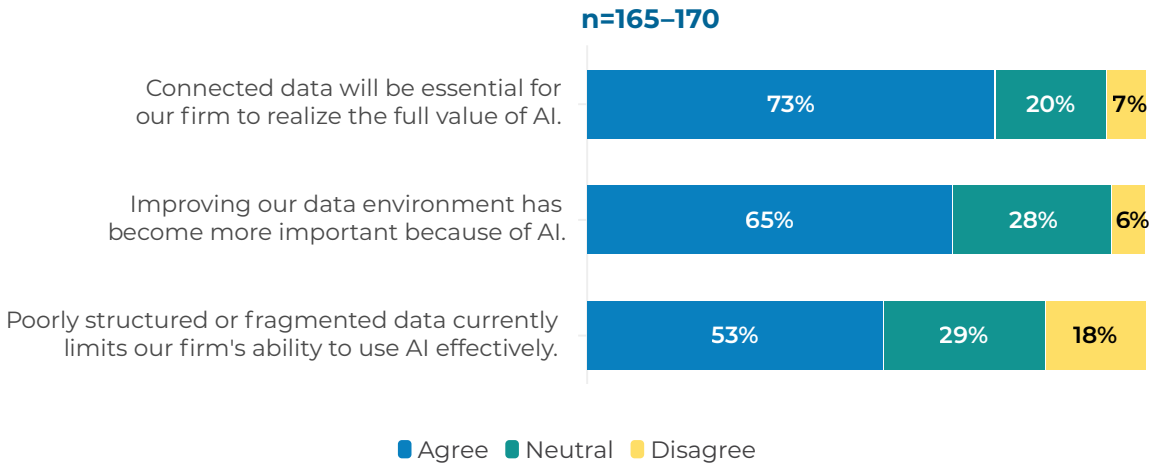
Artificial intelligence is increasing the strategic importance of connected data. The survey findings indicate that firms generally do not view AI and connected data as separate initiatives. Instead, respondents see the quality and connectivity of their data environment as an important factor in determining how effectively their firms will be able to use AI.

The relationship works in both directions. Fragmented data can constrain AI today, while the growth of AI creates a stronger incentive for firms to improve how their project data is structured, governed, connected, and reused.

Fragmented Data Are Already Limiting AI for Many Firms

More than half of respondents, 53 percent, agree that poorly structured or fragmented data currently limit their firm's ability to use AI effectively. Twenty-nine percent neither agree nor disagree, while 18 percent disagree.

FIGURE 20
Connected Data and AI



The fact that 53 percent already identify their data environment as an impediment to AI is significant because widespread use of AI within engineering is still developing. Firms do not need to wait for more advanced AI applications to encounter the underlying data challenge. For many, the structure and fragmentation of existing project data are already affecting what they can do.

Firm size also makes a substantial difference. Thirty-nine percent of firms with 1–25 FTEs agree that poorly structured or fragmented data currently limit their ability to use AI effectively, compared with 71 percent of firms with more than 200 FTEs.

That difference should not necessarily be interpreted to mean that smaller firms have better data. Larger firms typically operate across more projects, systems, offices, disciplines, and repositories, creating a more complex data environment. They may also be pursuing AI more actively and therefore encountering data limitations sooner.

The survey establishes the difference in perceptions, but not its cause.

Overall connected data maturity is also strongly related to this experience. Seventy-eight percent of firms rating their connected data capabilities Fair or Poor agree that poorly structured or fragmented data currently limit their ability to use AI effectively, compared with 51 percent of firms rating their capabilities Good and 41 percent rating them Excellent or Very Good. This relationship reinforces the broader finding that connected data maturity is becoming increasingly consequential as firms expand their use of AI.

AI Is Increasing the Urgency of Improving Firms' Data Environments

Sixty-five percent of respondents agree that improving their firm's data environment has become more important because of AI. Only six percent disagree, while 28 percent neither agree nor disagree.

The relationship with firm size is particularly pronounced. Among firms with 1–25 FTEs, 46 percent agree that improving their data environment has become more important because of AI. Agreement rises to 65 percent among firms with 26–50 FTEs, 72 percent among firms with 51–200 FTEs, and 85 percent among firms with more than 200 FTEs.

This progression suggests that the connection between AI strategy and data strategy is especially prevalent among larger firms. It also reinforces an important theme emerging throughout the survey: firms of different sizes may assess their overall connected data maturity similarly, but their specific practices and strategic priorities can look quite different.

The qualitative research anticipated this relationship. Interview participants generally did not argue that firms must first create a perfect connected data environment and only then begin using AI. Instead, they described parallel development. Firms can deploy AI against existing data while simultaneously improving the structure, accessibility, and governance of that data.

AI may therefore become one of the forces accelerating connected data investment. As firms discover what AI can do, they may also become more aware of the limitations created by fragmented, inconsistent, poorly structured, or difficult-to-access data.

Nearly Three-Quarters See Connected Data as Essential to Realizing AI's Full Value

The strongest finding in this series concerns the future relationship between the two capabilities. Seventy-three percent of respondents agree that connected data will be essential for their firm to realize the full value of AI. Twenty percent neither agree nor disagree, while only seven percent disagree.

Agreement again increases substantially with firm size. Fifty-four percent of firms with 1–25 FTEs agree that connected data will be essential to realizing AI's full value, compared with 77 percent of firms with 26–50 FTEs, 80 percent of firms with 51–200 FTEs, and 89 percent of firms with more than 200 FTEs.

Taken together, the three findings tell a coherent story. Fifty-three percent say fragmented data already limit their use of AI. Sixty-five percent say AI has made improving their data environment more important. And 73 percent believe connected data will be essential to realizing AI's full value.

The progression from 53 percent to 65 percent to 73 percent should not be interpreted as a trend because the statements measure different concepts. It does, however, illustrate the breadth of the relationship respondents see between AI and connected data: the issue affects current AI effectiveness, current investment priorities, and expectations about future value.

AI Raises the Stakes for Data Quality and Governance

The connection between AI and data also reinforces findings from earlier sections of the report. Thirty-seven percent of respondents identified incomplete data as significantly limiting their ability to connect or reuse information, 31 percent identified unstructured data, and 29 percent identified inconsistent data. At the same time, only 23 percent of firms report having data-quality or validation procedures, 19 percent have defined authoritative data sources, and 15 percent have designated data owners or stewards.

Those gaps take on greater significance when data are used by AI. In a traditional workflow, an experienced engineer may recognize that a document is outdated, understand an unusual naming convention, know which source is authoritative, or supply context that is not explicitly contained in the data. AI applications may not have access to that tacit organizational knowledge.

The qualitative interviews repeatedly raised this concern. Participants emphasized that AI can make disconnected data easier to search, organize, and analyze, but it does not eliminate the need for reliable underlying data. Poorly structured or poorly governed data can limit the reliability of AI outputs, while better-connected data can give AI applications more useful context.

> AI does not make connected data less important. For most respondents, it makes connected data more important. That is one of the clearest strategic findings in the study.

BUILDING THE CAPABILITIES FIRMS WILL NEED

Recognizing the importance of connected data does not mean firms currently possess all of the capabilities required to use it effectively. The survey shows substantial demand for additional expertise, particularly in AI, systems integration, workflow redesign, data strategy, and governance. Together, these needs reinforce that creating a more connected and interoperable data environment is an organizational capability, not simply a technology implementation.

