



Familiar challenges— new approaches

2023 Global Construction Survey



Foreword

The 2023 Global Construction Survey finds the industry in a cautiously optimistic mood, as the combination of widespread government infrastructure stimuli, the renewable energy revolution, increasing capital investment in strategically important sectors, and a post-COVID-19 pipeline create excellent opportunities for engineering and construction (E&C) companies.

At the same time, the industry faces a continuing volatile environment, with continued supply chain disruption, rising inflation of energy, materials and wages, labor shortages and a possible recession, which could have a major impact on certain subsectors.

Meanwhile, the perennial challenges of poor project performance, low productivity, and costly major project failures—and high-profile industry bankruptcies—continue to dog the sector.

Environmental, Social, and Governance (ESG) presents both opportunities and risks. On the positive side, the shift to a low-carbon, biodiverse, circular world can drive infrastructure and construction spend and bring competitive advantage, improved ROI for forward-thinking, diverse, and purposeful businesses, who should be top of the queue for both capital and new talent. However, ESG also brings rising scrutiny and compliance requirements, as well as

pressure to reduce embodied and operational carbon footprint, waste and pollution—at pace—that could be costly and presents significant and multi-dimensional obstacles.

The technology dilemma persists, as both project owners and, particularly, E&C companies ponder where to invest and how to find the substantial sums needed to become digital leaders. Some of the key breakthroughs—like modular/offsite manufacturing—are still relatively low-tech and, if not widespread, are definitely gaining momentum. According to our survey respondents, the proportion of projects using 50 percent or more modular/offsite manufacturing is set to rise from 14 percent to 28 percent in the next five years (see Exhibit 19).

And the looming specter of big tech casts a perpetual shadow over an industry ripe for disruption, as traditional players face the threat of convergence, and losing market share to more digital-savvy interlopers.

This is KPMG's 14th Global Construction Survey, and the biggest to date, containing the insights of nearly 300 E&C firms from around the globe. Thank you to all those who took the time to participate in the ongoing debate about how to advance an industry that plays a huge part in all our lives and can be an incredible force for good.



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Survey at a glance

Addressing industry performance challenges

- Two-thirds (66 percent) of respondents are optimistic about the direction of the construction market, and 78 percent feel infrastructure stimuli will have a positive impact.
- Yet project performance remains in the spotlight, with only half of owners saying their projects are completing on time and 87 percent stating that projects are coming under greater scrutiny.
- To address ongoing volatility, the biggest priority is improving estimating accuracy, transferring risk, and increasing innovation.

Rising influence of ESG

- ESG has climbed construction leaders' agendas, with 54 percent "fully envisioning" the benefits of ESG and aggressively pursuing maturity. Survey respondents say the key benefits of ESG are reputational improvement and competitive advantage—as well as a necessity to enhance access to project capital
- Diversity, equity, and inclusion (DEI) is the third most important factor determining future success, as the sector shifts away from its hard-hat image toward greater use of technology and more remote working.
- Owners are relatively more concerned with reducing greenhouse gases (GHG) while E&C companies place the highest priority on DEI. Embodied carbon (carbon released during the construction process) is a growing concern and is likely to be the subject of future regulations.

The great innovation race

- The construction industry is starting to embrace the power of technology to transform performance—with 81 percent of E&C firms adopting mobile platforms, 43 percent using robotics process automation (RPA) and 40 percent adopting artificial intelligence (AI)—although many are in the early stages.
- When it comes to improving ROI on capability projects, project management information systems (PMIS), building information modeling (BIM), and advanced data analytics are considered to have the greatest potential; digital twins, modular/offsite manufacturing, AI, and BIM are driving the greatest gains in project performance.
- A vast majority of respondents say prefabrication is an important solution for capability projects, although just one-quarter of E&C companies use modular manufacturing across all projects.
- There's growing recognition of the power of technology to improve safety, notably from use of D&A and modular manufacturing—the latter reduces dangerous, onsite work.

Chapter 1

Profitable, sustainable growth— or boom and bust?

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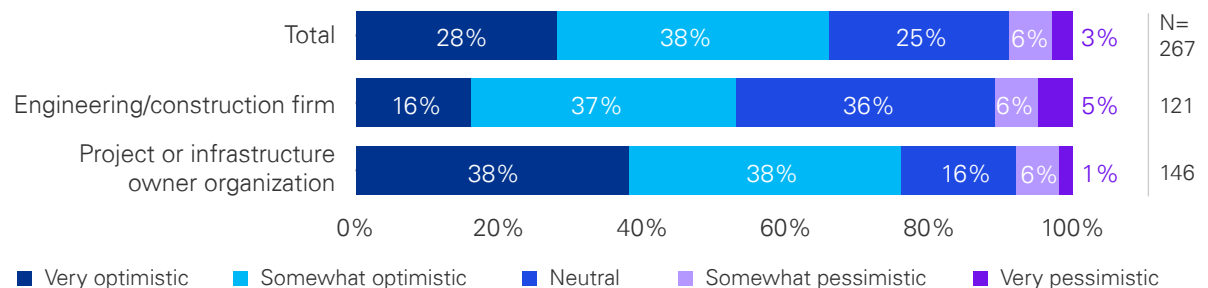
Profitable, sustainable growth—or boom and bust?

On the surface, the global engineering and construction (E&C) industry appears to be benefiting from positive momentum.

With a significant post-COVID-19 pipeline, government infrastructure funding in the U.S. and beyond, and ESG demands driving renewable energy and circular economy projects, it's perhaps little surprise that many of the respondents to the 2023 Global Construction Survey are in a positive frame of mind.

Two-thirds of this year's respondents (66 percent) say they are optimistic about the direction of the construction market and 38 percent of project owners are "very optimistic" (see Exhibit 1) compared to just 18 percent in 2021. And the proportion of owners anticipating greater than 20 percent capital program growth has more than tripled from 10 percent in 2021 to 36 percent in 2023 (see Exhibit 1), the highest figure in the 20-year history of the survey.

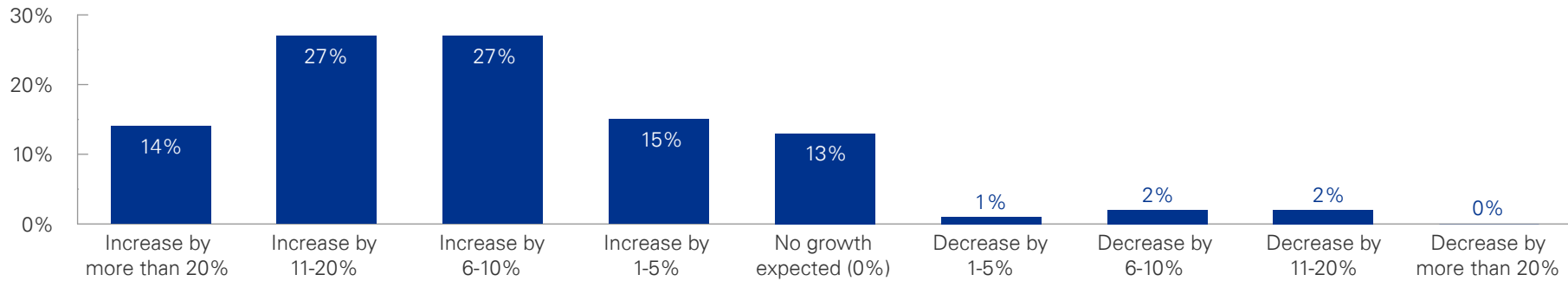
Exhibit 1: Which of the following statements best describes the direction of the construction market?



Four out of 10 E&C respondents expect revenue growth in the next 12 months to be greater than 10 percent, with just 18 percent predicting zero or negative growth (see Exhibit 2). E&C firms remain more cautious than project owners, but only a small proportion (7 percent) express

pessimism about the future state of the market—the corresponding figure for 2021 was 29 percent (see Exhibit 1). With contractors in the middle of supply chain disruptions and with limited visibility into owners' robust capital plans, such differences are to be expected.

Exhibit 2: What is the planned revenue growth for your organization over the next 12 months?

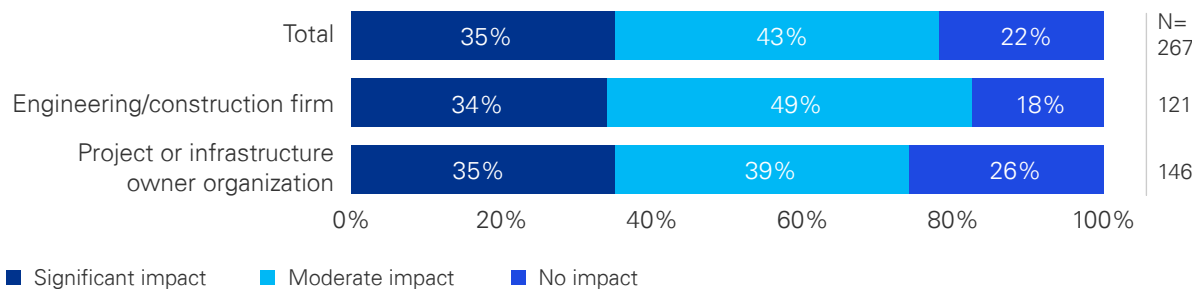


Note: Applicable only for engineering and construction firm (N=121)

There's also plenty of excitement about the prospect of government funding, investment and stimuli for large-scale infrastructure programs, such as Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, Inflation Reduction Act (IRA), and Infrastructure Investment and Jobs Act (IIJA) in the U.S., India's Production Linked Incentives (PLI) and Make in India campaigns, and similar programs

in other countries. According to global research from Oxford Economics, civil engineering is set to be the fastest-growing sector in the construction market.¹ More than one-third of survey participants (35 percent) feel this funding will have a significant impact and a further 43 percent expect a moderate impact (see Exhibit 3).

Exhibit 3: What impact will the government's funding, investment and/or stimulus of large-scale construction programs (e.g., CHIPS and IRA in the U.S., other programs in the jurisdictions where you operate) have on your organization in the next 12 months?



¹ Nicholas Fearnley, "Key Construction Themes 2023—Infrastructure to drive growth," Oxford Economics, December 14, 2022



Project performance in the spotlight

Despite the confidence expressed by respondents, the industry continues to face a number of challenges, in the form of continued supply chain disruption, high energy and materials prices, and labor shortages that are further pushing up costs and holding up projects.

The after-effects of COVID-19 are still apparent, with 45 percent of respondents saying they have experienced a pandemic-related schedule delay or cost impact of more than 20 percent (see Exhibit 4).

And the sector continues to struggle with poor project performance, with 37 percent of respondents reporting that they've missed budget and/or schedule performance targets over the past year due to lack of effective risk management—this is up from 32 percent in the corresponding 2021 survey (see Exhibit 5). In fact, only half of owners' projects are being completed on time.

Exhibit 4: What percentage of your projects have experienced a schedule delay or cost impact attributable to COVID-19?

