Research Insights

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Engineering and construction digital supply chains

How leaders are increasing visibility and insight

IBM **Institute for Business Value**

IBM

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Talking points

Supply chain improvement is a significant opportunity for engineering and construction.
Supply chain visibility and execution could drive massive cost savings, provide real-time supply-chain coordination, and increase ability to deliver the project on time. Engineering and construction organizations face large effectiveness gaps with their supply-chain operations. The supply chain needs to shift to a digital future.

Digital supply-chain leaders provide a unique perspective from which organizations can learn.
Companies furthest along in executing a digital supply-chain strategy also lead in financial performance and are more effective at addressing supply-chain challenges. The leaders have improved supply-chain efficiency and effectiveness.

Leaders enable digital supply chain through six levers.
These leaders have put in place governance and data management to support the implementation of digital. They have made appropriate digital technology investments. They have driven the creation of supply-chain platforms. Leaders address talent and culture. And they have made improvements in security.

The digital effect on the engineering and construction supply chain

Today's engineering and construction supply chains are still largely analog, with processes that are manual and with only limited automation. Without real-time supply-chain coordination and execution, companies have limited ability to forecast schedules when work will be done and when materials and equipment will be needed.
A digital supply chain can provide connections across the value chain and ecosystem, leveraging multiple sources of data to create transparency, provide advanced planning, and predict and avoid future problems.

To take full advantage, engineering and construction organizations need to enable these capabilities through a set of levers. With input from 250 executives worldwide, we explore how leading organizations have prepared for a digital supply chain, as well as what others can learn from them.

The need for a digital supply chain

Engineering and construction supply chains are a complex network with numerous relationships and materials, products /services, logistics and information, and money flows. These complex projects involve thousands of participants from hundreds of organizations and require volumes of documents and drawings. Increasing fragmentation in the industry adds to this challenge by adding more suppliers and contractors. Difficulty in controlling and managing construction arises from a project-based orientation (each project is unique) and from the many suppliers involved. Each player has its own schedule. Integration and synchronization of a master schedule is needed to manage the entire project lifecycle. Risks and disruptions in the supply chain can lead to lost materials, waste, increased downtime, and inefficiencies.

Only **31%** of industrial products company respondents say they are effective at supply-chain requirements

76% of executives from leading organizations say they are effective at managing material quality and risks

72% of executives from leading organizations report they have realized significant ROI from investing in predictive analytics for the supply chain

Compounding the industry's flat productivity, engineering and construction supply chains continue to be challenged by "pre-digital" processes that are manual, on paper, by phone, by people, and with little automation. Without real-time supply-chain coordination and execution, these companies have limited ability to forecast schedules when work will be done and when the next materials/equipment will be needed. As such, it is vital these companies take action and invest in digital to increase visibility and optimize their supply chains.

Both external and internal factors are putting pressure on engineering and construction enterprises to create a digital supply chain. From an external perspective, traceability of materials is critical. Tariffs have increased costs for heavy building materials. Supply chains also need to manage supply and demand disruptions due to varying vendors, fluctuations in resource availability, and weather impacts. Multi-enterprise supply-chain business networks, which support a community of partners that need to coordinate and execute on business processes, are increasing in importance and value.

From an internal perspective, inefficient processes require changes to reduce shocks to the supply chain. A research report from PlanGrid and FMI Corporation indicates that time spent on non-optimal activities, such as fixing mistakes, looking for project data, and managing conflict resolution accounts for USD 177.5 billion in labor costs per year in the US. Rework caused by miscommunication and inaccurate and inaccessible information will cost the US construction industry more than USD 31 billion in 2018.[1]

The supply chain also needs to address operational challenges caused by raw material quality and availability, scheduling constraints, and lack of integration across the network. Further, a lack of supply-chain visibility (including in-transit materials) often renders optimization efforts less efficient.

Only 38 percent of respondents told us their supply-chain functions are effective at managing materials quality and risks.