AI Expertise Is the Most Frequently Identified Capability Gap

Fifty-five percent of respondents say their firm needs to add or expand AI expertise to make greater use of connected data, making it the most frequently identified capability need.

Systems integration follows at 43 percent, while 42 percent identify digital workflow and process redesign. Thirty-eight percent need additional capabilities in data strategy or information architecture, and 36 percent identify data governance or data stewardship.

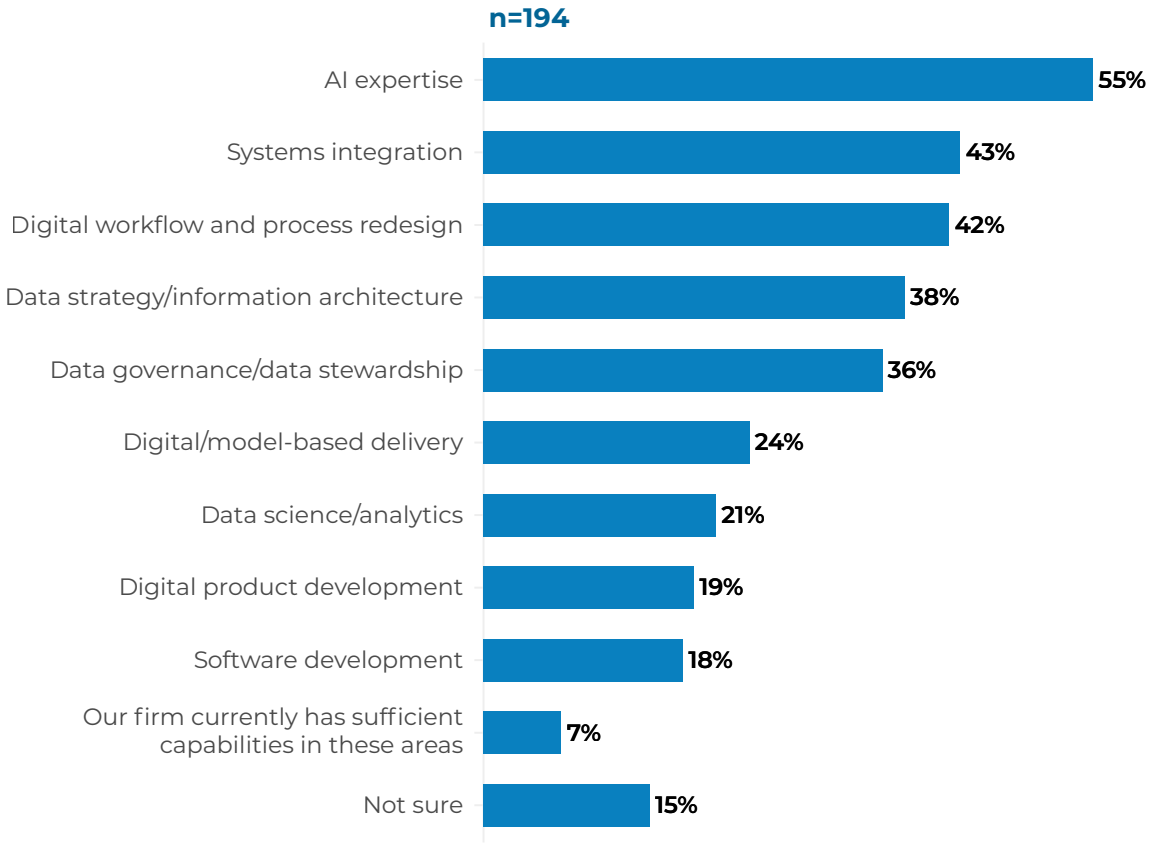
Other needs are less widespread. Twenty-four percent identify digital or model-based delivery, 21 percent data science or analytics, 19 percent digital product development, and 18 percent software development.

Only seven percent say their firm currently has sufficient capabilities across the areas listed. Fifteen percent are not sure.

This finding provides additional context for firms' broader self-assessments of connected data maturity. While 75 percent rate their overall connected data capabilities as Good or better, only seven percent say they currently have sufficient capabilities across the specific areas examined. This reinforces the distinction between broad perceptions of maturity and the specific capabilities required to support a more advanced connected data environment.

FIGURE 21

Capabilities Firms Need to Add/Expand to Make Greater Use of Connected Data



The breadth of these needs is noteworthy. Firms are not simply looking for additional technologists. Several of the most common gaps involve connecting technology to the way engineering work is organized: systems integration at 43 percent, digital workflow and process redesign at 42 percent, data strategy and information architecture at 38 percent, and data governance and stewardship at 36 percent.

Firm size again reveals important differences. Data governance or stewardship is identified as a capability need by 19 percent of firms with 1–25 FTEs compared with 70 percent of firms with more than 200 FTEs. Data strategy or information architecture rises from 20 percent to 68 percent, systems integration from 32 percent to 64 percent, and digital workflow and process redesign from 35 percent to 62 percent.

AI expertise follows the same general pattern, identified by 44 percent of firms with 1–25 FTEs and 72 percent of firms with more than 200 FTEs.

These differences reinforce the possibility that larger firms are further along in identifying the organizational capabilities required for a more connected data environment. Their greater complexity may create more acute needs, but greater exposure to advanced digital initiatives may also make those needs easier to recognize.

Firms Expect to Build Capabilities Primarily Through Their Existing Workforce

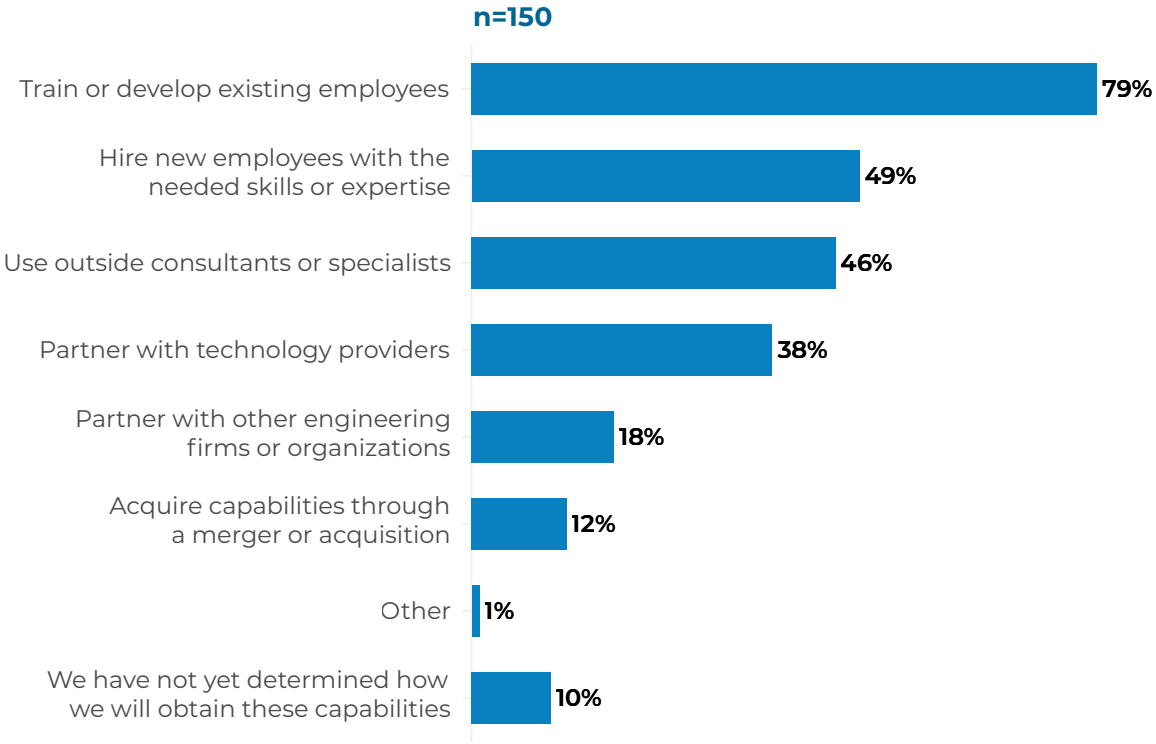
Among respondents asked how their firms expect to obtain the additional capabilities they need, 79 percent say they will train or develop existing employees. This is by far the most common strategy.