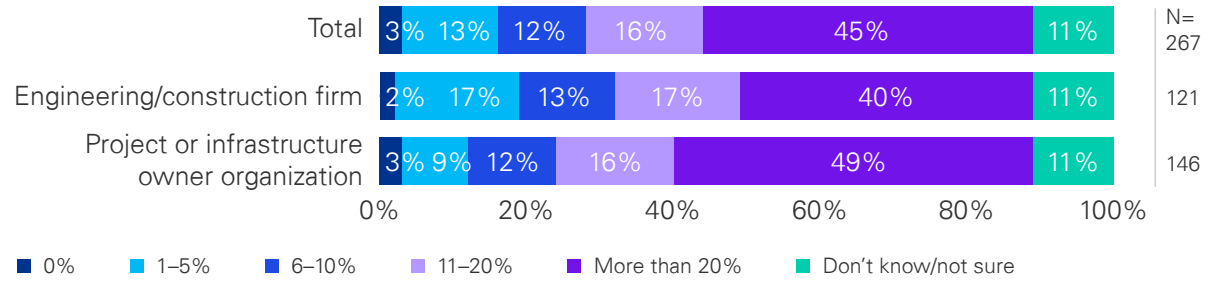
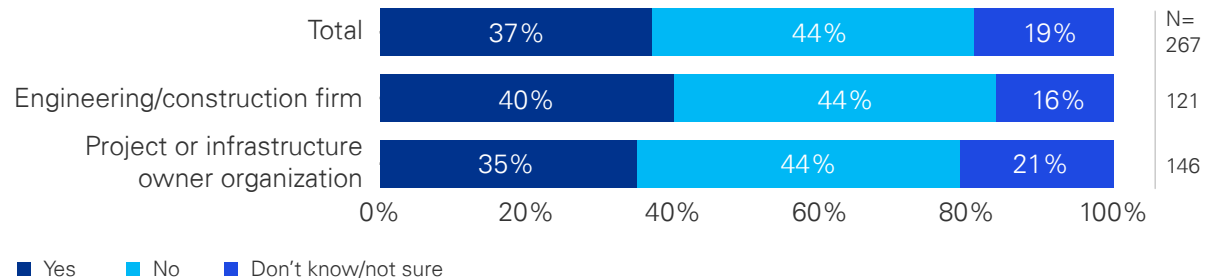


Exhibit 5: Over the past 12 months, have any of your capital projects significantly missed budget and/or schedule performance targets (20 percent or more) due to lack of effective risk management?

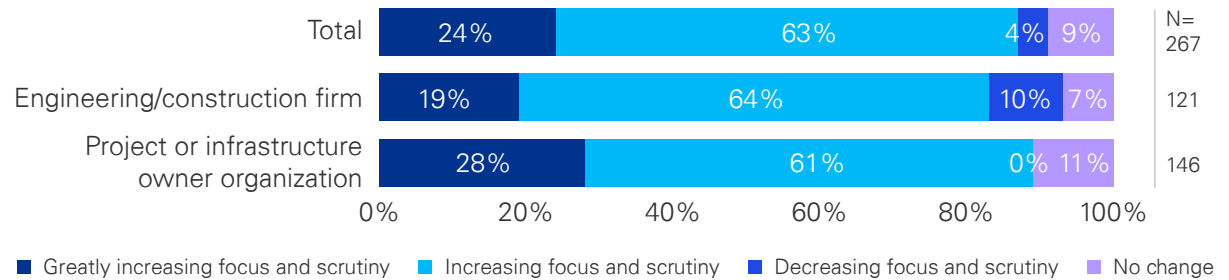


Consequently, owners are seeing increased interest in the economics of large capital projects, with 87 percent stating that they're coming under greater scrutiny (see Exhibit 6). Indeed, 28 percent of project owners say they're facing "greatly increased" focus and scrutiny.

Volatility has fueled market challenges, but so have the continued stagnant productivity and lack of innovation in E&C. Much of this is due to a highly fragmented structure where many players have neither the size nor the incentive to invest in new technology or methodologies, especially when contractors take on paper-thin margins that leave little room for error. Between 1997 and 2021, construction productivity actually fell by 7 percent, whereas in the manufacturing sector it rose by 126 percent.

Inadequate risk management has hardly helped, with insufficient linkage between project risk management and enterprise risk management that prevents owners and contractors from accurately aggregating all their risks to fully understand their corporate risk profile. With a multitude of players, a dearth of data sharing and interoperability, and a siloed value chain, visibility across individual and multiple projects is often lacking. Project managers are often unable to identify and address poor performing projects, sites, or individuals.

Exhibit 6: Which statement best reflects your perspective of the economics of large capital projects and the scrutiny surrounding their actual measured benefits and return on capital post project completion?



How is the industry responding to high volatility and poor performance?

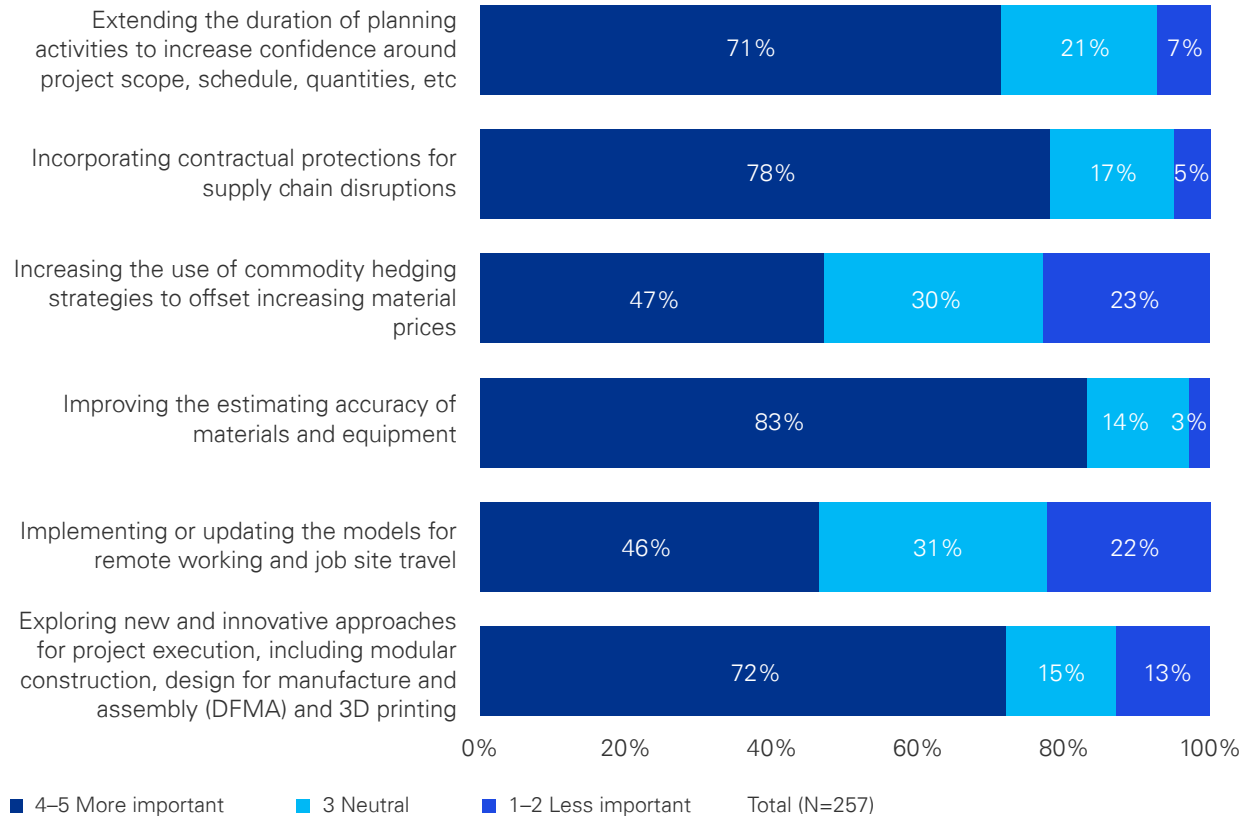
According to U.S. Bureau of Labor Statistics in March 2023, construction costs rose 17.3 percent year-on-year.² Add to this the war in Ukraine, the West potentially de-coupling its economy from China, resource constraints, and ongoing supply chain disruption, and it's evident that E&C firms and project owners face continuous volatility.

In response, 83 percent of survey participants say their single biggest priority is improving the estimating accuracy of materials and equipment, which accounts for a significant proportion of project costs (see Exhibit 7). Achieving

better contractual protection—which is about transferring risk—is another key imperative for both owners and contractors. However, such an approach can damage owner/contractor relationships at a time when the two parties should work together more closely to enable owners to better manage their own risks. With both owners and contractors attempting to transfer risk, there is likely to be an impasse, although continued tightness in the market should favor contractors, who are in high demand.

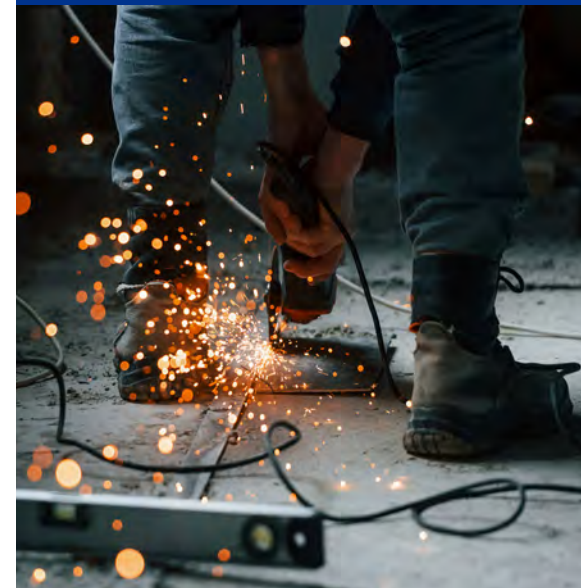
² US Bureau of Labor Statistics, New Manufacturing and Industrial Building Construction PPI, March 2023

Exhibit 7: How important are each of the following regarding your organization’s response to supply chain disruption, cost escalation, resource constraints, deglobalization, COVID-19 and other disruptive events?



We are seeing a dramatic shift by contractors away from fixed-price and guaranteed maximum-price contracts for major projects. Whether this is the result of learning from past mistakes, acknowledging that systems and tools are still not where they need to be, or simply driven by boards, bankers or risk officers, one thing is clear: we cannot expect business as usual. Contractors are no longer willing to assume primary responsibility for performance risk and, as contractors transition to more open-ended, cost-plus and time-and-materials contracts, owners will need to adjust how they control projects and programs.”

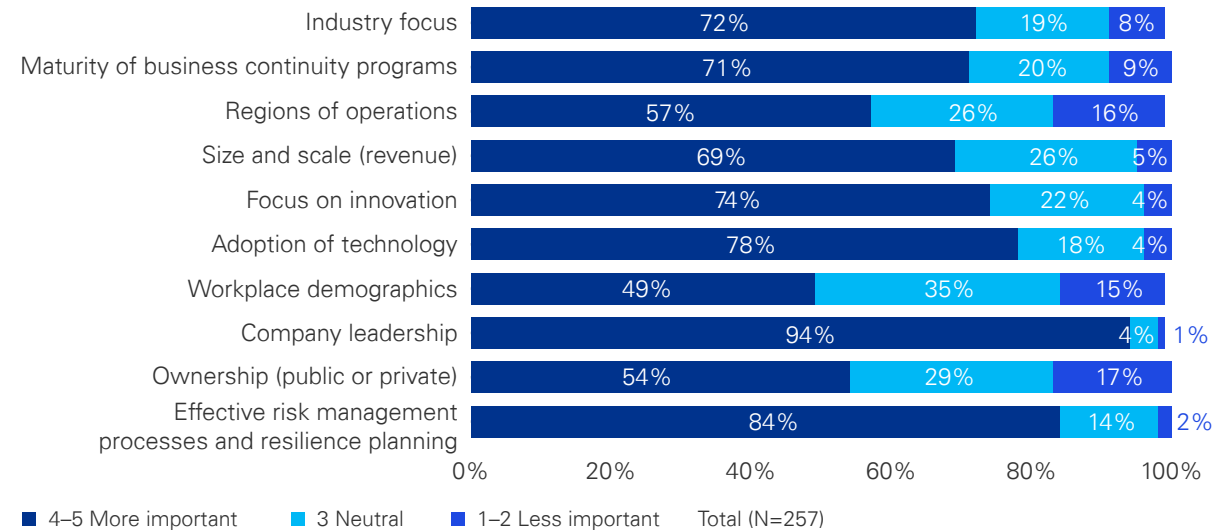
Colin Cagney, *Director, Infrastructure, Capital Projects and Climate Advisory, KPMG in the US*



Further potential options include longer planning periods to better manage project scope, schedule and quantities, which, regrettably, is not always an option in commercial and mission-critical projects.

