

Digital technology intersects supply chains

Chemicals industry leaders enhance intelligence and visibility

IBM Institute for Business Value

How IBM can help

The IBM Chemicals and Petroleum industry team designs and implements solutions for chemicals, as well as oil and gas companies. We help these companies turn information into insights that enhance exploration and production, refining and manufacturing efficiency, global trading, risk management and operations in real time. IBM offers end-to-end industry solutions, including integration and collaborative platforms, hardware for supercomputing, software to optimize operations, and business and IT consulting. For information about IBM Chemicals solutions, visit **ibm.com**/industries/chemicals

In this report

The three key capabilities of a digital supply chain

Digital technologies that chemicals industry respondents rated critical to their supply chain strategies

Imperatives cited by leaders of the most effective supply chain organizations

What's next in supply chains for chemicals?

The next-generation chemicals supply chain is here. It's data-driven and digitally executed to create transparency, enable advanced planning, predict demand patterns and leverage asset availability. It's predicated on real-time access to data across an extended enterprise and collaboration partners, and the use of advanced technologies. It integrates suppliers, manufacturing and customers for an end-to-end view. To take full advantage, chemicals organizations must define a clear digital supply chain strategy, create new capabilities and lay a data foundation. With input from 460 executives worldwide, we explore how leading organizations are preparing for and implementing digital technologies within their supply chains, and what others can learn from them.

The need for demand-driven supply chains

Riding the wave of one of the longest cycles on record, 2017 was the best year in a decade for global chemicals organizations. Oil demand remains strong, yet prices are fluctuating at lower levels than in the past. Gas is readily available for global power needs and for chemicals production, thanks to shale technology developments. New regulations and new mobility trends are expected to impact demand for refined products. Record M&A activity continues to re-shape the competitive landscape. For the rest of the decade, the chemicals industry anticipates riding the crest of an extended upcycle, approaching a potential peak by the turn of the next decade.[1]

Despite favorable conditions, much depends on the readiness of chemicals organizations to navigate the digital era upon them. For current evolutions to be sustainable and profitable at the rate set by the market, it's vital that chemicals companies understand the global forces driving change, including technological advances, feedstock and product supply, demand volatility and sustainability factors. These companies must then take action and quickly adapt by investing in operational resilience and flexibility, improving customer and employee experience. They must also strive to manage costs by increasing asset reliability and optimizing their supply chains.

Both external and internal factors are putting pressure on chemicals enterprises to craft demand-driven supply chains. From an external perspective, increased scrutiny on recalls and returns requires traceability of product from procurement to manufacturing to finished goods. The ability to quickly address price volatility as a result of changing energy markets (for example, raw material) and consumer markets such as construction, automotive, packaging and agriculture is necessary. Increasing competition and little differentiation make innovation essential, along with speed to market and the ability to shift from supplier to solutions provider. Supply chains also need to manage supply and demand disruptions as a result of varying vendors, regulations, geopolitical factors and cost pressures.



75%

of chemicals company executives tell us collaboration is the most important imperative for their supply chains



68%

of executives from leading organizations have a fully executed digital supply chain strategy, or a fully thought-out strategy and execution plan



40%

of executives from leading organizations have implemented artificial intelligence in their supply chains

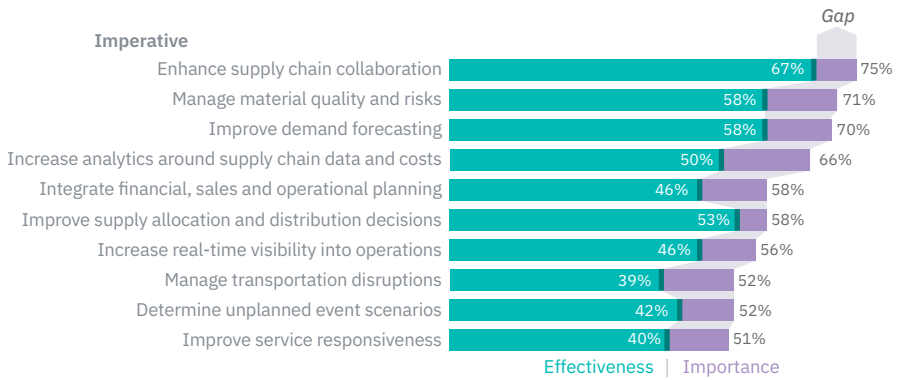
From an internal perspective, demand variations are the direct result of changes in the consumer industry, such as B2B, and require different engagement models to reduce shocks to the supply chain. The supply chain also needs to address operational challenges caused by raw material quality and availability, scheduling and plant maintenance constraints, R&D timelines, and lack of integration among business divisions such as sales and marketing, R&D and production. Further, a lack of supply chain visibility (including in-transit inventory) often renders optimization efforts sub-optimal.