Nearly half, 49 percent, expect to hire new employees with the necessary skills or expertise, while 46 percent expect to use outside consultants or specialists. Thirty-eight percent anticipate partnering with technology providers.

Less common strategies include partnering with other engineering firms or organizations, identified by 18 percent, and acquiring capabilities through a merger or acquisition, identified by 12 percent. Ten percent say their firm has not yet determined how it will obtain the capabilities it needs.

FIGURE 22

How Firms Expect to Obtain Additional Connected Data Capabilities



The 79 percent emphasis on developing existing employees is particularly consequential. It suggests that the connected data transition will affect a much broader portion of the engineering workforce than a strategy centered primarily on hiring specialized technology professionals would imply.

Hiring remains important at 49 percent, and external consultants at 46 percent and technology partners at 38 percent will also play substantial roles. But firms appear to expect capability development to occur to a large degree within their existing organizations.

This is consistent with the qualitative interviews, which suggested that the future engineering firm will require a combination of traditional engineering judgment and expanding capabilities in data governance, systems integration, digital workflows, AI, software, and data architecture. The interviews also suggested that existing engineering roles themselves may change as technology handles more routine data processing and engineers spend more time on judgment, problem definition, systems thinking, and client interaction.

The survey cannot determine exactly how individual occupations will change. It does, however, indicate that firms expect the transition to involve workforce development on a substantial scale.

Connected Data Is Becoming an Organizational Capability

Taken together, the AI and capability findings broaden the definition of connected data readiness. Readiness is not simply a matter of having the right software. Firms need people who can integrate systems, redesign workflows, establish data strategies, govern data, and apply emerging technologies to engineering work. This is particularly important for interoperability because the ability to exchange data across systems depends not only on technical standards, but also on how workflows, governance practices, and organizational processes are designed around those standards.

The finding that only seven percent of respondents say their firms currently have sufficient capabilities across the areas examined underscores how early this transition remains. At the same time, the overwhelming preference for developing existing employees suggests that firms see connected data capability as something that must become embedded within the organization rather than isolated within a specialized technology function.

That has implications beyond technology and workforce strategy. As connected data and AI allow firms to change how engineering work is performed, they may also change how firms create value, what they deliver to clients, and how they are compensated for that value.

> The next stage of the connected data transition may therefore be less about digitizing engineering work and more about changing the economics and structure of engineering delivery itself.

IMPLICATIONS FOR ENGINEERING BUSINESS MODELS AND SERVICES

The implications of connected data extend beyond technology and project delivery. Respondents expect it to affect what engineering firms deliver, how they create value, how contracts address data, and potentially how firms are compensated for their work.

The survey findings indicate that firms broadly recognize these implications. At the same time, the specific connected data services that might support new business models remain relatively uncommon today. The industry appears to see the direction of change more clearly than the eventual business models that will emerge from it.

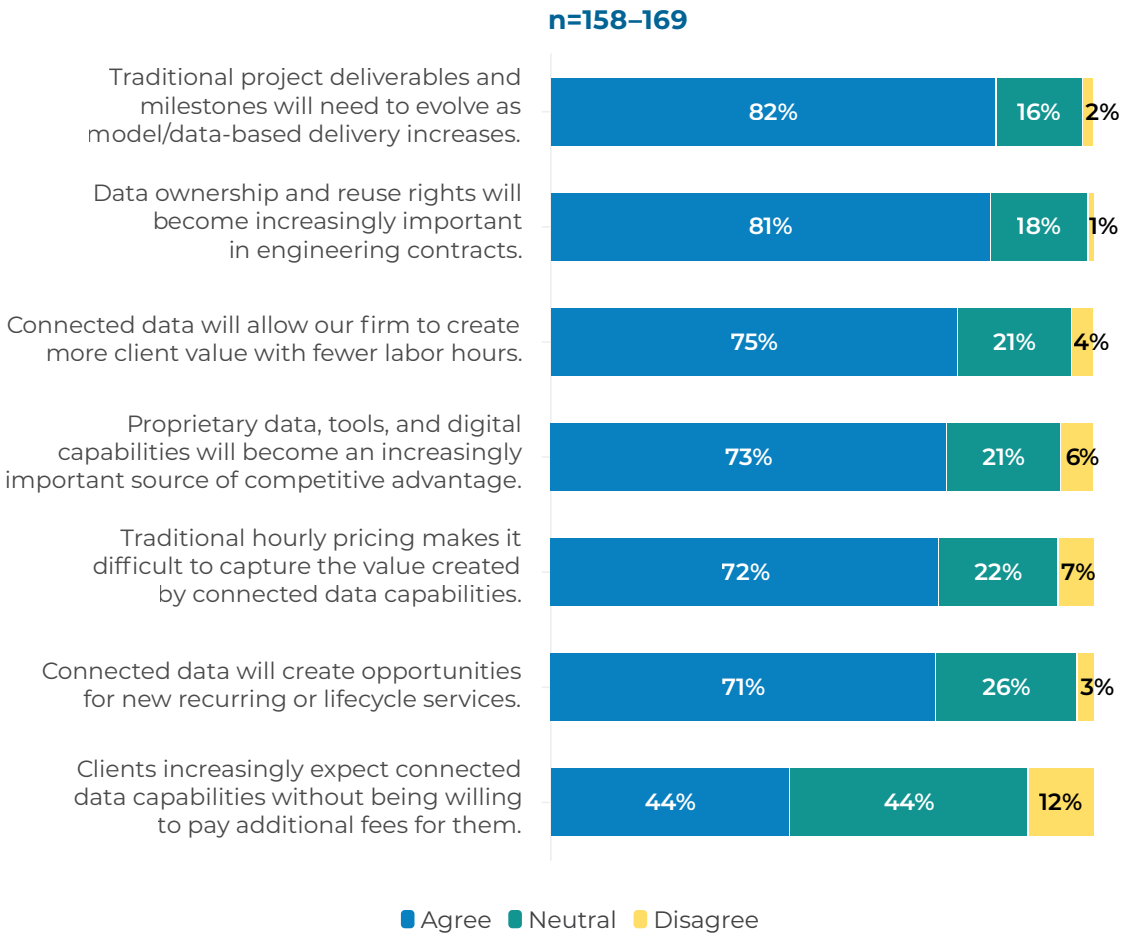
Traditional Project Delivery Will Need to Evolve

Eighty-two percent of respondents agree that traditional project deliverables and milestones will need to evolve as model- and data-based delivery increases. Only two percent disagree, while 16 percent neither agree nor disagree.