When it comes to dealing with disruptive events, respondents are placing a greater focus on innovation (up to 74 percent from 60 percent) and workplace demographics (up to 49 percent from 42 percent) than in the previous 2021 Global Construction Survey (see Exhibit 8). Effective risk management processes and resilience planning are also on the “to-do” list to help build resilience.

Exhibit 8: Please rate the following attributes that influence your organization’s success or failure in dealing with disruptive events.



View from the industry

Building supply chain resilience



S. N. Subrahmanyam, CEO & MD, Larsen & Toubro Limited

To address the pandemic and wider geopolitical disruptions, we enhanced our supply chain with alternate sourcing channels, multiple local vendors and strategic tie-ups. We devised deeper hedging strategies, adopted just-in-time sourcing, and proactively engaged with our clients to address price variations/contractual indexation of raw material input costs.

And, in response to sometimes unreliable supply chains, we've adopted indigenization, to gain greater independence. In one instance we manufactured complex launching equipment for India's high speed railways. In another, during the pandemic, we assembled and operated the country's largest tunnel boring machine, creating a world record for the highest monthly tunnelling rate of 456 meters on the iconic Mumbai Coastal Road project.



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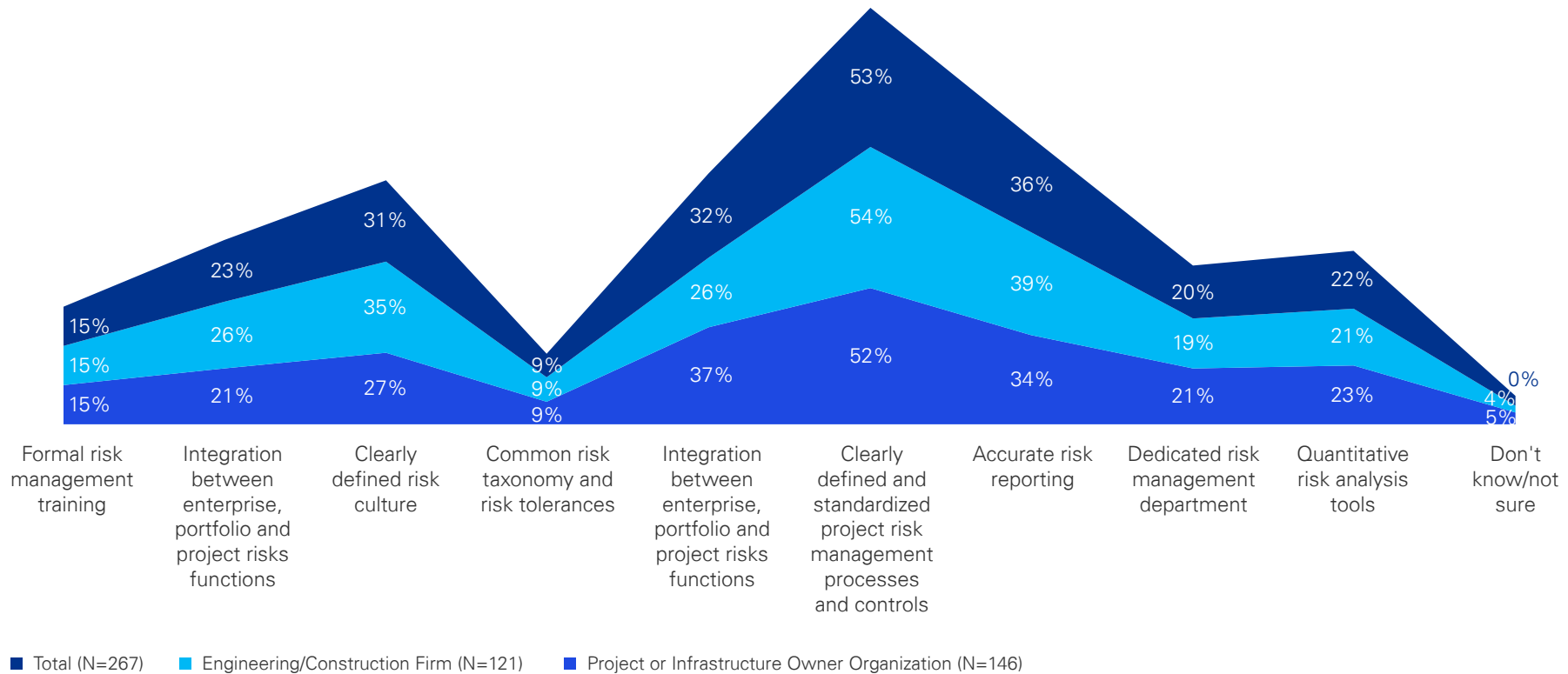
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Finally, given the risks inherent in the market in general, and in large and mega-projects in particular, E&C companies and capital project owners are seeking ways to improve portfolio-wide risk management. Their number one aim is to achieve clearly defined and standardized risk management processes and controls. There is a greater emphasis upon accurate risk reporting (up to 36 percent from 25 percent) and establishing a dedicated risk management department (up to 20 percent from 17 percent) compared to the previous 2021 survey (see Exhibit 9).

Exhibit 9: Which of the following elements are you focusing on to achieve successful portfolio-wide risk management?



Cracking the productivity and performance code

How can the E&C industry break the vicious cycle of poor performance, low productivity, and major project failures?

From a risk management perspective, the ability to aggregate risk at an enterprise level can bring a clearer view of portfolio risk, to avoid taking on projects that could break the company, as well as identifying emerging risks earlier to enable preventative action. Better transparency, allied with D&A, opens up understanding of risk interdependence, both within and across projects.

There are a number of ways to improve productivity, including the use of IoT sensors and data analytics to detect and assess problems like damage—this enables rapid response times that help minimize delays and cost overruns. Benchmarks for team performance can be easily created through shared data. Predictive maintenance—which can increase the likelihood of heavy equipment staying operational and minimizes shutdowns. Access to suppliers' data helps anticipate supply chain delays or shortages



earlier, enabling procurement teams to seek alternative sources.

It's also important to drive capital efficiency and effectiveness in a transparent and integrated manner. The first step is a robust capital planning and portfolio management process that is well integrated into project governance and PMO activities through strong processes. Dashboards and KPIs show the status and performance of projects and portfolios, and also provide insights into updated business cases linked to operations as well as customer and supply chain plans and models. (To learn more, read our recent paper, [CapEx decisions in a downturn](#)³.)

In a fragmented sector, E&C companies have an opportunity to form construction ecosystems where data and insights flow between contractors, suppliers, and owners to introduce a common understanding of project delivery objectives that's aided by greater supply chain transparency.

And finally, by paying careful attention to asset owners' customer experience, it's possible to create more society-friendly projects that reduce negative impact, whether it's reducing noise and pollution, or avoiding transport closures.

³ Capex decisions in a downturn, April 2023, KPMG

View from the industry

Driving continuous improvement



John Murphy, CEO, J. Murphy & Sons Limited

One of our main core values is to continually improve. Our other core values are to always deliver on time, on budget, and to a high level of quality. I feel our family ownership helps us to achieve these goals, enabling a longer-term view on how to realize sustainable growth five-to-ten years from now and to think differently about how we invest in the business.

We apply innovation from the very start of a project during engineering and design, so we can deliver the project safely, efficiently, with timeliness better cost control, and ultimately, with better quality. By investing in engineering capabilities and tools, we can drive efficient, practical solutions and find even more efficient ways to deliver projects year-on-year.

In an increasingly digital age, data is critical for measuring our productivity, determining how we deploy our resources more efficiently, and reducing the carbon impact of our projects, which is especially relevant to our work in the transport and energy sectors. At the same time, we don't

want to get swamped in data that overwhelms us and ceases to be useful.

We generate a lot of data from our projects, so we have to think about how we can utilize the data, get it into the right hands at the right time to drive better decision-making, and make more accurate predictions. Sharing data and insights from project to project prevents us from reinventing the wheel and helps us to work smarter across the business and learn from our successes, as well as our failures. Our application of technology and intellectual property also benefits our clients through improved project outcomes.

As our business grows, we want to be evolutionary rather than revolutionary. We are continuously investing to keep up with the pace of technological change—constantly progressing. I believe that's how we'll be able to maintain growth and improve our performance in the future and continue to deliver high-quality projects for our clients.

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Chapter 2

The rising influence of ESG

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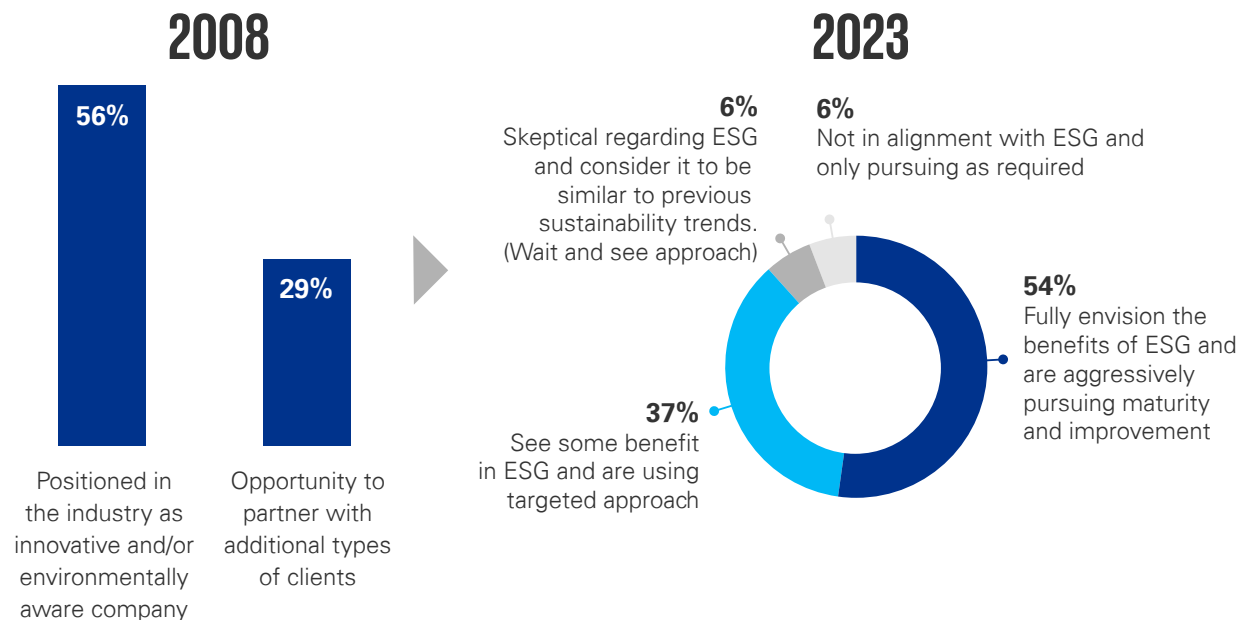
The rising influence of ESG

Our recent paper, *Construction in 2030*⁴, notes how the industry is regarded as high-carbon, high-waste, and high-polluting, with significant use of scarce resources like water and minerals, moderate usage of renewable energy, and limited progress with diversity in what remains a male-dominated sector. At the same time, E&C companies face growing regulatory pressure for sustainability in both its construction methods and the buildings and infrastructure it produces. Failure to meet such demands could impact access to—and push up the cost of—capital.