With new markets maturing and novel material formulations increasingly prevalent, organizations in the chemicals industry find they need supply chain technology that is agile and can meet ever-growing performance standards. At the very least, this means deploying predictive supply chain analytics systems and dynamic pricing systems. Next-generation supply chain solutions will likely require automated optimization and decision-making capabilities.

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

Figure 1

Chemicals companies worry that their supply chains are not up to the task



Source: IBM Institute for Business Value 2018 Chemicals Digital Supply Chain Study

For example, two-thirds of the 460 chemicals respondents who participated in our survey said it's vital to increase the use of analytics with supply chain data and costs. Yet only half told us their supply chain functions are effective at it. There are also large gaps between the importance that chemicals companies attribute to advancing imperatives—such as managing transportation disruptions, managing material quality and risks, improving demand forecasting and integrating financial, sales and operational planning—and their current proficiency at acting on these imperatives (see sidebar, "BASF: Creating a smart supply chain"). Across these ten imperatives, the average effectiveness gap is 11 percent.

BASF: Creating a smart supply chain[2]

With 2017 sales reaching EUR 64.5 billion, BASF offers a broad product portfolio that includes chemicals, plastics, performance and crop protection products, and oil and gas. Founded in 1865, these days BASF is leveraging digital technologies to become more efficient and effective. For example, the company is currently implementing a new mobile and remote-operated tank concept at its Ludwigshafen site. The concept includes an automated tank container terminal, the world's largest patented tank containers and an autonomous, tele-operated vehicle. Together, these can supply production plants faster and at lower costs.

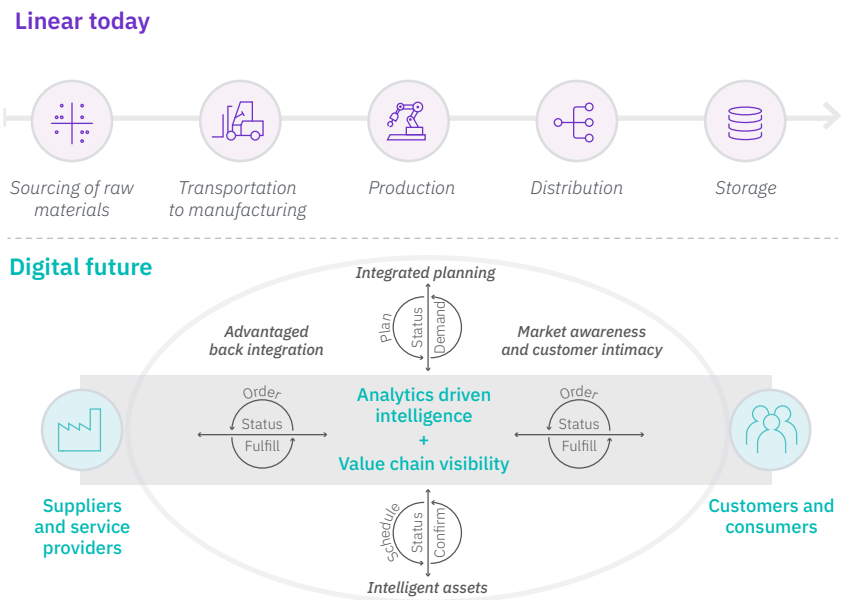
In addition, BASF is integrating its internal supply chains with partner supply chains. Using a digital platform, BASF connects and collaborates with customers and suppliers to help increase reliability and reduce costs throughout the entire supply chain. Digital technologies are also providing opportunities to better support customers with proactive location and delivery information. The company merges global transportation data and combines it with relevant weather data and news feeds from traditional sources, as well as social media. With a more comprehensive picture, BASF enables its logistics and customer service teams to collaborate on events impacting the supply chain, resulting in more timely and accurate information for its customers.

The digital future for the supply chain

Successful chemicals businesses will need to embrace advanced supply chain technologies to shift from a linear model to a digital future (see Figure 2). While the current linear model has discrete, sequential and event-driven processes, a digital future can deliver end-to-end, orchestrated and insight-driven processes.