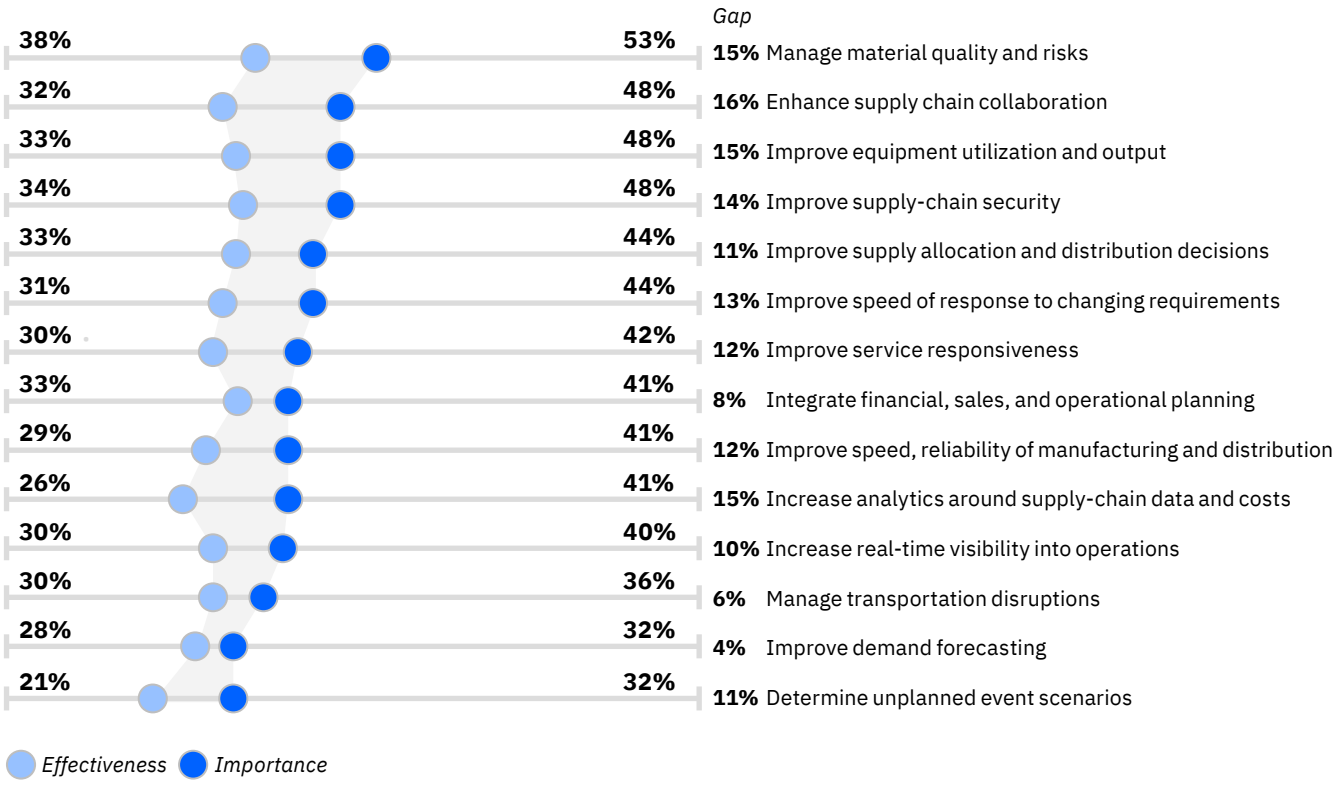
These needs are exacerbated by gaps in the effectiveness of the most important supply chain requirements (see Figure 1).

For example, over half of the 250 engineering and construction respondents in our survey said it's vital to manage materials quality and risks. Yet, only 38 percent told us their supply-chain functions are effective at it.

Large gaps also exist between the importance that engineering and construction companies attribute to advancing imperatives—such as enhancing supply-chain collaboration, improving equipment utilization and output, and increasing analytics around supply-chain data and costs—and their current proficiency at acting on these requirements. Across the 14 requirements in Figure 1, the average effectiveness gap is 11 percent.

Figure 1

Engineering & construction companies worry about the effectiveness of their supply chains



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

A digital supply chain includes three capabilities: synchronized schedules, value chain visibility, and intelligent assets.

The digital future for the supply chain

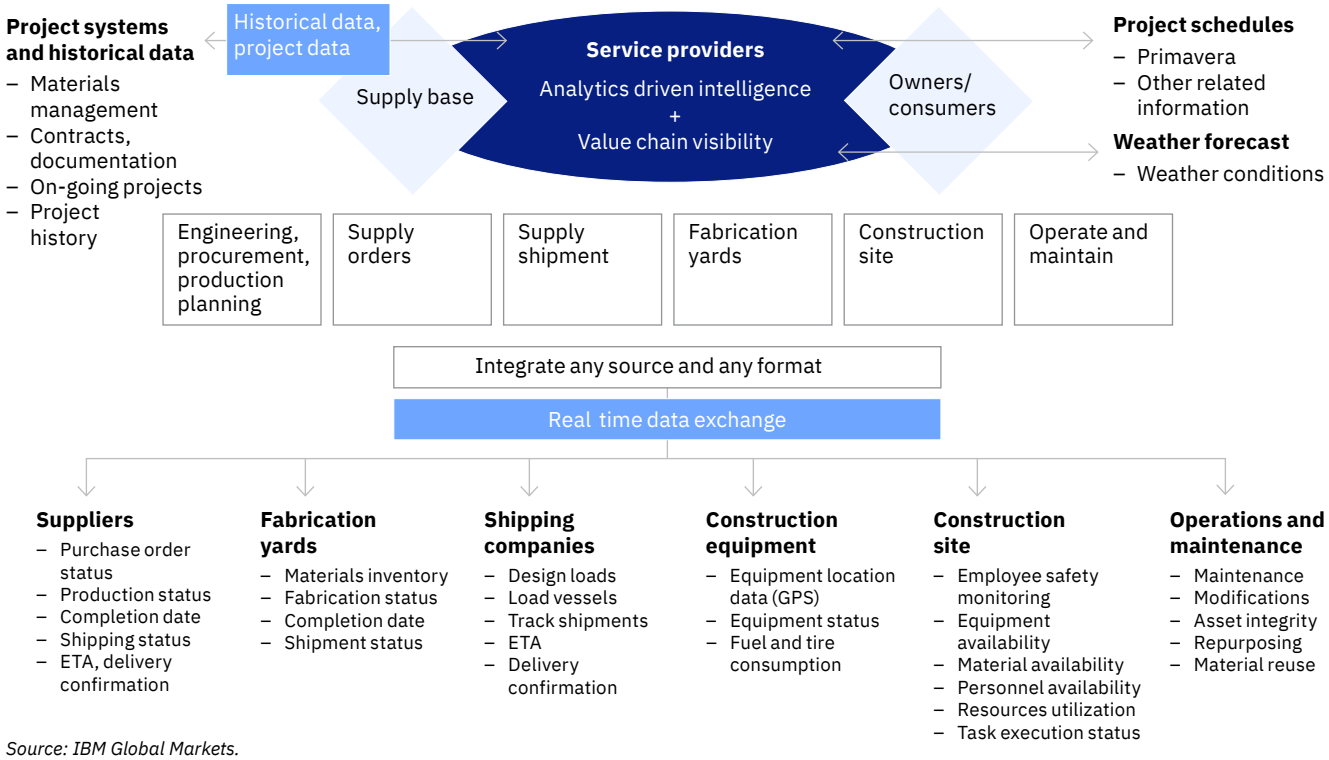
Successful engineering and construction companies will need to embrace advanced supply-chain technologies to shift to a digital future that can deliver end-to-end, orchestrated, and insight-driven processes (see Figure 2).