Looking back to our Global Construction Survey from 15 years ago, the top drivers for sustainability among E&C companies (see Exhibit 10) was to position themselves as innovative or environmentally aware (cited by 56 percent of respondents), and to increase business opportunities and competitiveness (29 percent).

However, in the 2023 survey, we see a strong commitment from the respondents. Nearly 54 percent fully envision the benefits of ESG and are aggressively pursuing maturity and improvement, whereas, nearly 37 percent see some benefit in ESG and are using targeted approach (Exhibit 10). In addition, nearly 50 percent of E&C firms view implementing ESG into capital projects and programs as a competitive advantage (Exhibit 11).

Exhibit 10: Changing trends of an organization’s internal views on ESG



⁴ *Construction in 2030*, February 2023, KPMG

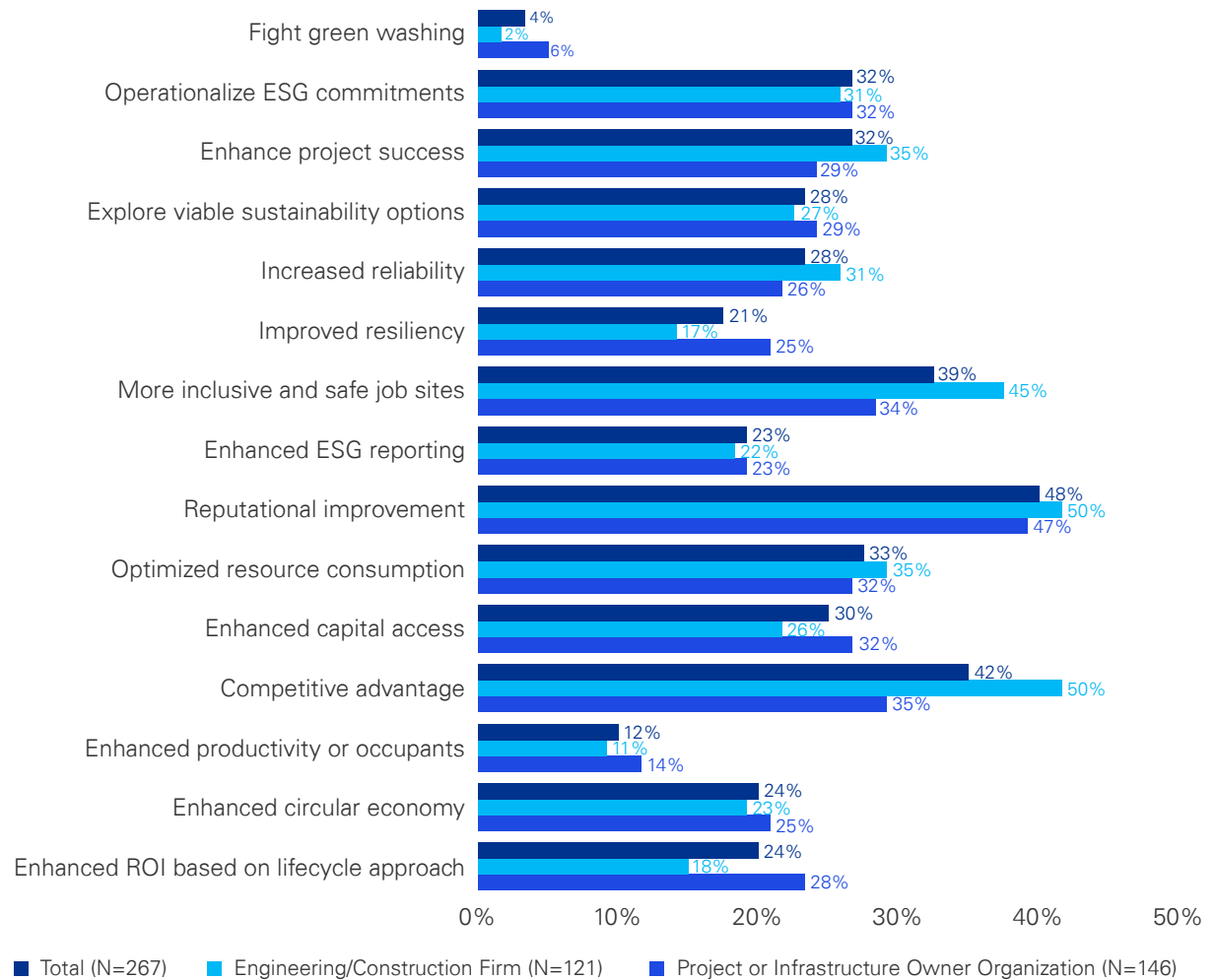
Project owners taking part in our global survey show substantially greater maturity in their approach to ESG compared to E&C companies. In the U.S. in particular, they face increasingly stringent legislation, procurement requirements, and building code improvements, and any laggards will have to play a fast game of catch-up.

When asked about the key benefits of embedding ESG into capital projects and programs, the top two responses were reputational improvement and competitive advantage. Half of E&C companies see opportunities to gain a competitive edge through ESG, suggesting that they're beginning to grasp the value of more fully embracing ESG (see Exhibit 11). Respondents from E&C also consider safe, inclusive sites as a benefit, reflecting a desire to attract a wider range of workers.

And 32 percent of owners recognize the need to integrate ESG in order to enhance their access to capital to fund projects (see Exhibit 11)—an acknowledgment of the importance of strong sustainability credentials to satisfy investors.

Interestingly, project owners and E&C firms differ in their views over the most crucial ESG trends. The former feel that reducing GHG output and developing renewable facilities are most important, while contractors are more concerned with social considerations, such as DEI, and meeting government requirements.

Exhibit 11: What benefits could your organization realize by implementing ESG into your capital projects and programs?



“As the three forces of ‘Environmental,’ ‘Social,’ and ‘Governance’ converge, E&C companies and project owners are set to accelerate their investment in ESG.”

Geno Armstrong, Global Lead and Principal, Infrastructure, Capital Projects, and Climate Advisory



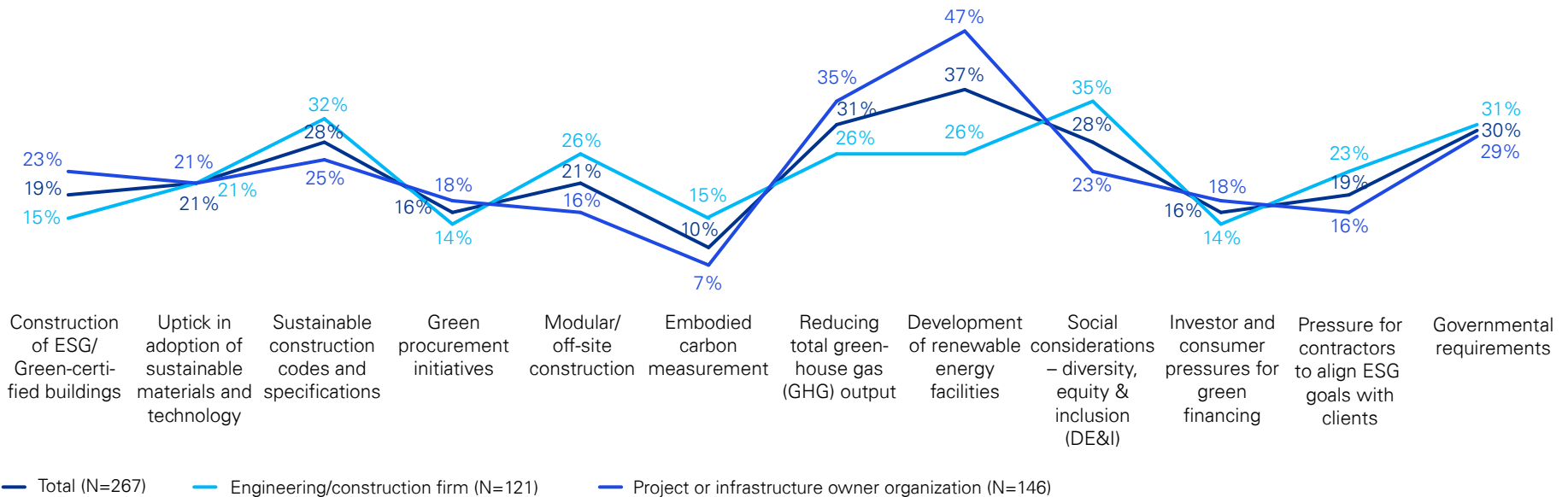
The built environment generates around 40 percent of global greenhouse gas emissions (GHGs) and uses approximately 40 percent of global energy resources. It is, therefore, no surprise that ESG regulatory and stakeholder pressure is on the increase. The industry has also shifted its thinking since our 2008 Global Construction Survey—where sustainability was thought of primarily as a profit vehicle—to 2023, where a higher proportion of leaders see ESG as a core element of business strategy. The next step is to operationalize ESG principles into capital projects to increase efficiency and sustainability, reduce waste, avoid greenwashing, mitigate risks, and enhance long-term value for all stakeholders.”

Firuzan Speroni, Ph.D., *Director, Infrastructure, Capital Projects and Climate Advisory, KPMG in the US*

This discrepancy is understandable as owners are currently being measured by Scope 1 and Scope 2 emissions of their facilities, whereas service providers gain market advantage by improving their DEI performance and adhering to requirements. As increasing Scope 3 regulations come into effect globally, owners are likely to ask service providers to disclose embodied as well as operational carbon, which in turn will direct the industry’s focus to total lifetime GHG emissions.

Decarbonization has become a central part of any construction project, and respondents listed the three most important practices as energy efficiency, reducing construction waste, and more efficient use of materials.

Exhibit 12: Which of the following ESG trends are the most important for the success of your organization?





Embodied carbon: The missing half of GHG emissions

Up to half of all carbon emissions are emitted before the building is operational, as a result of embodied carbon: the amount of the GHG emitted during the manufacturing, transportation, installation, maintenance, and disposal of building materials.

To date, facilities, real estate, and construction functions have ignored this half of their carbon emissions and it's not just them; current standards, guidelines, codes, and measurements mostly focus on operational carbon (from heating, air conditioning, and operating the facility) emissions. This presents a huge opportunity for many teams to further their commitments to decarbonization. For more on this vital topic, read our recent report, [Embodied carbon: the missing half of GHG emissions](#).

Firuzan Speroni, Ph.D., *Director, Infrastructure, Capital Projects and Climate Advisory, KPMG in the US*



Preventing wildfires in California



Jamie Martin, Vice President, Undergrounding, Pacific Gas and Electric Company (PG&E)

California has experienced an unprecedented increase in catastrophic wildfires over the past decade, with over half of PG&E's 70,000 square mile service area designated as "high-fire risk." By bringing power lines underground, we can reduce the risk of wildfires by 99 percent, and improve reliability for our 16 million customers. We have therefore committed to a huge program to move 10,000 miles (16,000 km) of overhead electric distribution lines underground in the highest risk areas.