Figure 2

The next-generation supply chain departs from past architecture



Source: IBM Services

SABIC: Tracking chemicals from space[3]

Based in Riyadh, Saudi Arabia, SABIC has operations in over 50 countries and ranks among the world's largest petrochemicals manufacturers. For SABIC, real-time tracking of rail cars carrying chemicals is a critical need as a result of cross-border regulations and safety measures. SABIC equipped its European fleet of 500 rail tank cars with satellite-based tracking and monitoring communications.

The solution is improving the efficiency, accuracy and timeliness of tracking and monitoring to help its rail tank cars reach their destinations safely and on time. In addition, the new technology is helping SABIC optimize its supply chain operations and enhance partner relationships.

A digital supply chain can dynamically predict demand patterns while improving visibility and leveraging asset availability (see sidebar, "SABIC: Tracking chemicals from space"). It includes three capabilities: integrated planning, value chain visibility and intelligent assets.

- *Integrated planning* aligns operational and financial performance goals and enables rapid decision making based on forecast variance, order changes, market intelligence and the like. It can optimize manufacturing plans, reduce setup disruptions as a result of variations in products or formulations, and help lower and hedge commodity spend on a broad array of base inputs.
- *Value chain visibility* helps maintain control of highly regulated products from inbound to customer receipt. It can identify risks and react to developing global supply events. It also helps collate information from key supply chain nodes and makes it available for reporting, real-time decision making and collaborative exception handling.
- *Intelligent assets* utilize the Internet of Things (IoT) and cognitive insights to help improve reliability and performance of equipment and assets through better visibility, predictability and operations. They can improve quality and yield of manufacturing operations from design through support, and increase resource consumption efficiency—such as worker, workforce or energy—while reducing costs.

These three capabilities enable a digital supply chain that can enhance performance across multiple dimensions:

- Optimized inventory
- Reduced logistics costs
- Higher customer fill rates
- Lower operating costs
- Incremental revenues
- New market opportunities.

From our study, chemicals 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 raw materials and products can be tracked and monitored. Mobile technologies allow ubiquitous access to information and help manage disruptions and improve customer service. Chemicals companies can use predictive analytics to spot anomalies in the supply chain (see sidebar, "Monsanto: Applying analytics in the supply chain"). Artificial intelligence (AI) takes this capability further by learning trends and root causes, and then developing corrective actions.

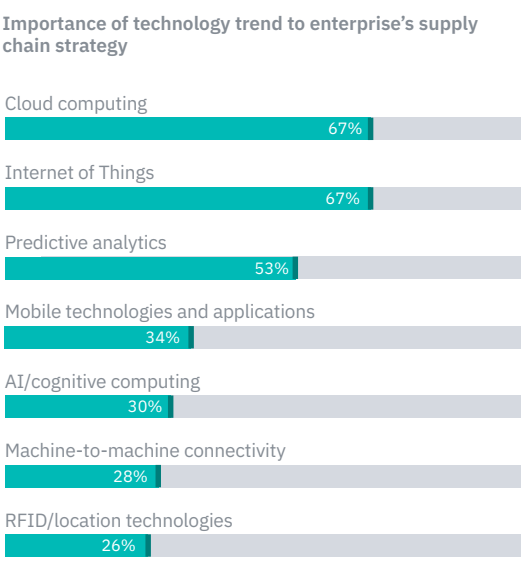
Monsanto: Applying analytics in the supply chain[4]

Monsanto is a global modern agriculture company recently acquired by Bayer. Monsanto's global supply chain uses analytics to improve its own efficiency and processes. By installing cameras to monitor conveyor belts at two seed production facilities, the company reduced seed loss from 5,400 bushels to just 30 bushels. Monsanto also installed temperature sensors to monitor over 500 corn trucks, improving the protection of 5,000 loads of seed.

As part of its commitment to becoming carbon neutral by 2021, the company also instituted the Transportation Management Solution (TMS), which includes a combination of real-time monitoring, automation of processes, analytics-based decision making, and standardization of tools and processes. This solution allowed the consolidation of some routes and helped optimize others. In Brazil alone, TMS helped reduce total vehicle miles by 1.4 million the first year. The corresponding reduction in carbon dioxide emissions exceeded 2,500 tons.