A digital supply chain can synchronize the multi-enterprise, supply-chain network while improving visibility and leveraging asset availability. It includes three capabilities: synchronized schedules, value chain visibility, and intelligent assets.

- Synchronized schedules across parties and between site supply chains (material, equipment, supplies) enables supply-chain changes to be propagated across the schedule hierarchy (master, field, material, equipment, contractor) to adjust forecasts, procurement, and delivery.
- Value-chain visibility helps maintain control of materials, equipment, and supplies milestones. It can identify risks and react to developing supply events. It also helps collate inventory/supplies from all parties and systems and makes it available for reporting, real-time decision making, and collaborative adjustments.
- Intelligent assets use the Internet of Things (IoT) and cognitive/artificial intelligence (AI) insights to help improve reliability and performance of equipment and assets through better visibility, predictability, and operations. They can improve quality and yield of operations from design through support, as well as increase resource consumption efficiency—such as worker, workforce, or energy—while reducing costs.

Figure 2

The digital future



Source: IBM Global Markets.

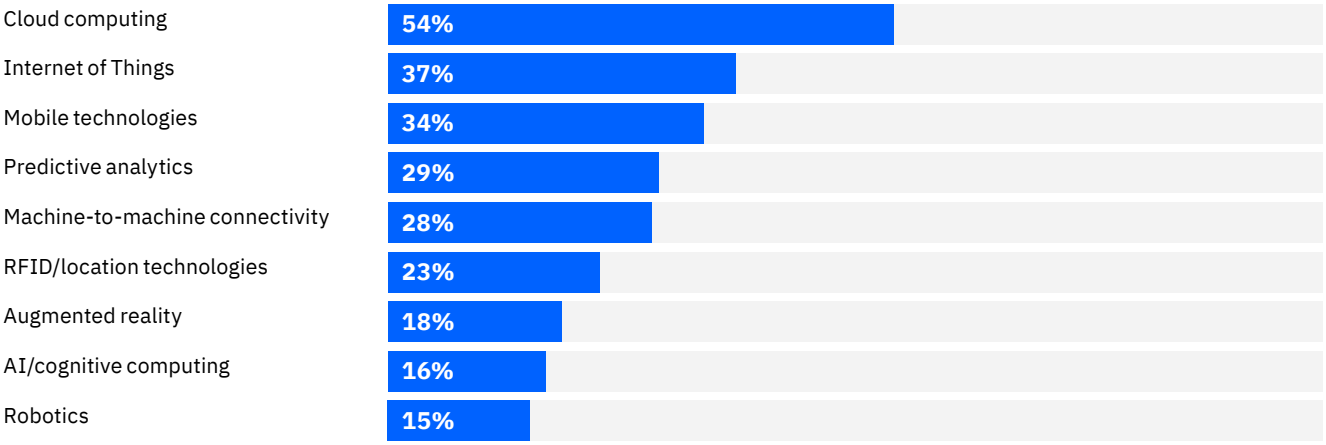
Combined, these three capabilities enable a digital supply chain that can enhance performance across multiple dimensions:

- Improved productivity
- Reduced downtime
- Lower costs
- Reduced waste
- Improved utilization of resources.

From our study, engineering and construction respondents confirmed that a collection of digital technologies is critical to their supply-chain strategies (see Figure 3). Cloud computing can be used to run supply-chain applications and store data. The IoT connects sensors and devices to networks so that materials, equipment, and supplies can be tracked and monitored. Mobile technologies allow ubiquitous access to information and help manage delays and shortages (see case study, page 7: “Katerra: Embracing technology transformation”).

Figure 3

Engineering & construction companies cite an essential combination of technologies for their supply chain strategies



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Our digital supply-chain leaders are two-to-five times more effective against supply requirements than their peers.