Undergrounding is just one part of our integrated strategy to manage and reduce ignition risk. Our comprehensive monitoring and data collection programs include wildfire

cameras and inspections to give valuable insights into changing environmental hazards around our assets. Enhanced powerline safety settings (EPSS) automatically switch the grid off if danger—like a tree branch striking the power line—is detected. Downed conductor detection tells us when a pylon has collapsed or been damaged. We also manage the environment around the electric grid, such as trimming back vegetation.

We know that we cannot complete this important wildfire safety work alone and will need help from our customers, communities, and other stakeholders. Through our outreach approach, we share a comprehensive vision for

wildfire risk reduction, including how we plan to utilize undergrounding, communicating early and often with customers and stakeholders to keep them informed and answer questions and concerns. For our local, state, federal and tribal agency partners, we communicate through regular meetings, permitting discussions, and updates of planned work locations. And, in the worst-case scenario, we support customers before, during, and after wildfire events.

Through collaboration and breakthrough thinking, we are working together to mitigate wildfire risk and make our hometowns safer and more reliable for generations to come.

Continuing efforts to improve worker safety

The construction sector has made impressive advances in worker safety in the past decades, and the responses to our global survey suggest that companies continue to prioritize this vital area. For both project owners and E&C firms, the single most crucial factor is the tried-and-trusted behavioral, leadership and cultural change, to create a climate with zero-tolerance towards accidents. Respondents—especially owners—are keen to increase safety monitoring and onsite health and wellness testing of workers, to reduce the risk of incidents.

Technology also plays more of a role to create safer working spaces, with respondents making greater use of data and analytics (D&A) to predict and prevent, as well as modular/offsite fabrication to reduce potentially dangerous onsite tasks. Our survey results suggest that other innovations are at an earlier stage, with less frequent use, such as smart sensors and monitors, drones, remote-operated machines, and robotics. The low take-up of such potentially advantageous technology could be a wake-up call for progressive players to improve

their safety records through digitalization and automation.

Mental health is becoming destigmatized in the industry, with many companies taking tangible steps to support workers, including risk assessments that cover both physical and mental health, sharing resources around mental wellbeing, and offering practical help like trained peer support.

Post-COVID-19, the use of PPE and worker wellbeing has become high-priority, with some

construction companies going the extra mile by providing employees with innovative new PPE items that not only help keep them safe, but also enable them to do their jobs more comfortably—such as 3D printed masks and safety footwear that helps revitalize blood flow through the legs and feet and gives the wearer greater energy.⁶

As one would expect, safety is a crucial pillar of ESG-led performance and part of all ESG ratings assessments.



Safety training and information exchange are increasingly benefiting from technology and software that engages staff and empowers workers to communicate risks. Smart devices like connected wristbands and helmets enable workers to be more proactive in their safety processes, share information about hazards and potential incidents in real-time, all while fostering a positive safety culture.”

Clare Lunn, *Partner, ESG, Advisory, KPMG in the US*

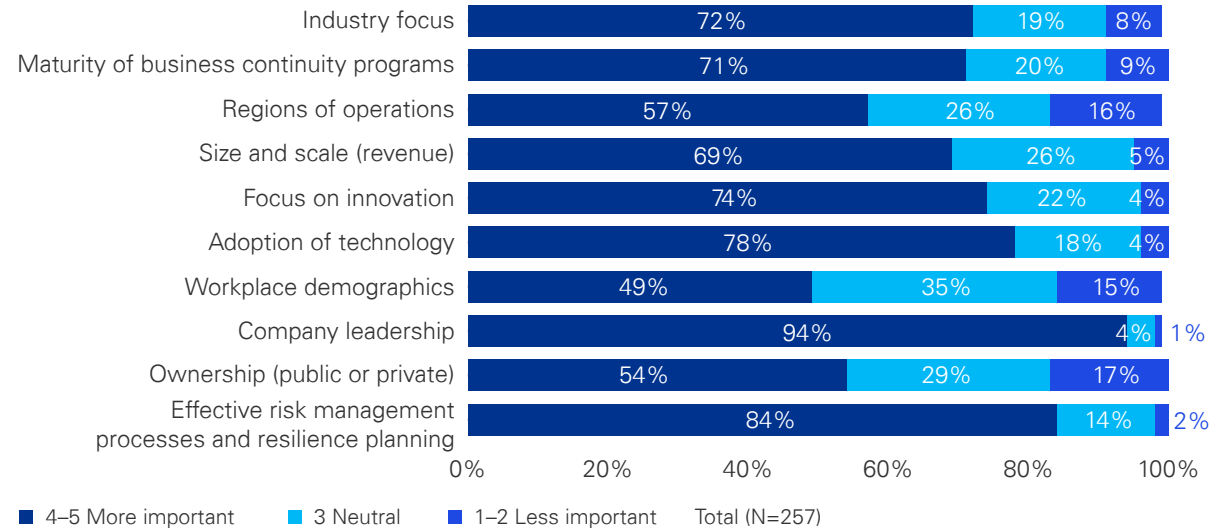
⁶ Grant Prior, “Anti-fatigue safety footwear boosts energy,” *Construction Enquirer*, October 3, 2019

Adapting to the needs of a future, diverse workforce

The E&C industry is undergoing rapid change in its working practices, with a shift away from traditional, hard-hat, onsite positions towards technology-related capabilities that are often performed remotely. At the same time, both E&C firms and project owners are competing for scarce talent with companies from virtually every other sector.

Respondents to the 2023 global survey rank DEI as the third most important factor determining future success (see Exhibit 13). An increasing proportion (50 percent, compared to 42 percent in 2021) cite the importance of diversified workplace demographics to help address disruption—the diversity helps introduce new skills to tackle longstanding project cost and schedule challenges.

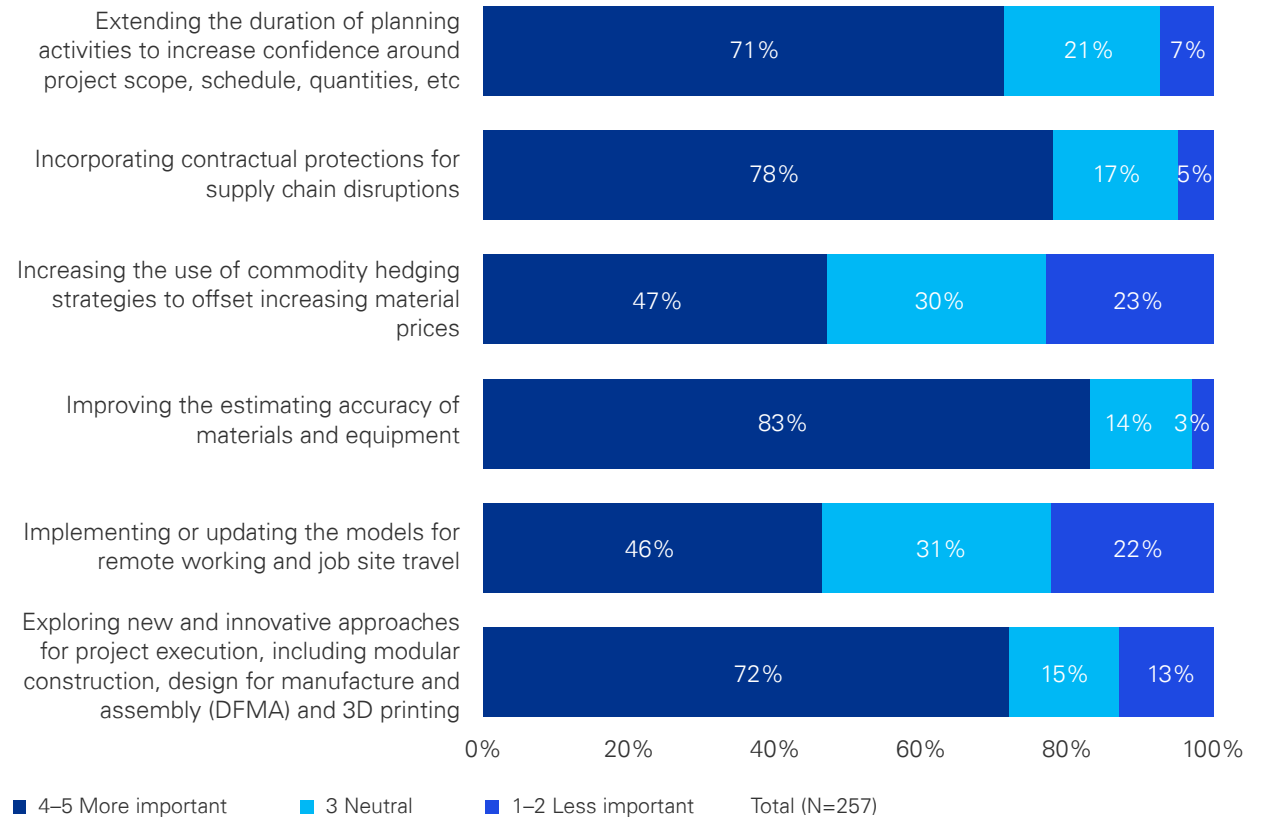
Exhibit 13: Please rate the following attributes that influence your organization’s success or failure in dealing with disruptive events.



And almost half (46 percent) acknowledge that implementing or updating models for remote working and job site travel can play a part in making construction projects more resilient and able to thrive during volatile times (see Exhibit 14).

But it will be tough to make these breakthroughs without the right people, which means doubling down on efforts to build a more diverse workforce.

Exhibit 14: How important are each of the following regarding your organization’s response to supply chain disruption, cost escalation, resource constraints, deglobalization, COVID-19 and other disruptive events?



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Creating an industry of choice for the best talent

Attracting the best graduates and school leavers means offering fulfilling careers on the cutting edge of innovation, in purposeful, sustainable organizations, offering varied development paths, flexible working conditions and greater work-life balance. More and more employees are looking for companies that prioritize DEI, employee health and wellbeing, community building, and strong governance—while minimizing their environmental impact.

As we discuss in *Construction in 2030*⁷, the sector has a golden opportunity to shed its male-dominated, “hard-hat, manual labor” image by becoming more technology- and sustainability-oriented. This shift should help persuade graduates that this is an exciting industry to join.

In a 2022 KPMG survey of U.S. workers, “Looking for more: Employee expectations are on the rise⁸,” an overwhelming 90 percent of respondents said work-life balance is an important factor when looking for a new

employer. Almost half—45 percent—don’t feel they have adequate, diverse career path opportunities into lateral and upward roles.

Another KPMG paper, “Navigating the tech hiring freeze⁹,” argues for a greater focus on workforce planning to determine an organization’s talent needs and identify how to satisfy these demands by training and upskilling. And by building a compelling digital workplace experience, E&C companies can enthrall existing workers and attract future stars.

Respondents to this year’s Global Construction Survey rank the development of improved and innovative training programs as the number one strategy to attract next-generation talent into the sector. The metaverse offers particularly exciting opportunities to onboard, train, and interact. In “Want to win in the metaverse? Think internal first¹⁰,” KPMG surveyed companies from the technology, media and telecommunications industry and found the top uses of the metaverse were for internal activities such as employee training and onboarding, and employee collaboration.

Given the continued digitalization of E&C, investment in the metaverse could be a catalyst for improving the employee experience.



We need to think differently about the people that we attract into the industry, so that businesses become far more diverse and far more reflective of society.”