Figure 3

Chemicals companies cite an essential combination of technologies



Source: IBM Institute for Business Value 2018 Chemicals Digital Supply Chain Study

Meet the supply chain leaders

How can chemicals companies take advantage of a digital supply chain? To help answer this question, we analyzed survey responses and identified a small group of chemicals "leaders," consisting of 14 percent of our study. Executives provided scores on their organization's effectiveness regarding 10 imperatives on a scale of 1 to 5, with 1 being ineffective and 5 being highly effective. Leaders were those with total scores of 40 or greater across these 10 critical imperatives:

1. Improve demand forecasting.
2. Enhance supply chain collaboration.
3. Improve supply allocation and distribution decisions.
4. Integrate financial, sales and operational planning.
5. Determine unplanned event scenarios.
6. Manage material quality and risks.
7. Increase analytics around supply chain data and costs.
8. Increase real-time visibility into operations.
9. Manage transportation disruptions.
10. Improve service responsiveness.

Why pay attention to the most effective supply chain organizations? Because they delivered better financial performance than other industry peers – in both revenue growth and profitability. These leaders also have much smaller supply chain imperatives gaps (importance minus effectiveness), with an average gap of 5 percent across the 10 imperatives compared to 12 percent for their peers. And 68 percent of the most effective organizations have further developed digital strategies and execution plans versus 52 percent of their peers.

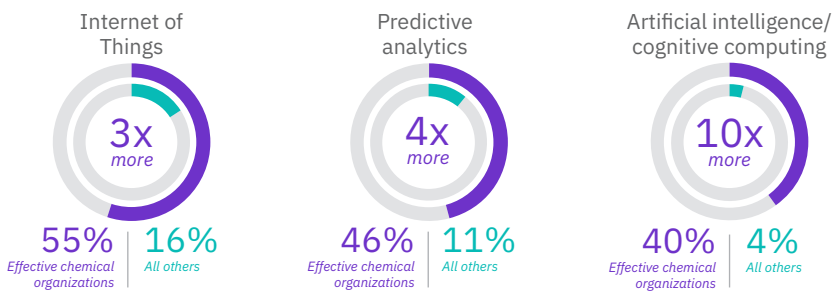
Adoption and value of digital technologies in the supply chain

Chemicals businesses will need to digitize their supply chains to create fully integrated, flexible and agile operating environments. The most effective organizations see the importance of digital technologies for their enterprises' supply chain strategies. Over 70 percent of these leaders view a combination of technologies as critical, including cloud computing, IoT, predictive analytics, machine-to-machine connectivity, AI and mobile technologies. They see AI impacting all the supply chain imperatives, especially material quality and risk management. Over 92 percent of the leaders say IoT, cloud computing and RFID technologies help enhance supply chain collaboration, while over 88 percent see IoT, mobile technologies and cloud computing impacting real-time visibility into operations. And a staggering 94 percent of the leaders see mobile technologies as important to managing transportation disruptions.

Overall, more of the most effective organizations have implemented these digital technologies broadly in their supply chains (see Figure 4).

Figure 4

Leaders are further along in their adoption of digital technologies in their supply chains



Source: IBM Institute for Business Value 2018 Chemicals Digital Supply Chain Study

These leaders are also applying multiple technologies for specific supply chain activities (see Figure 5).

Figure 5

Leaders apply varying combinations of technologies for each supply chain activity

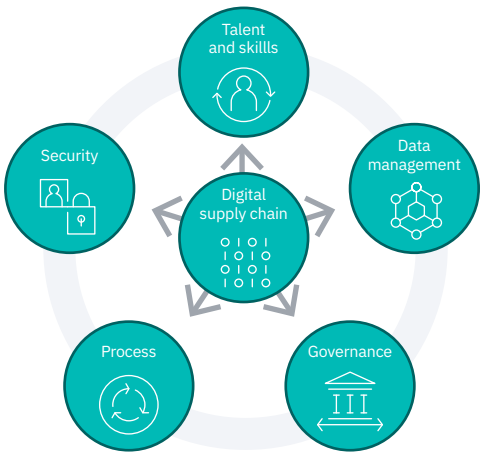
Supply chain activity	Predictive analytics	Cloud computing	AI/cognitive computing	Internet of Things	Machine-to-machine connectivity	Mobile technologies	RFID/location technologies
Demand planning and forecasting	95%	68%	86%				
Warehousing and distribution			64%	91%	56%	84%	96%
Sourcing and supplier management	69%	94%	72%	74%	52%		
Transportation management					55%	94%	80%
Customer service		55%				84%	
Asset management				78%	52%		
Fulfillment						76%	
Risk assessment	94%		66%				
Internal supply chain		65%					

Teal bars represent technologies where **50 percent or more of leaders** have applied those technologies to the supply chain activity

Source: IBM Institute for Business Value 2018 Chemicals Digital Supply Chain Study

For example, they have applied cloud computing, predictive analytics and AI for demand planning and forecasting. They are using IoT and machine-to-machine connectivity for asset management. Not surprisingly, over two-thirds of the leaders have realized a significant ROI from applying cloud computing, AI, IoT and predictive analytics in the supply chain. The benefits come from a variety of sources including reducing transportation, service, R&D and quality control costs, enhancing workforce utilization and reducing supply chain downtime. These leaders are likely to benefit in the future as many leaders plan to implement IoT, predictive analytics and AI more broadly over the next three years.