The implications extend to the underlying economics of engineering work. Seventy-five percent agree that connected data will allow firms to create more client value with fewer labor hours. At the same time, 72 percent agree that traditional hourly pricing makes it difficult for firms to capture the value created through connected data.

FIGURE 23

Implications of Connected Data for Engineering Business Models



These findings identify a potential tension for engineering firms. If better data, automation, and AI allow a firm to accomplish work more efficiently, the client can benefit from improved outcomes or lower effort. But when revenue remains closely tied to labor hours, the firm may not capture the economic value of that improvement.

This issue also emerged during the qualitative interviews. Participants questioned whether business models centered on hours, staffing, utilization, project milestones, and document-based deliverables remain fully aligned with an environment in which reusable data can create greater value with less labor. They also raised questions about how firms should be compensated for reusable tools, digital capabilities, and data that may continue creating value after a project is complete.

The survey does not indicate what pricing model should replace or supplement hourly pricing, nor does it establish how quickly such changes will occur. It does show that the underlying tension is widely recognized: 75 percent believe connected data can create more client value with fewer labor hours, while 72 percent believe hourly pricing makes capturing that value difficult.

Data Are Becoming Part of the Commercial Relationship

As project data becomes more reusable and valuable, respondents also expect data-related issues to become increasingly important in contracts. Eighty-one percent agree that data ownership and reuse rights will become increasingly important contractual issues.

This finding reflects a fundamental change in the role of project data. If data are created solely to support a specific project deliverable, questions about their longer-term use may be relatively limited. If the same data can support future projects, AI applications, lifecycle analytics, digital products, or other services, ownership and reuse rights become more consequential.

The qualitative research surfaced related questions about who owns project data, who can reuse it, what rights engineering firms retain in tools or derived data, and how responsibilities should be allocated when data continues to be used beyond its original purpose.

These issues are closely related to competitive strategy. Seventy-three percent of respondents agree that proprietary data, tools, or digital capabilities will become increasingly important sources of competitive advantage.

The implication is that firms and owners may need to distinguish more deliberately between the interoperability of data and the ownership of intellectual property. Data may need to move across systems and organizations in sufficiently open and interoperable forms to remain useful without requiring firms to surrender proprietary tools, processes, analytics, or other capabilities that create differentiated value. Openness and proprietary value are therefore not necessarily opposing objectives, but contracts and data strategies will increasingly need to define the boundary between them. Similarly, interoperability does not determine who owns data or who has the right to reuse them; those are governance and contractual questions that must be addressed separately.

Firms See Opportunities for Recurring and Lifecycle Services

Seventy-one percent of respondents agree that connected data will create opportunities for recurring or lifecycle-based services beyond traditional project delivery.

That expectation is consistent with the longer-term value identified elsewhere in the survey. Twenty-nine percent of respondents identify improved project, asset, and capital-planning decisions as one of the greatest potential sources of connected data value over the next three to five years, while 21 percent identify improved infrastructure lifecycle management.

The qualitative interviews expanded on what these opportunities might eventually include. Participants discussed services related to digital strategy, data roadmaps, digital twins, lifecycle analytics, predictive asset management, ongoing infrastructure intelligence, and other ways engineering firms could continue supporting clients after the traditional design or construction assignment has ended.

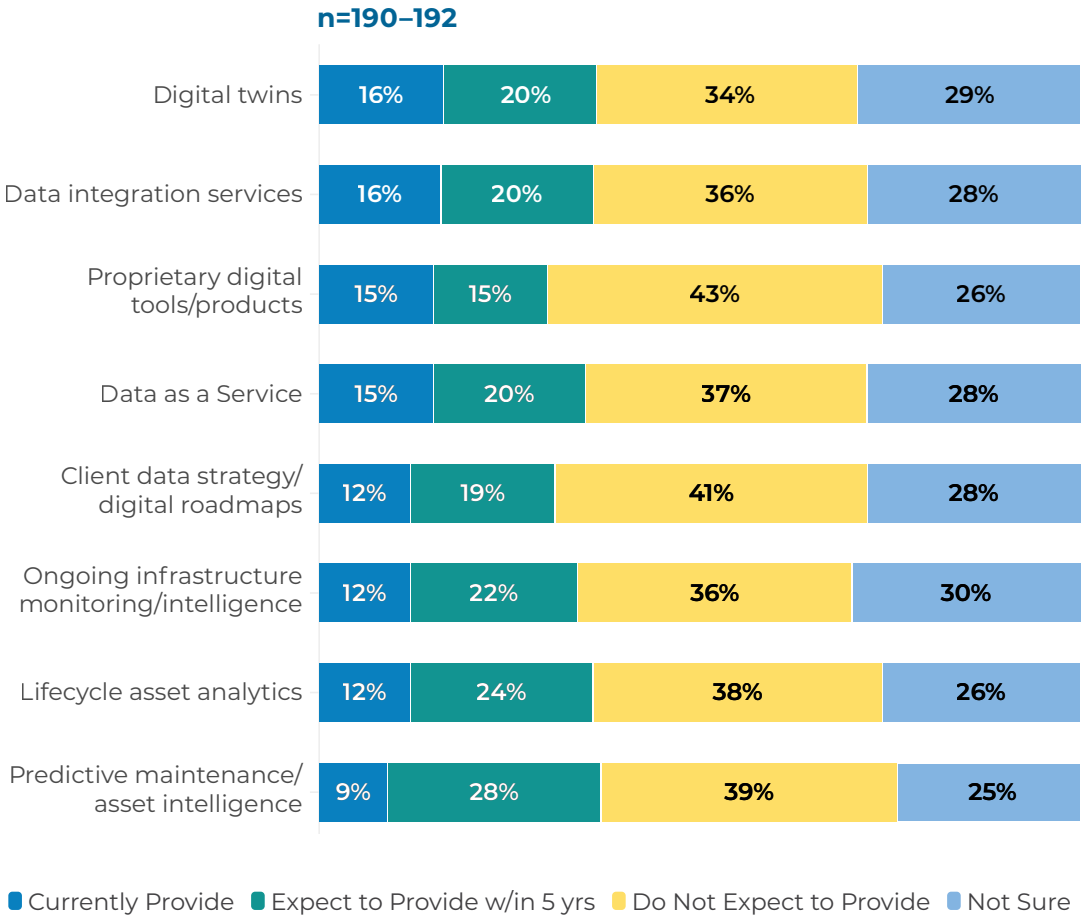
However, the quantitative findings indicate that these service models remain at an early stage.

Connected Data Services Are Still Emerging

Across the eight connected data services examined in the survey, only nine percent to 16 percent of respondents report that their firms currently provide each service. Current provision is therefore limited across the entire set of services.

FIGURE 24

Connected Data Services Firms Provide Today and Expect to Provide Within Five Years



Expectations for the next five years indicate broader interest, but they also reveal considerable uncertainty about which service models will ultimately become established. Across the eight services, the percentages reported for firms expecting to provide each within five years range from 15 percent to 28 percent.