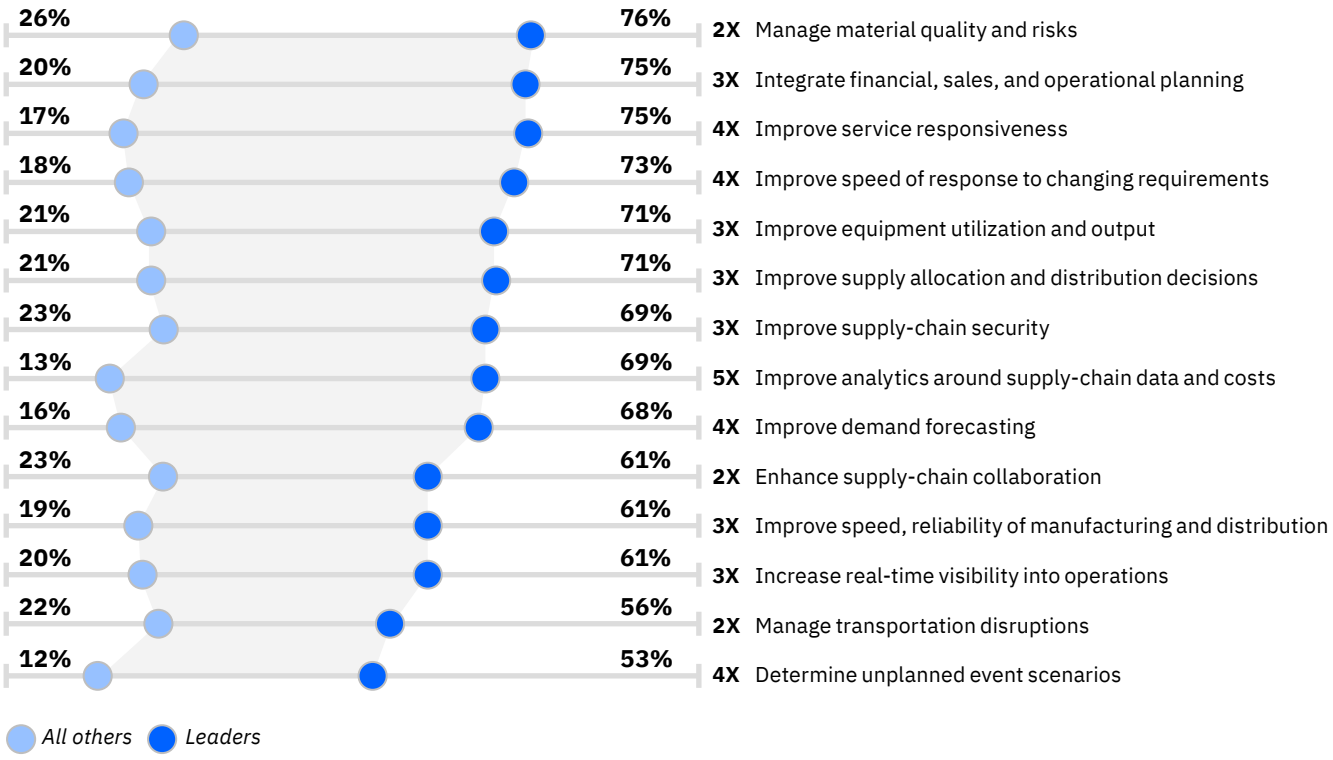
Digital supply-chain leaders

We analyzed survey responses and identified a small group of engineering and construction "leaders" that make up 24 percent of our study. These leaders reported that their organizations were furthest along in executing either a fully executed digital supply-chain strategy or a fully thought-out digital supply-chain strategy and execution plan, and have taken steps to transform.

Companies can learn from these leaders. Leaders report that their enterprises delivered better financial performance over the past three years than industry peers. Seventy-three percent their revenue growth outperforms the industry, versus only 15 percent of peers. And the leaders' profitability is more than six times better than their peers. Leaders are two-to-five times more effective against supply requirements than others (see Figure 4). Also, leaders have realized a higher ROI from investing in digital for the supply chain—13 percent compared to 8 percent of peers.

Figure 4

Engineering & construction leaders excel at addressing supply chain requirements



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Katerra: Embracing technology transformation[2]

Katerra is a technology-driven offsite construction company and an end-to-end building services provider.

Katerra incorporates state-of-the-art technologies into the construction supply chain to exploit the rise in digitalization within the industry and differentiate itself from other modular builders. Katerra uses advanced SAP technology, a proprietary analytics platform, a mobile app, and industrial IoT tools (which incorporate machine learning and big data technology) to optimize its design and construction processes, on-site communication, tracking of raw materials, and labor utilization.

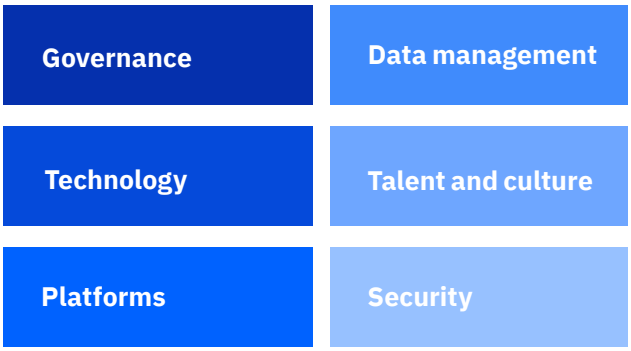
The use of these technologies has also allowed Katerra to create a standard "kit" of pre-designed components. Having this level of standardization among a set of general components has enabled Katerra to take advantage of an advanced raw materials inventory tracking system to determine the optimal quantity and timing of raw materials it should order. By doing this, Katerra reduces material costs for its customers by both eliminating materials waste and creating economies of scale through placement of larger orders from its suppliers (as it combines the needs for common materials across multiple projects and different clients).

Enabling a digital supply chain

To achieve a digital supply chain, engineering and construction organizations should address six levers (see Figure 5).

Figure 5

Leaders enable a digital supply chain through six levers



Source: IBM Institute for Business Value.