Figure 6
Five key domains support a digital supply chain



Source: IBM Institute for Business Value

Preparing for a digital supply chain

To achieve a digital supply chain, chemicals organizations need to enhance capabilities in five domains (see Figure 6).

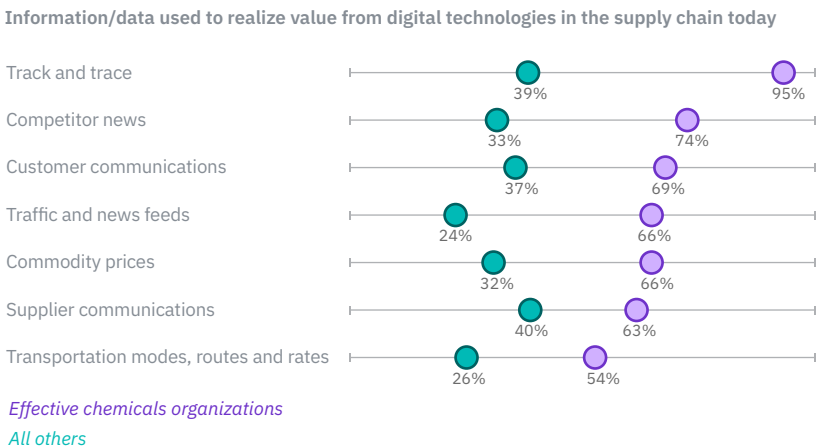
Talent and skills. Chemicals businesses will need to identify, hire, build and retain the necessary talent to create and sustain a digital supply chain. The most effective organizations recognize that employee roles and skills will need to change to support digital reinvention. Fifty-eight percent of leaders have a strategy in place to help supply chain employees adapt, versus just 26 percent of their peers. The most effective organizations have also acted to gain skills that support a digital supply chain. An impressive 74 percent of leaders have implemented training for employees engaged with digital technologies, and 55 percent have established a formal process to identify needed digital skills.

Data management. More than three-fourths (78 percent) of leaders have implemented data lifecycle management to support digital supply chains, compared to 56 percent of others. The most effective organizations are working with their ecosystems to take advantage of additional data: 72 percent have established common standards with collaboration partners versus 44 percent of others.

In terms of data sources, the leaders are far outpacing others (see Figure 7). More than twice as many leaders as their peers are leveraging various information and data to realize value from digital technologies in the supply chain. The most effective organizations say they will get even better by adding more sources of data in the future. Again, by a factor of more than two times their industry peers, leaders plan on including social listening, geopolitical data and economic indicators.

Figure 7

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



Source: IBM Institute for Business Value 2018 Chemicals Digital Supply Chain Study

Governance. For leaders, a digital supply chain starts at the top with a clear view of what they want to achieve with governance. It is critical that a chemicals organization views its customers as core to the supply chain. Eighty-two percent of the leaders have established performance management/KPIs for digital activities versus 47 percent of others. To react to market dynamics and meet ever-shifting customer expectations, chemicals companies should lead on key supply chain metrics related to "perfect orders"—the percentage of orders delivered on time. This would require looking at on-time deliveries, products shipped complete, damaged free deliveries, accurate invoices and customer feedback.

Process. Sixty percent of leaders have optimized processes. This would include the redesign of processes for distribution and logistics, manufacturing and engineering, and planning and procurement. Distribution and logistics would benefit from a logistics advisor, and from inventory management and optimization in order to enable visibility and logistics improvement, responsiveness and surety of supply. In manufacturing and engineering, automating business processes and orchestrating relationships provides electronic workflows. Planning and procurement would support financial, supply and demand planning by using internal and external data and insights. It would offer buyer assistance, logistics improvement and visibility to provide responsiveness and surety of supply.[5]

Security. A digital supply chain links chemicals companies with its suppliers, manufacturers and customers. The vast amount of data and intellectual property shared among the partners creates vulnerabilities and cybersecurity risks (see sidebar, "Supply chain meets blockchain"). Fifty-five percent of leaders surveyed have addressed cybersecurity issues as part of implementing digital technologies for their supply chains. This is about having a good security culture and a clear security crisis protocol. And the supply chain needs to consistently practice, plan and prepare for many different situations.