John Murphy, CEO, *J. Murphy & Sons Limited*



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⁷“Construction in 2030,” February 2023, KPMG,

⁸“Looking for more: Employee expectations are on the rise,” August 2022, KPMG

⁹ “Navigating the tech hiring freeze,” January 2023, KPMG

¹⁰ “Want to win in the metaverse? Think internal first,” KPMG

View from the industry

At the forefront of sustainable construction



David Paterson, Managing Director, Construction, Lendlease

Sustainability underpins everything we do

As a company we're absolutely committed to climate action, with an intentionally bold goal of "absolute zero carbon" by 2040. To achieve this, we must eliminate all emissions from construction sites, without the use of carbon offsets. And we've set ambitious targets:

- Phase out fossil fuel diesel and gas across our operations
- Use 100 percent renewable electricity before 2030
- Collaborate with supply chain partners to set pathways to absolute zero by 2040

Good data is essential to a credible plan, not just to report performance, but also to forecast our emissions to stay on track.

We must pull together to tackle climate change

We're fortunate to be working with some amazing partners to accelerate our net zero ambitions. These include MECLA—

the Materials & Embodied Carbon Leaders Alliance—Responsible Steel, and the University of Queensland.

No single party can fix the environment—it needs to be a team effort across the value chain. We need clients to request zero- and low-carbon options, for contractors to assess their supply chain, suppliers to innovate, while designers need to trust the options and be willing to test new things. Governments need to set supportive policies, and industry advocacy groups need to champion fossil fuel-free construction.

A key role for governments

Here in Australia, the government, state governments and the finance industry can support a domestic renewable diesel industry with investment into refineries or financial support for the use of renewable diesel. Mechanisms include tax relief, subsidies and rebates, green low interest loans and finance,

grants, and a phase-out of financial support for fossil fuels.

All state governments have carbon emission reduction targets, and governments can align their procurement policies with decarbonization targets for construction activities, to help reduce emissions on infrastructure projects.

No time to lose

Don't delay—there are solutions available today that can be deployed at scale. Understand your data, your emissions profile and the risks and opportunities to your business strategy. Learn about climate change, carbon emissions, scope boundaries and accounting and educate your employees, clients, and customers. The G20's Taskforce on Climate-related Financial Disclosure framework (TCFD) is a powerful way to explore the impact of climate change. Lastly, align to 1.5 degrees, this is the change the world needs us to make.

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Chapter 3

The great innovation race



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The great innovation race

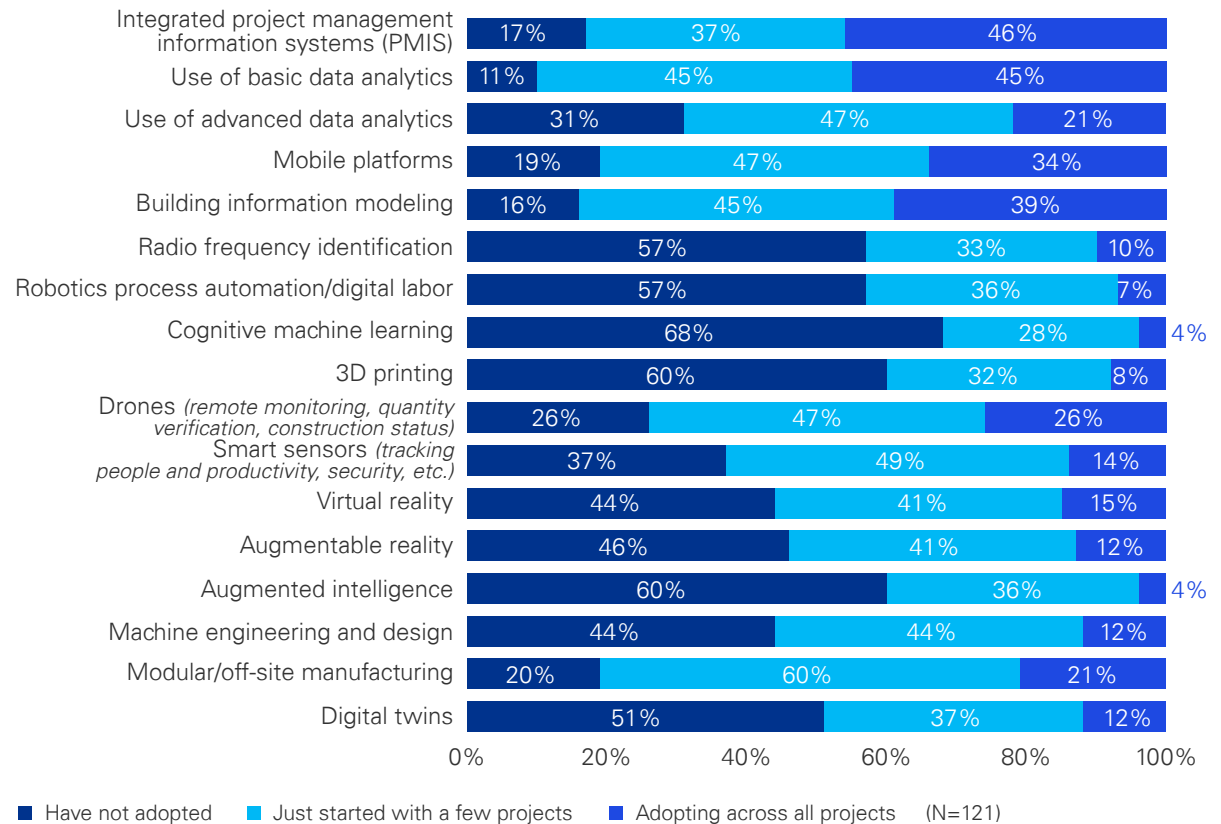
What is the role of digital and other innovative technologies in the new construction landscape?

That's a burning question facing the sector's leaders as they ponder how to overcome continued poor project performance, adopt, safe, sustainable construction methods, and improve the quality, efficiency and carbon footprint of buildings and infrastructure. Tech giants are both potential collaborators—bringing new and exciting innovations—as well as competitors, as they use their data mastery to gain market share, and also attract the best talent.

Our 2017 Global Construction Survey took a deep dive into technology and found an industry embracing building information modeling (BIM), analytics and project management information systems (PIMS), just starting to adopt drones, smart sensors and mobile, with a few bold innovators exploring 3D printing, machine learning (ML), virtual reality (VR) and robotic process automation (RPA).

Fast forward to this year's survey and 81 percent of respondents from E&C firms say their organizations have adopted, or are starting to adopt, mobile platforms (up from 69 percent in 2017, see Exhibit 15), while 43 percent are either using or starting to use RPA compared to just 10 percent in 2017. Meanwhile, take-up of VR (either using or starting to use) has doubled from 28 percent to 56 in the same time period.

Exhibit 15: Please rate your level of adoption of each of the following technologies



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Accelerating tech adoption

Innovation is a familiar buzzword in board rooms, corporate offices and construction sites, and some companies have made impressive progress. We've seen robotic dogs that "sniff out" unsafe incidents and practices onsite, capture ongoing construction in three dimensions for close-to-real-time work measurement, and check design alignment vis-à-vis a 3D model.

Then there's the project owner organization that ordered out all major packages in record time, by collectively bargaining with its service providers, shaving precious months off the implementation schedule. In another example, a prime contractor uses 5D BIM layered with its custom workflows and internally developed Theory Of Constraints (TOC)-based lean construction methodology, for a fully integrated concept-to-design-to-delivery approach.

Digital technologies serve as one of the largest levers for owners and E&C firms to implement innovative ideas and solve project implementation problems. The key is to use a combination of already available and tested technologies.

In the rush for instant results that yield a positive, short-term ROI, many potential digital technology investments are overlooked. A 3–5 year horizon is realistic when assessing the investment case. And don't underestimate the importance of cultural barriers in both owner and contractor organizations; a shift in culture is often necessary to drive innovation at business unit, functional and individual levels, creating a virtuous cycle.

As our survey responses demonstrate, established industry players are deploying PMIS, BIM and advanced data analytics, and are making inroads into the use of digital twins, AI, VR/AR, 3D printing, RPA. The successful adopters are championing innovation from the very top and investing in educating their teams. In addition to encouraging digital technology use for project implementation, management can also apply these technologies to conduct management reviews and governance, sending a further signal that the organisation is shunning conventional, manual methods and striving for digital leadership."

Suneel Vora, (PMP), Partner, Business Consulting – Capital Projects and Industry 4.0, KPMG in India



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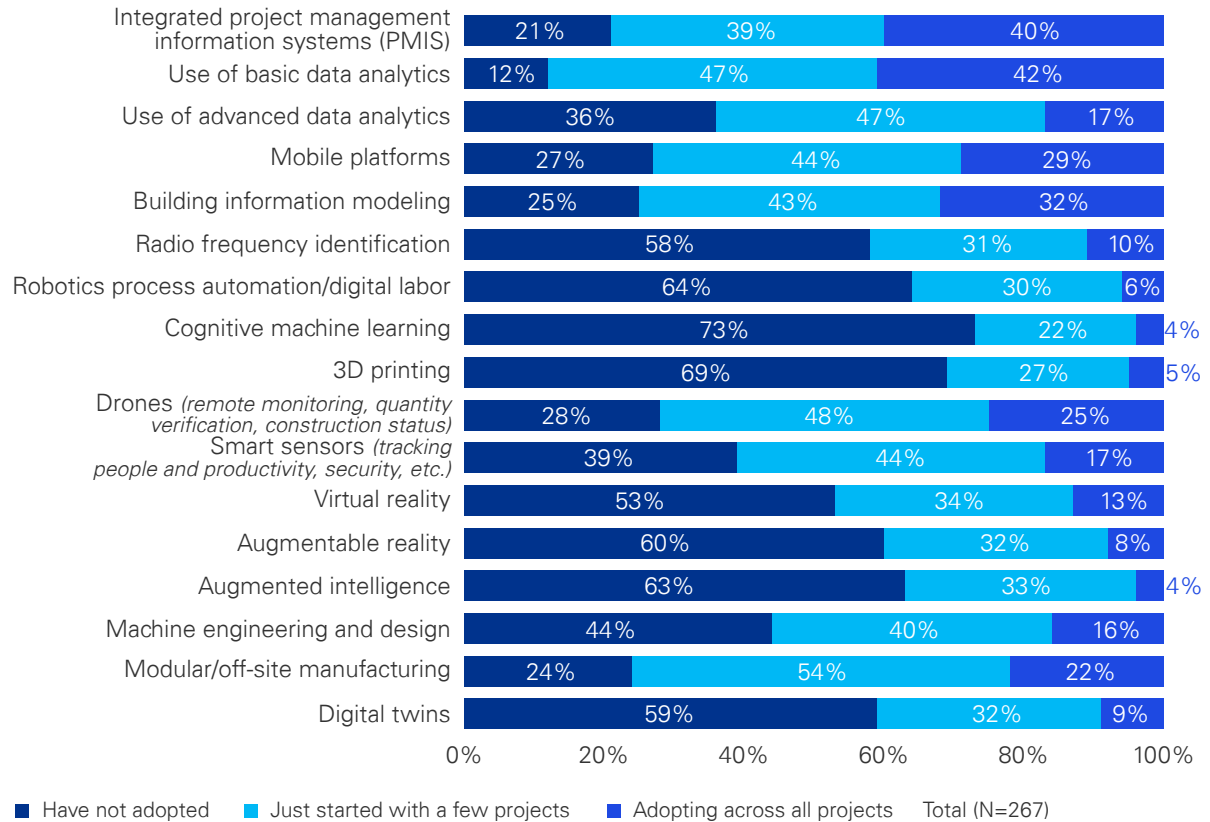
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However, a far smaller proportion of respondents' companies are applying these and other technologies across all projects—just 6 percent for RPA, 5 percent for 3D printing, 4 percent for ML and 8 percent for AR. With a lack of consistent standards across the industry, the full benefits of such innovations are some way off.