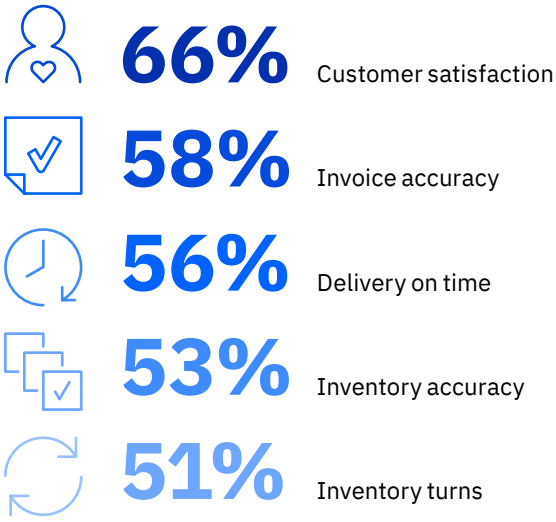
Governance

For leaders, a digital supply chain starts with a cross-functional governance/steering team. Sixty-nine percent of leaders have this team in place to help drive the implementation of digital technologies for the supply chain, compared to 14 percent of their peers. To support execution, the leaders have established performance management/KPIs for their supply-chain digital activities. To react to market dynamics and meet ever-shifting customer expectations, these companies use quality and cycle-time metrics to measure digital supply chain success (see Figure 6). As a result, they can improve on-time deliveries, inventory management, invoice accuracy, and customer feedback.

Given the complexities of numerous relationships, these leaders have also put in standards to manage information flow internally and externally. Over three quarters have implemented common standards across the supply chain, versus just 18 percent of peers. And 58 percent of leaders have established common standards with collaboration partners. This enhances communications and, ultimately, productivity.

Figure 6

Leaders track key metrics for a digital supply chain



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Leaders view cloud computing, predictive analytics, IoT, and AI as critical technologies.

Technology

Engineering and construction companies will need to digitize their supply chains to create fully integrated, flexible, and agile operating environments. Over three quarters of leaders expect to invest most prominently in technologies for the supply chain. They view a combination of technologies as critical, including cloud computing, predictive analytics, IoT, and AI. Cloud computing improves sourcing and supplier management. Predictive analytics enhances demand planning and forecasting. IoT provides connections across ecosystems and helps with asset management. AI can be applied for customer service (see case study, page 11: “Bechtel: Enhancing productivity with AI”). These technologies can be used across supply-chain activities (see Figure 7).

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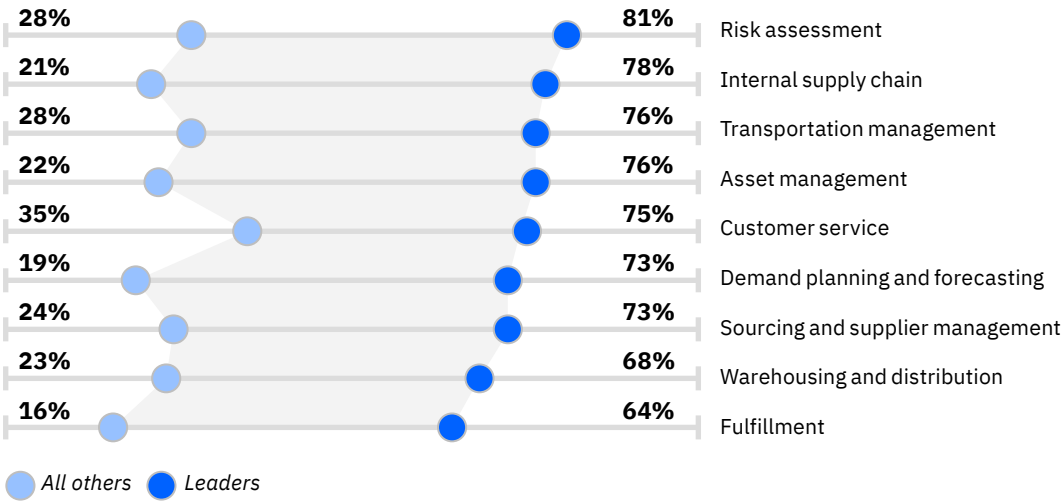
Figure 7

Engineering and construction leaders view digital investment as important across supply-chain activities



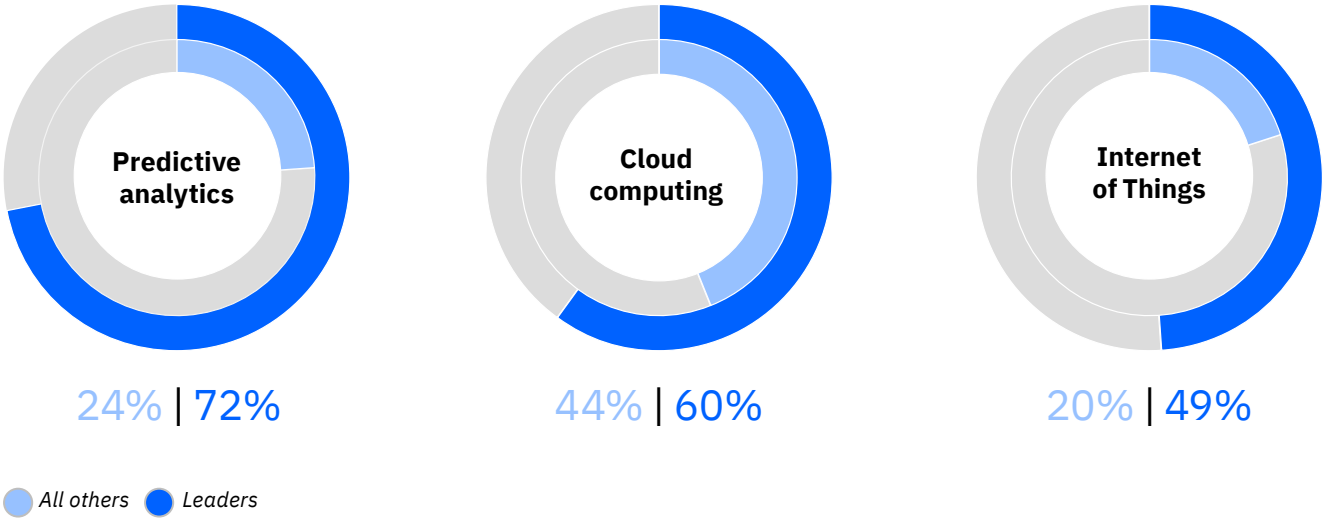
Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Over three quarters of leaders say predictive analytics and cloud computing help improve speed of response to changing requirements.