This is an important counterweight to the strong agreement seen in Figure 23. Firms broadly expect connected data to affect project delivery, contracts, competitive advantage, and opportunities for lifecycle services, but relatively few currently provide the specific connected data services examined in Figure 24.

The findings therefore do not support a conclusion that engineering firms are already transforming rapidly into digital-service businesses. A more accurate interpretation is that firms recognize the strategic potential of connected data before specific service models have become widespread.

That gap between expectation and current practice is one of the more important findings in the study. The industry appears to anticipate meaningful business-model change, but the commercial forms that change will take are still developing.

Connected Data May Change What Engineering Firms Sell

Taken together, the findings suggest that connected data may gradually expand the unit of value in engineering. Traditionally, much of the industry's commercial model has centered on professional labor applied to defined projects and deliverables. Connected data creates the possibility that value may increasingly reside not only in the work performed, but also in reusable data, proprietary capabilities, automated processes, ongoing analytics, and knowledge that persists across an asset's lifecycle.

The survey does not establish how quickly this transition will occur or which new business models will prove viable. It does establish that respondents expect many of the underlying conditions to change: 82 percent believe traditional deliverables and milestones will need to evolve, 81 percent believe data ownership and reuse rights will become increasingly important, 75 percent believe connected data can create more value with fewer labor hours, 73 percent see proprietary data, tools, or digital capabilities becoming more important competitively, 72 percent see a challenge in capturing that value through hourly pricing, and 71 percent anticipate opportunities for recurring or lifecycle services.

> The business-model implications of connected data are widely anticipated, even though the services and commercial models that will capture that value are still emerging. That combination of strong expectations and limited current adoption is characteristic of an industry in transition.

THE FUTURE OF CONNECTED DATA IN ENGINEERING

The final set of survey questions asked respondents to look beyond individual technologies and consider how connected data may affect the engineering industry more broadly. The findings indicate substantial agreement about the direction of change.

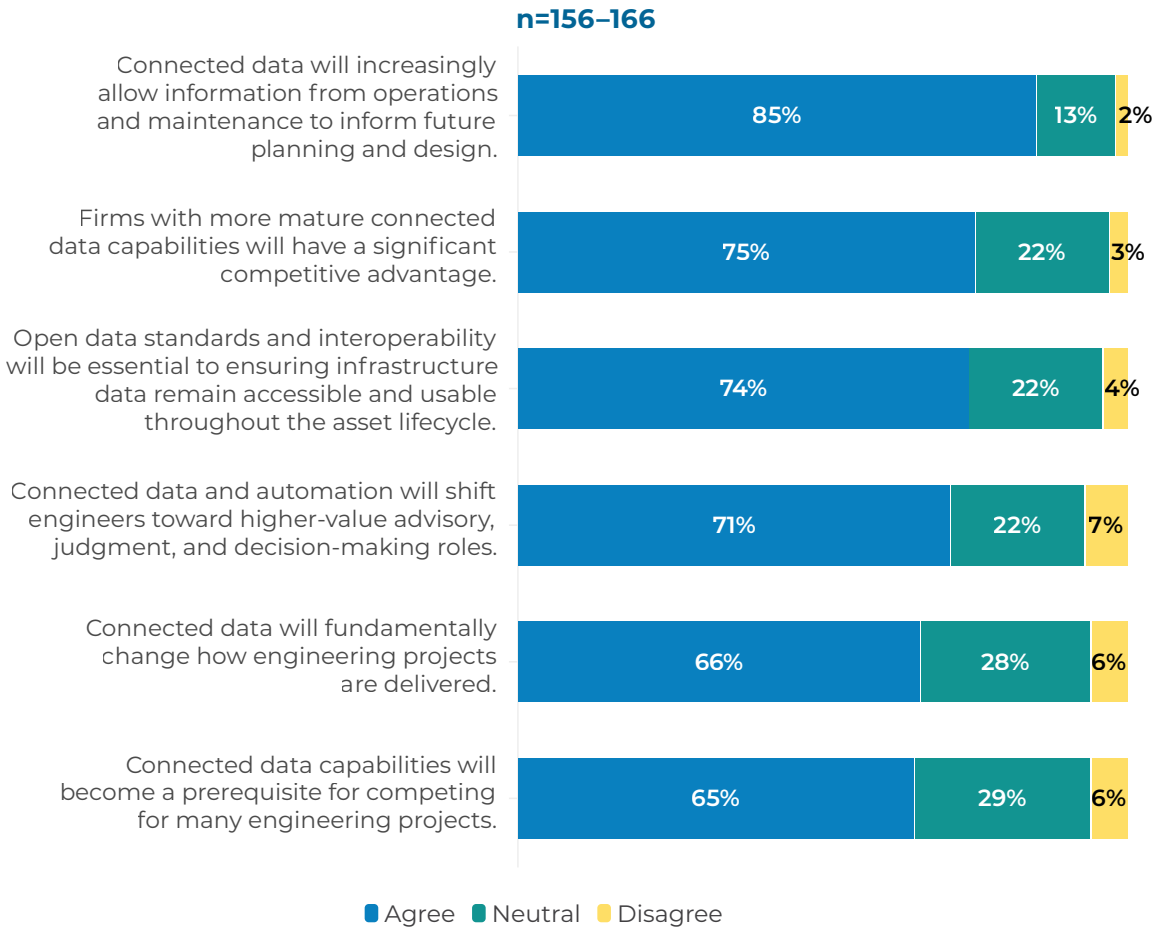
Respondents expect mature, connected data capabilities to become a competitive advantage, believe engineers' roles will increasingly shift toward higher-value judgment and advisory work, see interoperability and open standards as essential, and anticipate a much stronger feedback loop between infrastructure operations and future planning and design.

Together, these findings point toward an engineering data environment that is more continuous across projects, organizations, and the infrastructure lifecycle.

Connected Data Maturity Is Expected to Become a Competitive Advantage

Seventy-five percent of respondents agree that firms with mature, connected data capabilities will have a significant competitive advantage. Only three percent disagree, while 22 percent neither agree nor disagree.

FIGURE 25
The Future of Connected Data in Engineering



This finding is consistent with the business-model results. Seventy-three percent previously agreed that proprietary data, tools, or digital capabilities will become increasingly important sources of competitive advantage. Taken together, the results suggest that respondents increasingly see data capability as more than an internal efficiency issue.

The competitive implications could operate in several ways. Firms with stronger connected data capabilities may be better able to reuse knowledge, automate workflows, support AI, meet sophisticated client requirements, or provide services that extend beyond conventional project delivery.

The survey does not determine which of these advantages will prove most important. It does show that three-quarters of respondents expect connected data maturity itself to become competitively consequential.

The competitive implications extend beyond providing an advantage to firms that are more mature. Sixty-five percent of respondents agree that connected data capabilities will become a prerequisite for competing for many engineering projects. Six percent disagree, while 29 percent neither agree nor disagree.

The distinction is important. A competitive advantage helps differentiate a firm from its competitors. A prerequisite becomes part of what a firm needs simply to compete for certain work. While respondents are somewhat more likely to anticipate the former than the latter, nearly two-thirds expect connected data capabilities to become a requirement for competing for many projects within the next five to ten years.