Another technology growing in popularity is AI. Since the 2018 Global Construction Survey, use of AI—in the form of digital twins, smarter construction equipment, data and document management, and enhanced safety and communication—has increased significantly. In 2018, just 23 percent of respondents said they were either adopting or just started to adopt AI. That figure rose to 29 percent in 2021, and climbed to 37 percent in 2023 (see Exhibit 16). As a measure of how far there is to go, a mere 4 percent are applying AI across every project, although 33 percent have started to use AI on a few projects.

Exhibit 16: Please rate your level of adoption of each of the following technologies



Making the right technology investment bets

Which technologies have the potential to deliver the greatest overall return on investment (ROI) in capital projects? The picture has changed little since the same question was asked in our 2017 survey, with integrated project management information systems (PMIS), BIM and advanced data analytics as the top three responses. These proven innovations are clearly making their mark, but the survey findings suggest there is a lot of untapped potential from newer, emerging tech such as digital twins, AI, VR/AR, 3D printing, RPA and—as we will discuss shortly, modular manufacturing.

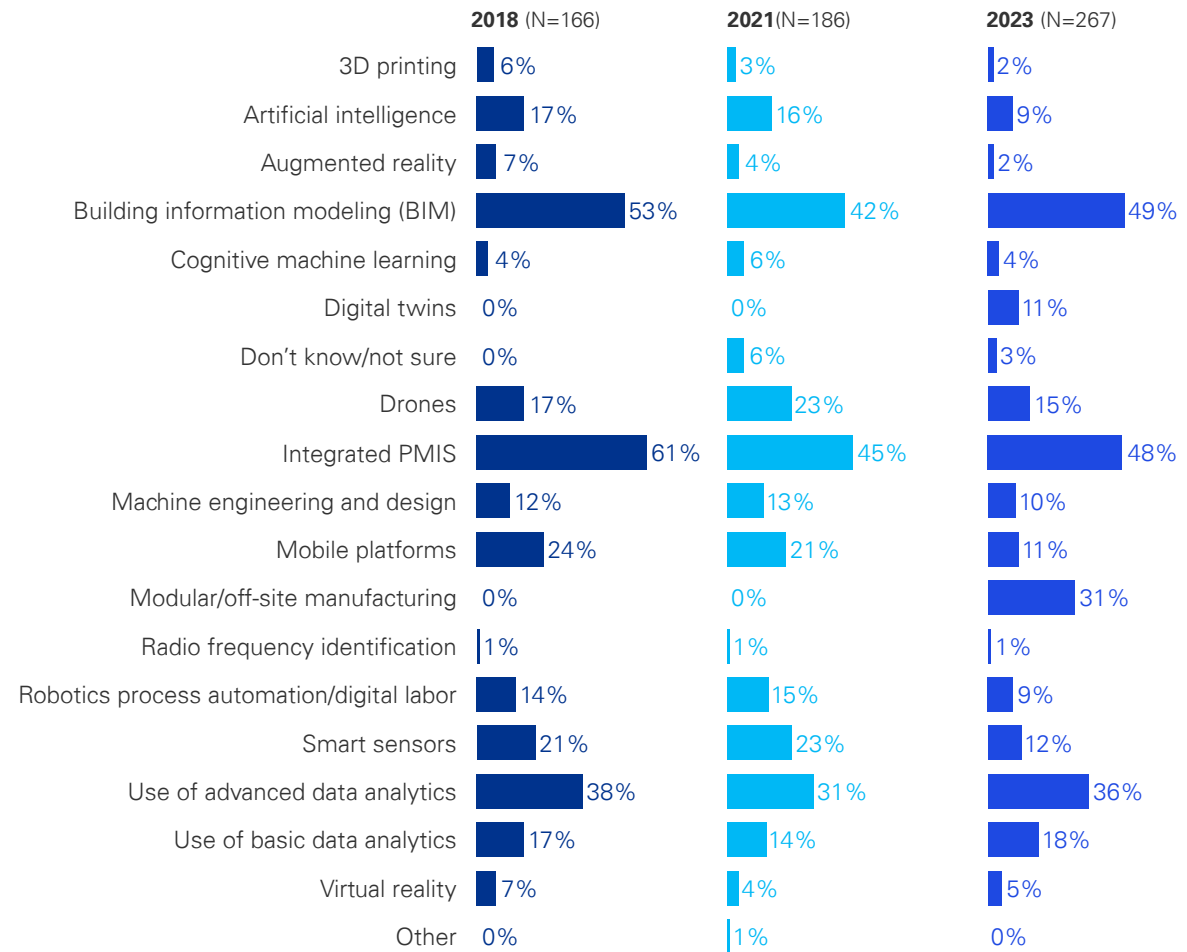
The industry’s mixed record of going over budget and over schedule is something that everyone involved in construction has been striving to overcome for decades. So it was fascinating to hear how the various new technologies were contributing to cost and schedule performance improvement, or avoiding overruns.

The technologies that are gaining most traction are digital twins and modular/offsite manufacturing, while, AI and RPA appear to be in early stages of adoption. These responses suggest that, while some forward-looking companies are gaining tangible benefits on project performance metrics, others are failing to make the best use of technology. They could benefit from team members with business process, technology and change management experience, and individuals who can drive

technology implementations to ensure they deliver on their approved business cases. This often requires a structured project management

office (PMO) dedicated to technology implementation and associated business processes.

Exhibit 17: Technologies with potential to deliver the greatest overall ROI





The stage is set for modular

In their new book “*How Big things Get Done*”¹¹, Bent Flyvbjerg—chair of major programme management at Oxford University’s Saïd Business School—and co-author Dan Gardner present a passionate argument for the benefits of modular manufacturing, taking construction from the site to the factory floor, making use of standardized designs to cut costs, improve quality and safety, and speed up construction.

Accordingly, 2023 is the first year the Global Construction Survey has tracked the use of modular/off-site manufacturing, with one-quarter of E&C respondents reporting that they leverage such an approach across all projects, and a further 61 percent starting to adopt on a few projects. More than eight out of 10 (84 percent) of respondents—both owners

and E&C companies—say that prefabrication is an important solution for capital projects, suggesting that all parts of the industry should work together to advance its use.

Looking more closely at the use of modular manufacturing, a majority (69 percent) apply it for less than one-fifth of projects (see Exhibit 18). Interestingly, only 28 percent expect to adopt this technology across more than half of their projects within five years. Hopes are high for modular—almost one-third (31 percent) feel that it has potential to deliver the greatest ROI. It’s now time for this approach to go mainstream, to achieve the kind of industry disruption that other sectors have experienced, like automotive with electric vehicles (EVs).

Technology and worker safety

Having worked tirelessly to create a safety-first culture, E&C companies are turning to more technical solutions to ensure that workers don’t come to harm. The most widely used technologies in this respect are data and analytics to predict and prevent incidents, and modular manufacturing, to reduce the volume of onsite work.

Other advancements that improve safety include robotics (cited by 8 percent as driving better safety), remote operated machines (15 percent), drones for monitoring (18 percent) and smart sensors for notifying high-risk activity or health concerns (24 percent). These relatively modest figures indicate significant room for improvement in use of digital technologies to meet critical safety KPIs.

¹¹ Bent Flyvbjerg, Dan Gardner, “How Big Things Get Done,” Currency, February 7, 2023

Making modular manufacturing work

It may have been around for decades, but modular construction’s moment has arrived as a way to address challenges like supply chain disruption, labor shortages, and rising interest rates, as well as reducing carbon footprint, improving environmental impact, and enhancing worker safety. To fulfill modular’s potential and drive the industry forward, we need to address several key challenges...

One of the factors limiting modular’s growth is plant capacity. Although new modular manufacturing facilities are emerging, many of the more ambitious larger-scale projects cannot be fulfilled directly from regional suppliers. This means they either manufacture (with all the added time and complexity) or revert to hybrid construction models. We expect a wave of financing to expand manufacturing footprint and increase production throughput, along with creative collaborations to use excess capacity between projects.

Financing is a key bottleneck limiting the number and scale of modular projects. Unlike traditional construction, where developers can get financing for around 80 percent of project costs, modular financing typically provides just 40–50 percent, with a higher proportion paid out up front.

To deliver on its full potential, modular construction requires strong vertical integration across the project delivery lifecycle, to drive standardization, enjoy economies of scale and bulk purchasing, and reduce (and, ideally eliminate) inefficiencies and errors that occur at key interface points between design, procurement, construction, and commissioning.

Delivery support. Unlike traditional manufacturing, where the product is (largely)

complete when it ships from the factory, modular buildings need to be treated with great care during delivery and commissioning. Therefore, manufacturers need onsite representatives, which add cost and limit the potential customer reach—unless delivery support is provided by a trusted and knowledgeable dealer or a general contractor (GC) construction partner.

Exhibit 18: What percentage of your projects currently leverage modular/off-site manufacturing?

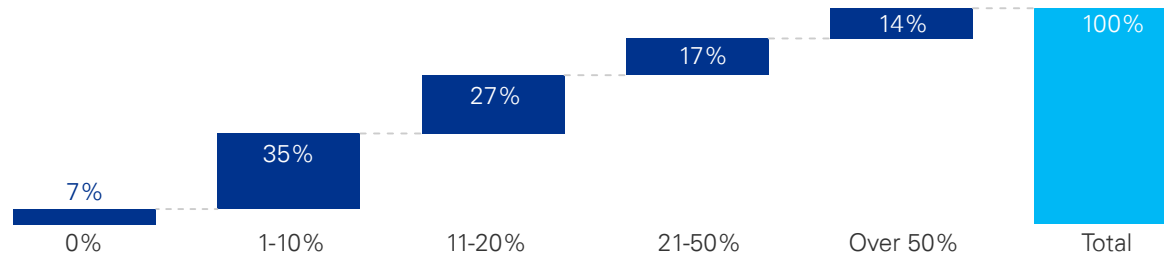
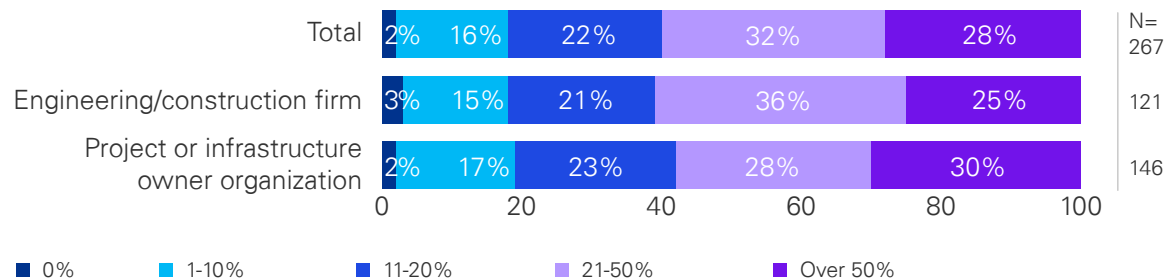


Exhibit 19: What percentage of your projects currently leverage modular/off-site manufacturing in five years?