Overall, more leaders have implemented specific digital technologies and achieved significant ROI in their supply chains (see Figure 8). They see predictive analytics improving demand forecasting and improving speed and reliability of distribution. Over three quarters of the leaders say predictive analytics and cloud computing help improve speed of response to changing requirements. And leaders report that cloud computing and IoT assist in enhancing supply-chain collaboration to provide visibility and improve sourcing.

Figure 8

Leaders have seen a significant impact on ROI from the application of digital technologies in the supply-chain



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Bechtel: Enhancing productivity with AI[3]

Bechtel Corporation is an engineering, procurement, construction, and project management company. It is the largest construction company in the United States.

Bechtel has created the Big Data and Analytics Center of Excellence. With 120 years of data through digitization efforts, the company can ask where hidden inefficiencies might lie and what might drive them. Bechtel is developing a machine-learning tool to identify the most efficient construction packaging sequences for the most complex projects. Through artificial intelligence, the company is able to find connections and learn new solutions that they could not be able to find if every possibility had to be tested. This can be done in the presence of dynamic factors and shifting constraints. Once faced with unexpected weather, material or labor shortages, project teams are able to ask: “What is the best approach from this point forward?” Machine learning allows Bechtel to optimize in real time as events impact schedule and execution.

Platforms

For engineering and construction companies, platforms are increasingly a tangible way of supporting the supply chain. Platforms can connect companies with customers and partners to share supply-chain information and conduct transactions. Three quarters of the leaders from our study are participating in supply-chain platforms, compared to only 3 percent of their peers. And 82 percent of leaders have created a platform and have done one of three things:

- Invited customers and partner organizations to operate on the platform
- Invited customers to operate on the platform, but not partner organizations
- Invited partner organizations to participate, but not customers.

Leaders offer a significant value proposition to supply-chain platforms.

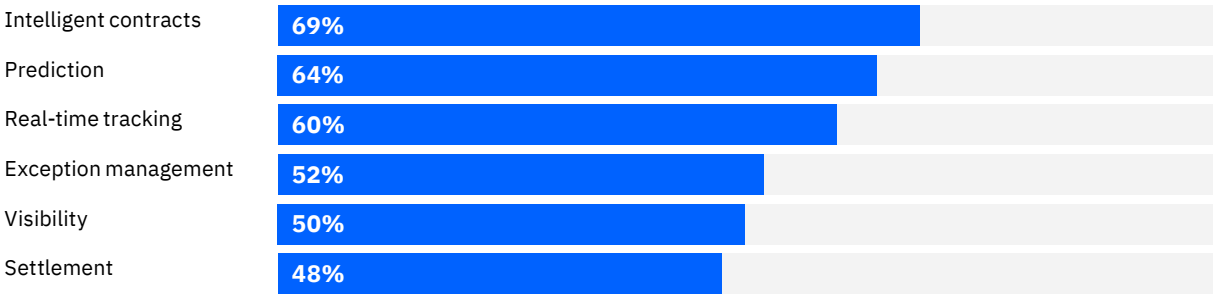
They recognize the many advantages of participating in platforms to both toplines and bottom lines. Meeting customer expectations, funding opportunities, and satisfying new demands can manifest themselves in increased revenues. Decreasing infrastructure costs, increasing operational efficiency, and providing insights into supply-chain performance can improve the cost structure.

Specifically, the leaders are offering a significant value proposition to supply-chain platforms (see Figure 9).

A combination of digital technologies helps connect platform participants. Platforms powered by AI can predict problems and proactively direct automation to improve quality. The combination of AI with other emerging technologies, such as cloud computing and IoT, help integrate participants on a platform and support the continuous learning required to succeed. And digital technologies enable constant roll-out of new services in the platform.

Figure 9

Leaders provide services or intellectual property to a supply-chain platform



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Data management

Nearly three-fourths of leaders have implemented data lifecycle management (69 percent), established data interfaces (73 percent), and created a flexible data architecture (71 percent) to support a digital supply chain. This robust-but-flexible data foundation allows them to take advantage of digital technologies. This infrastructure also allows the supply chains to be nimble enough to respond to new market dynamics, customer demands, and user needs (see case study, page 14: "AECOM: Transforming supply chain management").

Leaders are far outpacing others in data sources. Five times more leaders than their peers are integrating information across a variety of sources to realize value from digital technologies in the supply chain. Data on track-and-trace transportation modes, routes, and rates allow them to adjust for events that impact the supply chain, resulting in more timely and accurate information for customers. Customer and supplier data assist leaders in transforming the performance of their supply chains to help predict demand, improve forecasting, and enhance sourcing (see Figure 10).