Two-thirds of respondents, 66 percent, agree that connected data will fundamentally change how engineering projects are delivered. Six percent disagree, while 28 percent neither agree nor disagree.

This expectation is consistent with findings elsewhere in the study. Respondents anticipate changes to traditional project deliverables and milestones, greater use of automation and AI, and data that remains useful beyond individual project phases and organizational boundaries. Connected data therefore appears likely to affect not only the technologies firms use, but also the processes through which engineering work is performed and delivered.

Engineers' Roles Are Expected to Shift Toward Judgment and Advisory Work

Seventy-one percent of respondents agree that connected data and automation will shift engineers toward higher-value advisory and judgment-based roles. Seven percent disagree, while 22 percent neither agree nor disagree.

This finding should not be interpreted as a prediction that engineering labor will simply be replaced by technology. Respondents instead anticipate a change in the nature of engineering work.

The qualitative interviews provide useful context for what that change might involve. Participants described technology taking on more routine data processing, data retrieval, coordination, and analysis, while engineers spend more time interpreting results, defining problems, applying professional judgment, thinking across systems, managing risk, and interacting with clients.

This shift also connects to the workforce findings discussed earlier. Seventy-nine percent of firms that identified additional capability needs expect to develop those capabilities by training existing employees. Firms therefore appear to anticipate adapting their current workforce as connected data, automation, and AI become more deeply embedded in engineering practice.

Open Standards and Interoperability Are Viewed as Essential

Seventy-four percent of respondents agree that open standards and interoperability will be essential to ensuring that infrastructure data remain accessible and usable throughout the asset lifecycle. Only four percent disagree, while 22 percent neither agree nor disagree.

This is particularly significant because interoperability has surfaced throughout the study. Thirty-nine percent of respondents identify moving data between different software applications as an area of significant difficulty maintaining continuity, context, or usability. Twenty-six percent identify software interoperability as a barrier to greater use of connected data, while 24 percent identify lack of common data standards.

The future-looking result places those current problems in a broader strategic context. Nearly three-quarters of respondents believe open standards and interoperability will ultimately be essential to ensuring that infrastructure data remain accessible and usable throughout the asset lifecycle.

Public owners interviewed during the qualitative phase placed particular emphasis on this issue. Infrastructure assets may remain in service for decades, while the software platforms, engineering firms, contractors, and technology providers associated with them can change repeatedly. Owners therefore have a strong interest in data that can remain accessible and usable across changing technology environments.

Connected infrastructure cannot depend on every participant using the same technology. It depends on data retaining sufficient structure, context, meaning, and relationships to remain usable as they move between technologies.

That principle may become increasingly important as the industry attempts to connect data across the full infrastructure lifecycle.

The Strongest Future Expectation Is a Feedback Loop Across the Infrastructure Lifecycle

The highest level of agreement among the six future-looking statements concerns the relationship between operations and future engineering work. Eighty-five percent of respondents agree that data generated during operations and maintenance will increasingly feed back into future planning and design decisions. Only two percent disagree, while 13 percent neither agree nor disagree.

This finding represents an important evolution from the traditional linear conception of project delivery. In a conventional model, data moves from planning through design and construction before ultimately being handed to the organization responsible for operating the asset.

Connected data creates the possibility of a continuous data cycle instead. Operational performance, maintenance history, asset condition, failures, interventions, and other data generated during the life of an asset can become inputs into future capital planning and engineering decisions.

The public-owner interviews strongly reinforced this opportunity. Owners described the potential to use data accumulated during operations not simply to manage existing assets, but to improve how future infrastructure is planned, designed, constructed, and maintained.

The quantitative result indicates that engineering firms broadly recognize the same opportunity. At 85 percent, agreement on this statement is higher than for any of the other five future-looking statements examined in the survey.

From Projects to a Continuous Data Lifecycle

Taken together, the findings suggest that the future of connected data will involve more than better integration among today's software applications.

The broader transition is from an industry in which data are created primarily for individual projects and deliverables toward one in which data can retain value across projects, organizations, technologies, and stages of the infrastructure lifecycle.

Several findings throughout the study point in this direction. Eighty-five percent expect operations and maintenance data increasingly to inform future planning and design. Eighty-two percent believe traditional project deliverables and milestones will need to evolve, and 81 percent believe data ownership and reuse rights will become increasingly important. Three-quarters expect mature, connected data capabilities to provide significant competitive advantage, while 65 percent go further and expect those capabilities to become a prerequisite for competing for many engineering projects. Two-thirds, 66 percent, believe connected data will fundamentally change how engineering projects are delivered.

Achieving that transition will depend on whether data can remain usable as it moves across systems, organizations, and lifecycle phases. Seventy-four percent of respondents agree that open standards and interoperability will be essential to ensuring that infrastructure data remain accessible and usable throughout the asset lifecycle. This reinforces a central finding of the research: the future of connected data is unlikely to depend on every participant using the same technology. It will depend on the ability of data to retain its structure, context, and usefulness as technologies, organizations, and project participants change over time.

The qualitative research helps explain why these changes are interconnected. Project data can create greater long-term value only if it remains understandable and usable after the project team that created it has moved on. That requires attention not only to technology, but also to standards, governance, data quality, contracts, ownership, skills, incentives, and organizational behavior.

It also requires collaboration across the infrastructure ecosystem. Engineering firms cannot create lifecycle connectivity independently. Owners, contractors, technology providers, and other participants all influence whether data remains usable as it moves.

The study therefore points toward a broader definition of connected data maturity. The most advanced state is not simply one in which firms can access more data or connect more applications. It is one in which data retains enough structure, context, quality, and interoperability to continue creating value as its users, systems, organizations, and purposes change.

> The next transition for the engineering industry is not simply from paper to digital or from digital files to connected systems. It is from project data that exists to infrastructure intelligence that remains useful.

IMPLICATIONS FOR ENGINEERING FIRMS AND INFRASTRUCTURE OWNERS

The findings of this research point toward a connected data environment that will require changes from both engineering firms and infrastructure owners. Neither group can create lifecycle connectivity independently. Firms generate, transform, and deliver substantial amounts of infrastructure data, while owners ultimately determine how much of those data continue to create value throughout an asset's lifecycle.

The implications therefore extend beyond technology adoption. They involve how organizations manage data, design workflows, develop their workforces, establish project requirements, structure contracts, and determine where connected data can create sufficient value to justify additional investment.

Engineering Firms Should Treat Connected Data as an Organizational Capability

Connected data should not be viewed primarily as a technology initiative. The research indicates that firms need capabilities spanning systems integration, workflow redesign, data strategy, governance, AI, and engineering practice. Only seven percent of respondents say their firms currently have sufficient capabilities across the areas examined, while firms expecting to add capabilities overwhelmingly anticipate developing existing employees as part of the solution.

For engineering firms, this suggests that responsibility for connected data cannot reside solely within IT, digital-delivery, or innovation teams. Those functions may provide critical expertise, but data is created, interpreted, structured, and reused throughout engineering workflows. Project managers, engineers, technical leaders, and other employees therefore influence whether connected data practices become embedded in normal project delivery.