Benefits of modular construction



Reduced
schedule time



Improved
safety product



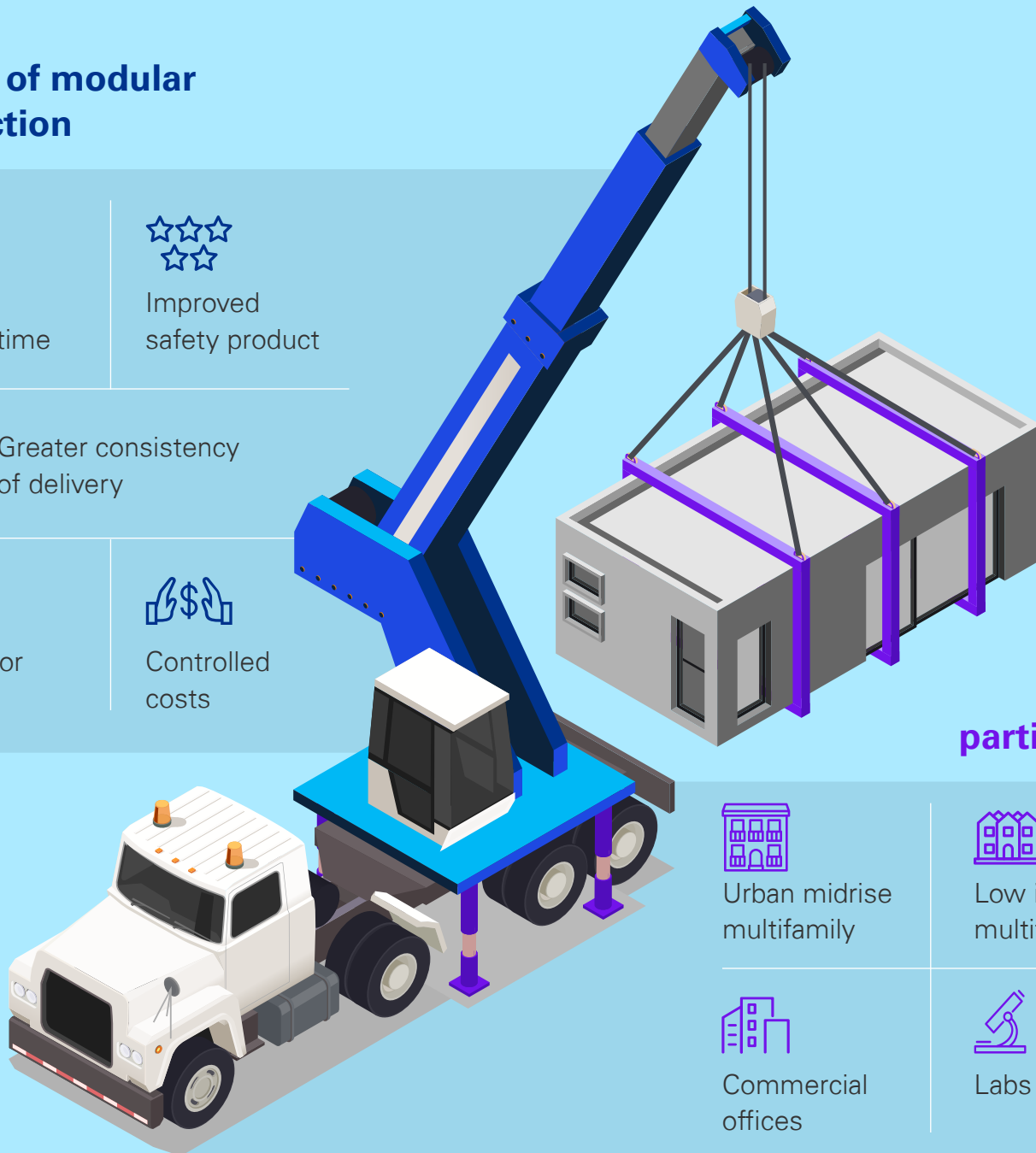
Greater consistency
of delivery



Lower labor
costs



Controlled
costs



**Modular can
be used on all types
of projects but is
particularly well suited to:**



Urban midrise
multifamily



Low income
multifamily



Urban medical
centers



Commercial
offices



Labs



Data centers

View from the industry

Embracing modularization and digital technologies



S. N. Subrahmanyam, CEO & MD, Larsen & Toubro Limited

Our clients are becoming ever more demanding, which is why we employ multiple digital construction technologies and continue to focus on improved productivity. Greater pre-fabrication, pre-casting, and modular manufacturing improves quality, reduces the risk of error, and speeds up construction, as does mechanization and automation.

By combining prefabricated, pre-finished volumetric construction (PPVC), structural steel construction, modular construction and 3D printing, we've managed to reduce typical project durations by an incredible 50 percent. In one example, we successfully built 96 residential flats in just 96 days, and a seven-story building in less than 45 days. These kinds of timescales would have been unthinkable a few years ago.

And thanks to our digital tools and systems, we now get the benefit of real-time updates, predictive forecasting and better collaboration between different teams—together they enable faster decision-making. Digital twins accelerate

development of designs and allow us to customize designs more closely to client needs.

It's not just about construction; digitalization also enhances operations of our client's assets to reduce operating costs and maintenance, by making them smarter. And 5G is set to bring even higher speed and lower latency.

Underpinning much of this is our continued investment in our IT and technology services businesses, which we plan to grow multi fold. We are building our capabilities in high-growth areas such as data centers, cloud, AI, cybersecurity, and blockchain, among others. We have already launched two new digital e-commerce platforms: a B2B marketplace for industrial goods (called L&T SuFin), and an online learning platform for upskilling and vocational training (L&T Edutech).

With these kinds of advances, we're confident that our business will be in a strong position to compete in an increasingly digital world.



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Key takeaways

Address productivity as a matter of urgency

By taking an outside-in approach, the E&C industry can learn from the best practices from other sectors—primarily manufacturing—to gain efficiencies from scale, standardization/ modularity, and value chain ecosystems. In doing so, project owners and E&C companies can finally make the kind of productivity gains that have eluded them for so long.

Master enterprise risk management

The capability to assess organization-wide risks, across multiple projects, large and small, is vital in bidding, pricing, and resourcing. A modern E&C company, with a good understanding of risk interdependence, should have the confidence to say “no” to unprofitable projects and avoid a race to the bottom, as well as spotting potentially damaging risks earlier and taking decisive action to prevent project failure.

Truly embed ESG

Future leaders spanning the construction sector will likely lead purposeful organizations that recognize the benefits of sustainable construction, infrastructure, and buildings, along with sustainable supply chains, diverse workplaces, and strong community ties. A changing regulatory environment, compounded by heightened expectations from investors, employees, and customers, has made ESG a business imperative. Failure to prioritize ESG could result in a negative sustainability profile, reducing access to capital and top talent, further limiting companies’ ability to keep up with ESG leaders. Lip service to ESG is no longer enough.

Become data masters

Those companies that can capture data, analyze it, and produce practical insights will likely enjoy lower costs, better project performance, greater efficiency, and safer workplaces. They are also likely to attract a new breed of digital worker who sees exciting opportunities to create the smart, sustainable buildings and infrastructure of the future.

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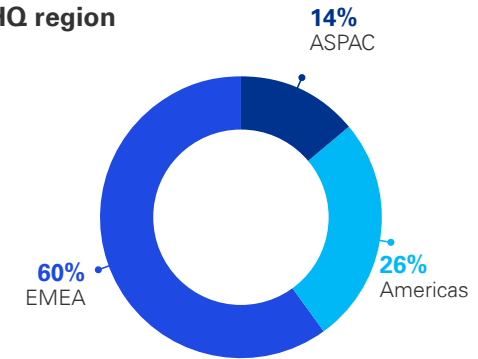
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About the survey

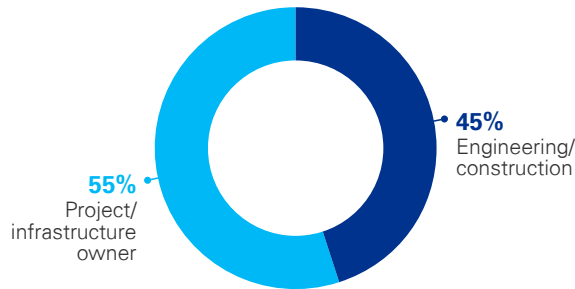
In this survey, you will find the perspectives of 267 people from engineering and construction companies and project owners from a variety of industries (121 represented E&C companies, 146 represented project owners).

Many of the responses were gathered during face-to-face interviews in 2021 with senior leaders, with a large number of them serving as chief executive officers. The vast majority of respondents are from organizations carrying out significant capital investment projects.

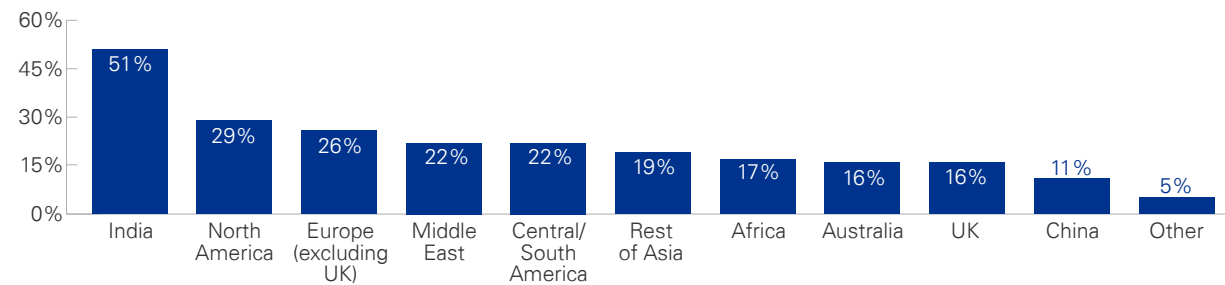
HQ region



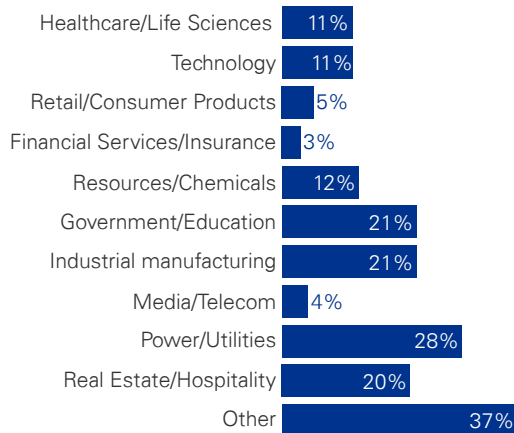
Organization category



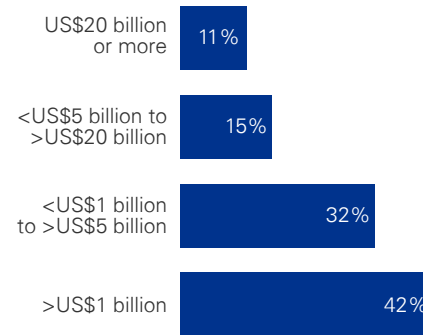
Regions of operation (multiple selections allowed)



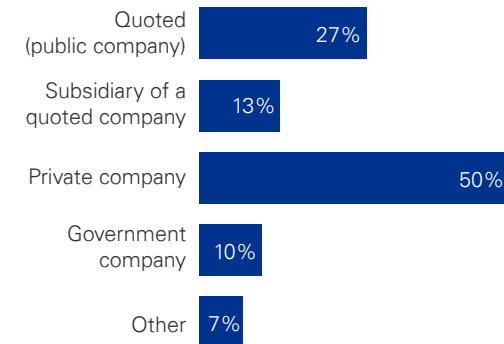
Industry sector



Approximate entity revenue from operations in the last 12 months



Entity type (multiple selections allowed)



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