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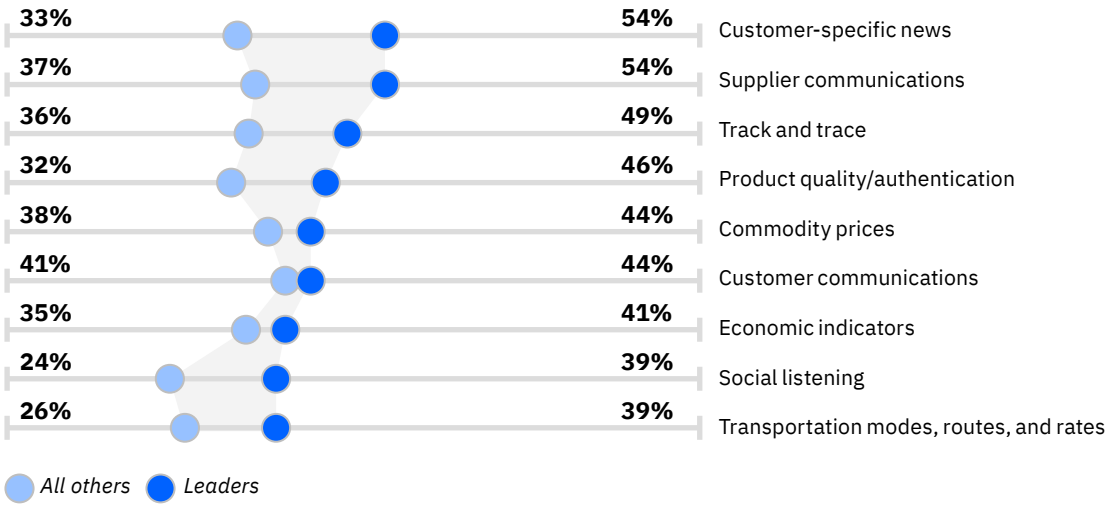
Figure 10

Leaders leverage a variety of data sources to take advantage of digital technologies



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

AECOM: Transforming supply chain management[4]

AECOM is a US-headquartered multinational engineering firm that provides design, consulting, construction, and management services to a wide range of clients.

AECOM has partnered with IFS to strengthen its supply chain by using IFS Applications, a software suite for critical business processes such as supply chain management, predictive maintenance, and digital transformation. It helps AECOM automate and streamline front- and back-office processes, enabling the company to tighten the procurement cycle, regardless of whether inventory is received at an AECOM warehouse, a customer location, or a construction site.

The integrated application suite expands AECOM's service offerings, increases efficiency, reduces manual processes, and provides better value to customers. Through the implementation of dynamic supply-chain technology, AECOM can help clients achieve performance excellence and optimize their opportunities. Clients can realize increased value and savings through robust automation, significantly improved response times, reductions in inventory levels, and planned on-time deliveries.

Talent and culture

Engineering and construction companies will need to identify, hire, build, and retain the necessary talent to create and sustain digital supply chains. Leaders recognize that employee roles and skills will need to change to support Digital Reinvetion®. Seventy-three percent of leaders have a strategy in place to help supply-chain employees adapt, versus just 15 percent of their peers. And 80 percent of these leaders say that their supply chain's shift toward digital reinvention technologies is being supported by change management.

The leaders have acted to address skills and create a culture that supports a digital supply chain. Over three quarters of leaders have established a formal process to identify needed digital skills, and 75 percent have implemented training for employees engaged with digital technologies. And four times more leaders have built a data-driven culture to take advantage of the supply-chain information coursing through their organizations and across the ecosystem.

Leaders are building a new team and have invested in specialized skills to support digital supply chains (see Figure 11). With the importance of using supply-chain insights, companies now need both technology- and data-minded talent. Eight times more leaders than others have acquired machine learning skills to train cognitive systems. These AI-related skills help them improve supply-chain efficiency and reduce risks. Four times more leaders have invested in skills such as advanced data architecture, data visualization, advanced data analysis, and data acquisition. These skills mean leaders can support setting the digital agenda and driving the supply chain as a core differentiator.

The leaders have also made changes to their operating models. Three quarters report creating service scalability by forming centers of excellence/shared services for supply-chain optimization, versus 5 percent of others.

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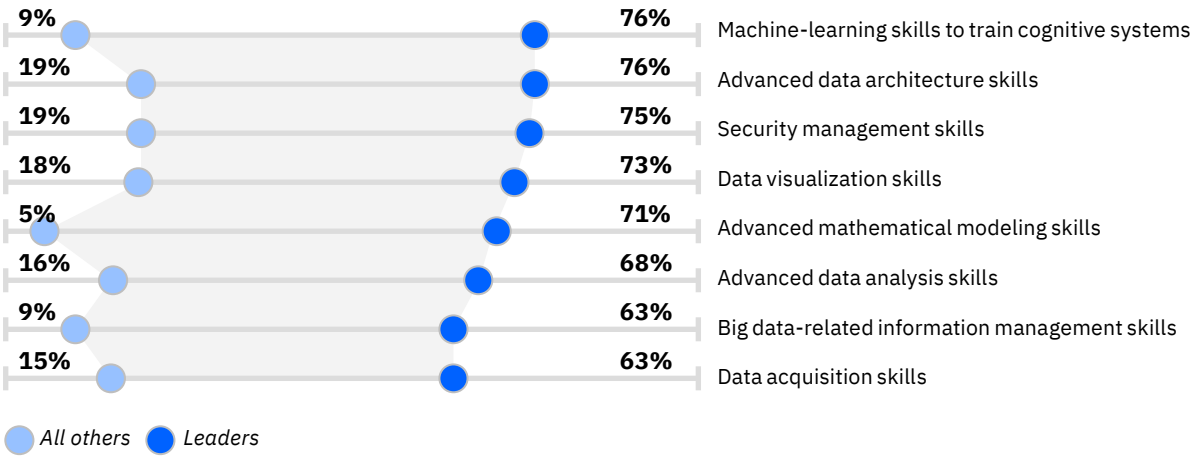
Figure 11