This is particularly important for smaller firms. Firms of different sizes assess their overall connected data maturity relatively similarly, yet larger firms have substantially more formal governance structures and greater adoption of many advanced technologies and practices. Smaller firms may not need to replicate the structures or technology environments of much larger organizations. They do, however, need to determine which capabilities are essential to their own markets, clients, workflows, and future strategy.

Data Governance Should Develop Alongside Technology

Greater connectivity increases the importance of knowing whether data is reliable, authoritative, sufficiently documented, and appropriate for reuse.

The research shows that basic standards are considerably more common than formal governance. Seventy-one percent of firms have standard data or file structures and 69 percent have standard naming conventions, but only 23 percent have data-quality or validation procedures, 19 percent have defined authoritative sources, 15 percent have designated data owners or stewards, and 14 percent have metadata or classification standards.

For firms and owners, the implication is that governance should develop as part of connected data strategy rather than after greater connectivity has already been achieved. Data that becomes easier to access and exchange is not necessarily more useful. Incomplete, inconsistent, outdated, poorly documented, or unreliable data can retain those deficiencies as it moves through a connected environment.

The growth of AI makes this more consequential. Information that once depended on an experienced employee to supply missing context may increasingly be retrieved or interpreted automatically. Governance practices that establish quality, authority, ownership, context, and appropriate use therefore become part of the infrastructure supporting AI and automation as well as connected data itself.

Firms Should Look for High-Value Friction Before Pursuing Connectivity for Its Own Sake

The research does not suggest that every data source, application, or workflow needs to be connected. Instead, it identifies recurring points where disconnected data creates measurable friction.

Software interoperability is the most frequently identified area of significant difficulty, while historical data and reuse of data from completed projects also rank prominently. Employees spend time searching for and validating data, and no respondents say their firms never need to substantially rework, remodel, convert, or recreate data received from external project partners.

These findings suggest a practical way to frame connected data investments: identify where data repeatedly loses usefulness and where preserving that usefulness would create meaningful value.

That may involve a handoff between applications, repeated reconstruction of historical data, inconsistent data structures across projects, difficulty identifying authoritative data, or a client deliverable that cannot readily be incorporated into another system. Addressing these specific points of friction can provide a clearer connection between connected data investment and improvements in efficiency, quality, rework, knowledge reuse, or client service.

AI Strategy and Data Strategy Should Be Considered Together

AI creates a particularly strong reason for firms to examine their underlying data environments.

Fifty-three percent of respondents already report that poorly structured or fragmented data limit their ability to use AI effectively. Sixty-five percent say AI has made improving their data environment more important, and 73 percent believe connected data will be essential for realizing AI's full value.

These findings do not imply that firms should delay AI adoption until their data environments are fully mature. The qualitative research suggests that AI and connected data can develop in parallel and reinforce one another. AI may itself help organizations search, classify, organize, and analyze data.

The implication is instead that organizations should consider the two strategies together. AI initiatives can reveal weaknesses in data quality, accessibility, structure, governance, and interoperability. Conversely, investments that improve those characteristics can increase the range and reliability of AI applications available to the organization.

Connected data investments therefore may need to be evaluated not only according to the immediate data-management problem they solve, but also according to whether they create a stronger foundation for AI and automation.

Engineering Firms Have an Opportunity to Help Clients Define the Future of Digital Delivery

Most engineering firms currently play a relatively reactive role in client digital delivery. Fifty percent report following client-defined data or digital-delivery requirements, while considerably smaller percentages help clients develop standards, advise them on data strategy, recommend improved approaches, or provide ongoing lifecycle data and analytics services.

At the same time, the owner interviews indicate substantial variation in owners' internal capabilities. Some are developing sophisticated digital-delivery and asset-data environments. Others continue to face legacy systems, organizational silos, inconsistent data, and limited resources or expertise.

That variation creates an opportunity for engineering firms with stronger capabilities to move beyond complying with client requirements and help clients determine what those requirements should be. Depending on the client's needs, this could include helping establish data standards, developing digital-delivery strategies, improving integration with asset-management systems, or determining which data will create sufficient downstream value to warrant collecting and maintaining it.

This role will not be appropriate for every firm or every client. But as connected data becomes more consequential, digital and data strategy may increasingly become part of the advisory value engineering firms can provide.

Infrastructure Owners Should Define the Data They Need Beyond Project Closeout

Owners occupy a particularly important position because their need for infrastructure data extends well beyond the duration of an individual engineering or construction contract.

Yet current requirements remain heavily oriented toward traditional deliverables. Eighty-two percent of engineering-firm respondents say clients request or require traditional 2D/PDF deliverables most or all of the time, compared with 13 percent for structured project data in addition to documents or models, 12 percent for data formatted for integration into owner systems, and 13 percent for data intended for ongoing operations and maintenance.

For owners seeking greater lifecycle value from project data, the implication is that the desired future use of data should be considered earlier. If data ultimately need to populate asset-management systems, support maintenance, enable analytics, inform future capital planning, or feed future design decisions, those requirements may need to influence how data is structured and delivered during the project itself.

This does not necessarily mean requiring more data. Additional data creates value only if it serves an identifiable purpose and can be maintained and used. The more important question is whether owners are receiving the right data, in a form that remains usable for the decisions they expect to make later.

Firms and Owners Need to Address Who Pays for Lifecycle Value

One of the most difficult issues identified by the research is the separation between who incurs the cost of creating better-connected data and who eventually receives the benefit.

Sixty-two percent of engineering-firm respondents say client unwillingness to pay additional fees for connected data capabilities limits their ability to provide more advanced deliverables or services most or all of the time. The qualitative research similarly identified situations in which a project team or organization bears the immediate cost of structuring, classifying, documenting, or preparing data while much of the value is realized later by another project, department, organization, or lifecycle participant.

This suggests that conversations about connected data requirements should include the economics of creating and maintaining the data, not simply the technical specifications for delivering it.

Owners need sufficient evidence that additional requirements will create value. Engineering firms need a viable way to recover the resources required to meet those requirements. Both need greater clarity about where the benefits occur and over what period.

Without that alignment, the infrastructure ecosystem can create a persistent incentive problem: everyone may benefit from better-connected data collectively, while individual participants have limited incentive to bear the additional cost required to produce it.

Contracts Will Need to Address the Expanding Value of Data

As project data becomes more reusable, questions about ownership and reuse become more important. Eighty-one percent of respondents expect data ownership and reuse rights to become increasingly important contractual issues. Respondents also anticipate greater competitive importance for proprietary data, tools, and digital capabilities.

This creates a balance that firms and owners will increasingly need to manage. Infrastructure data needs sufficient interoperability and openness to remain useful across technologies and lifecycle phases. At the same time, engineering firms may develop proprietary tools, processes, datasets, analytics, or other capabilities that create legitimate competitive value.

Contracts may therefore need to become more explicit about what information belongs to the owner, what may be reused by the engineering firm, what constitutes proprietary intellectual property, how derived data may be used, and what responsibilities accompany future reuse.

These questions become particularly important when data continues creating value after the original project has ended.

Interoperability Should Be Prioritized Over Uniformity

The research provides little support for a future in which connected data means every participant uses the same platform. Infrastructure delivery involves too many organizations, disciplines, technologies, and asset lifecycles for that to be a realistic objective.