Leaders have upskilled their supply-chain organizations



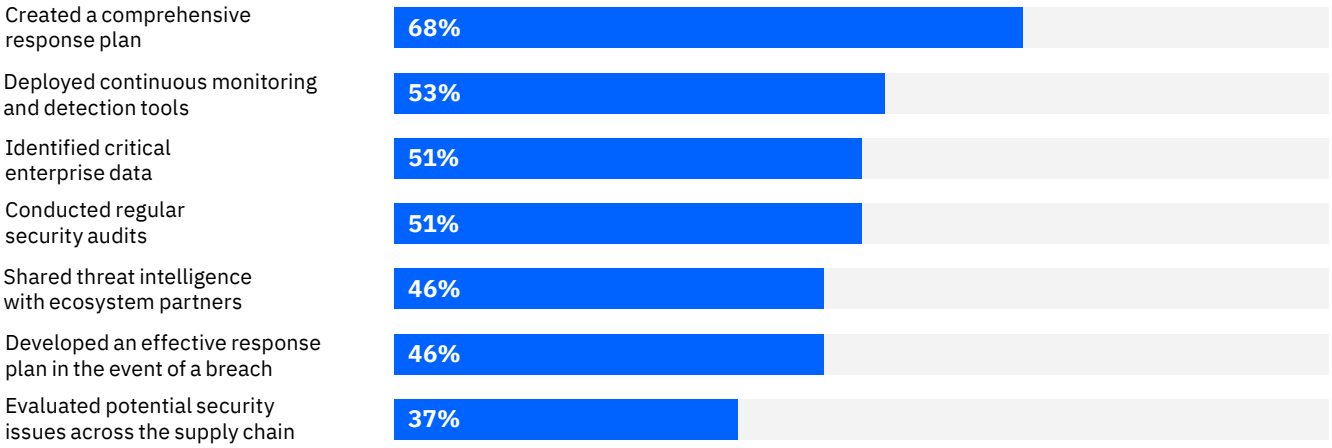
Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Security

A digital supply chain links engineering and construction companies with its suppliers and customers. The vast amount of data and intellectual property shared among the partners creates vulnerabilities and cybersecurity risks. Eighty percent of leaders surveyed—compared to 21 percent of their peers—have addressed cybersecurity issues as part of implementing digital technologies for their supply chains. They have taken specific actions to create good security cultures and clear security crisis protocols (see Figure 12). And they consistently practice, plan, and prepare for many different supply chain situations. Technology tools, such as blockchain and AI-enabled cognitive security solutions, could help address security concerns.

Figure 12

Leaders address digital supply-chain security through planning, monitoring and sharing intelligence



Source: IBM Institute for Business Value 2019 Industrial Products Digital Supply Chain Study.

Recommendations: Becoming a digital supply chain leader

Uncover new intelligence

Digitize the real-time signals and information sources collected, connected and consumed across the supply chain. Apply intelligence to supply-chain activities to power real-time, actionable insights. Check that your supply-chain data strategy targets the structured and unstructured data needed to address supply-chain imperatives. Tap the multi-enterprise supply chain business network. Leverage the network to share information.

Create supply chain processes that can "think"

Infuse digital technologies with advanced analytics to optimize processes and understand trends to improve demand planning, while simultaneously communicating changes and disruptions throughout the supply chain. Use data interpretation, prediction, AI technologies, and cognitive solutions across the supply chain to reveal patterns people might not otherwise notice.

Ready your digital skillset

Train employees to use digital technologies and work with intelligent processes. Equip them with data management, visualization, analytical, and problem-solving skills. Consider a "new-collar" approach to address the digital skills gap to include technical and vocation programs.[5] Equip employees with automated human-to-device and device-to-human understanding. Use connected mobility to empower supply chain and ecosystem workers in real time.

Are you ready for a digital supply chain?

- How effective is your schedule management to make sure equipment, materials, and construction personnel are at the right time and right place?
- What communications do you have in place to provide project status to your partners?
- What real-time information do you have on your supply chain, such as in-transit materials, equipment, and supplies?
- How will your analytics support decision-making across materials management, supply and demand forecasting, and logistics?
- What skills are employees equipped with to solve supply chain challenges in real time when or before they occur?

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Study approach and methodology

In cooperation with Oxford Economics, the IBM Institute for Business Value surveyed 250 engineering and construction leaders in 19 countries between January and February 2019. We collected responses from Chief Executive Officers, Chief Supply Chain Officers, Chief Operating Officers, Chief Information Officers, Chief Digital/Transformation Officers, VPs of Operations and VPs of Supply Chain. Engineering and construction was defined as companies that design, build, operate, and maintain assets and facilities for buildings (commercial, residential), infrastructure (transport, power, water, sewer, waste, telecom), and industrial (petroleum, mining, manufacturing and power plants).

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