Instead, 74 percent of respondents believe open standards and interoperability will be essential to ensuring that infrastructure data remain accessible and usable throughout the asset lifecycle. Public owners placed particular emphasis on data remaining usable even as software platforms, engineering firms, contractors, and technology providers change over time.

For both firms and owners, this suggests that technology decisions should consider not only what a system can accomplish internally, but also how data enters and leaves that system, whether relationships and context are preserved, and whether data can remain usable when the surrounding technology environment changes.

The objective is not technological uniformity. It is continuity of useful data.

Firms Should Prepare for Connected Data to Affect How Engineering Value Is Created and Captured

The business-model findings suggest that connected data eventually may challenge some assumptions underlying traditional engineering economics.

Seventy-five percent of respondents believe connected data will allow firms to create more client value with fewer labor hours, while 72 percent believe traditional hourly pricing makes capturing that value difficult. Seventy-one percent expect opportunities for recurring or lifecycle-based services beyond traditional project delivery.

These findings do not establish that hourly billing will disappear or that any particular alternative pricing model will become dominant. Nor do the current service findings indicate that engineering firms have already made a broad transition to digital or lifecycle-based revenue models.

They do suggest that firms should begin examining where value may migrate as engineering work becomes more data-enabled and automated. Reusable data, proprietary capabilities, automated workflows, analytics, lifecycle services, and professional judgment may account for a greater share of the value delivered to clients even when they do not require proportionately more labor hours.

The strategic question for firms is therefore broader than how to use connected data to perform existing work more efficiently. It is also how to capture an appropriate share of the value that greater efficiency, better data, and new capabilities create.

Progress Will Require Firms and Owners to Move Together

The research ultimately points to a shared challenge.

Engineering firms cannot preserve data across the infrastructure lifecycle if owners do not know what data they need, cannot use what they receive, or do not value the additional effort required to create it. Owners cannot realize the full value of connected infrastructure data if engineering firms, contractors, and technology providers cannot produce and exchange data in usable forms.

Neither side is uniformly ahead of the other. The qualitative research found sophisticated and less mature organizations among both firms and owners. The transition is occurring unevenly across the ecosystem.

The implication is that progress will depend increasingly on coordination: clearer data requirements, greater interoperability, stronger governance, better alignment of incentives, development of workforce capabilities, and more explicit decisions about which data should remain valuable after a project ends.

The destination is not simply more digital engineering. It is an infrastructure ecosystem in which data created throughout an asset's lifecycle can continue contributing to engineering decisions, operations, maintenance, and future investment.

METHODOLOGY

The research for this study was conducted in two phases: qualitative interviews with engineering firms and public infrastructure owners, followed by a quantitative survey of ACEC member firms. The qualitative phase was designed to explore how connected data challenges and opportunities appear across the infrastructure lifecycle and to inform the development of the quantitative survey. The quantitative survey was then used to assess the prevalence of these experiences, practices, and perspectives across a broader group of engineering firms.

Qualitative Research

The qualitative phase consisted of 14 in-depth interviews conducted during July and August 2026. Eight interviews were conducted with representatives of engineering firms and six with representatives of public infrastructure owners.

Participants were selected to provide perspectives from organizations with different experiences, responsibilities, and levels of connected data maturity. The engineering-firm interviews explored how firms currently manage and exchange project data, where data connectivity breaks down, the value firms derive from better-connected data, barriers to greater connectivity, client requirements, data governance, AI, workforce and capability needs, and potential implications for engineering services and business models.

The public-owner interviews examined many of the same issues from the client and infrastructure-lifecycle perspective, including how project data is received and used, challenges associated with integrating data across systems and lifecycle phases, digital-delivery requirements, interoperability, governance, asset management, and the long-term value of engineering and infrastructure data.

The interviews were semi-structured. A common discussion guide provided consistency across the research, while allowing participants to elaborate on their organizations' experiences and identify issues that were not anticipated when the research began.

The qualitative research was intended to identify themes, experiences, and perspectives rather than produce statistically representative estimates. Findings from the owner interviews are therefore used throughout the report to provide context for the engineering-firm survey and to identify areas of alignment or difference between engineering firms and infrastructure owners.

Quantitative Survey

Following the qualitative research, a quantitative survey was conducted among ACEC member engineering firms from September 8 through September 19, 2026.

Approximately 2,400 firms were invited to participate. The research sought one response per firm and requested that the survey be completed by an individual familiar with the firm's project data, digital-delivery practices, and use of data across the infrastructure lifecycle.

A total of 251 engineering firms participated in the survey, resulting in an approximate response rate of 10.5 percent.

The survey examined firms' current connected data maturity and practices, areas where data continuity and usability break down, data governance and quality, current and potential value from connected data, barriers to greater adoption, client requirements and constraints, AI, workforce and capability needs, business-model implications, and expectations for the future of connected data in engineering.

Respondents represented firms of different sizes, geographic regions, market orientations, and areas of practice. Detailed characteristics of participating firms and respondents are presented in the Respondent and Firm Profile section.

Definition of Connected Data

Respondents were provided with a common definition of connected data to establish a consistent frame of reference for the survey. See the Introduction of this report for the definition.

Analysis and Reporting

Survey results are reported primarily for the total sample of participating engineering firms. Where differences among firm subgroups were both statistically significant and substantively meaningful, selected differences are discussed in the report.

Subgroup analysis included comparisons by firm size, geographic region, public- versus private-sector revenue orientation, respondent role, and overall connected data maturity. Statistical significance testing was conducted at the **95 percent confidence level.** Statistical significance indicates that an observed difference between groups is unlikely to be attributable to sampling variation alone, but it does not necessarily indicate that the difference is large or practically important. For that reason, the report focuses on subgroup differences that are both statistically significant and meaningful to the interpretation of the findings.

Sample sizes vary for some questions because of survey routing, item nonresponse, and the treatment of "Not sure" responses. Some questions were asked only of respondents for whom they were applicable. For selected questions, "Not sure" responses were excluded from percentage calculations so that results reflect respondents able to provide a substantive assessment. Where "Not sure" represented a meaningful response to the question, it was retained.

Percentages may not total 100 percent because of rounding or because respondents were permitted to select more than one response.

Interpreting the Findings

The quantitative results represent the experiences and perspectives of the engineering firms that participated in the study. As with any voluntary survey, the responding firms may differ from firms that did not participate. The findings should therefore be interpreted as an assessment of participating ACEC member engineering firms rather than a precise estimate of every engineering firm's practices or experiences.

The public-owner component of the research is qualitative. The six owner interviews provide important context about how connected data issues appear from the infrastructure-owner perspective, but they should not be interpreted as statistically representative of public infrastructure owners generally.

The combination of the two research approaches provides a broader perspective than either could provide independently. The quantitative survey identifies patterns across engineering firms, while the qualitative interviews provide additional context about how and why those patterns occur and how connected data challenges extend across organizational boundaries and the infrastructure lifecycle.

Transparency Statement

AI-assisted tools were used to support qualitative analysis for this report. All research decisions, interpretations, conclusions, recommendations, and final editorial content reflect the independent judgment and responsibility of the the research team.

THANK YOU TO OUR CONTRIBUTORS

The ACEC Research Institute provides the engineering industry with cutting-edge research, trend data, and economic analysis to help firm owners make decisions and delivers thought leadership that advances engineering's essential value to society.

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