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 and adopt standards (such as Industry 4.0) where possible. Apply intelligence to supply chain activities to power real-time, actionable insights. Check that your supply chain data strategy targets structured and unstructured data needed to address the supply chain imperatives. Broaden your ecosystem of partners and leverage it by sharing data and information. Communicate constantly throughout the supply chain.

Create supply chain processes that can "think"

Create ecosystems to match variable willingness-to-pay with variable willingness-to-supply. Infuse digital technologies with advanced analytics to optimize processes and understand trends to improve demand planning. Use data interpretation, prediction and AI technologies, and cognitive solutions across the supply chain to reveal patterns that 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.[7] 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.

Supply chain meets blockchain[6]

Blockchain is based on a general ledger that can quickly distribute and validate information across its network nodes. This technology illustrates that there are ways of enabling faster, permissioned, immutable, transparent and auditable B2B transactions among participants in a given network. By integrating blockchain technology into supply chain systems, chemicals manufacturers can address challenges within their current record-systems. For example, BASF is investigating blockchain's potential to provide shipment information about the position and movement of goods within the supply chain. The idea is that the system could be used to track missing parts, with information about those shipments shared between all points along the manufacturing pipeline.

Are you ready for a digital supply chain?

In what ways does your supply chain enable flexible formulation to optimize costs and increase speed to market?

What real-time information do you have on your supply chain assets, such as in-transit inventory?

How will your analytics support decision-making across inventory management, supply and demand forecasting, distribution costs and manufacturing?

What skills are employees equipped with to solve supply chain challenges in real time when or before they occur?

About the authors

Markus Deppe is a partner in IBM Services and leads the IBM GBS Chemicals business in Europe. He has been in business consulting roles for more than 20 years, and helps Chemicals and Industrial Products clients improve business processes, optimize organizational structures and leverage technologies. Functionally, this includes areas such as Supply Chain, Sales & Marketing, R&D, Engineering, Production, Procurement, Finance and HR. He can be reached at markus.deppe@de.ibm.com and on LinkedIn at https://www.linkedin.com/in/markus-deppe-7aa767/

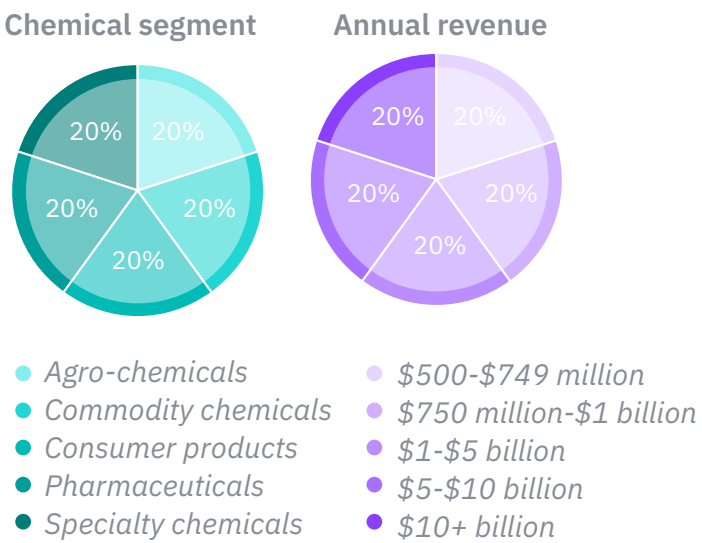
Dr. Viswanath Krishnan is a thought leader and solutions executive in Chemicals and Petroleum with IBM. He has over 25 years of experience in manufacturing and supply chain operations within the process industry. His current focus is on digital disruptors, including IIoT, Cognitive and Blockchain technology in operational environments. He holds a Ph.D. in Chemical Engineering and has published multiple articles in industry journals. He can be reached at viswanath.krishnan@ibm.com and on LinkedIn at linkedin.com/in/v-krishnan/

Spencer Lin is the Global Chemicals and Petroleum, and Industrial Products Lead for the IBM Institute for Business Value. Spencer has more than 20 years of experience in financial management and strategy consulting. He can be reached at spencer.lin@us.ibm.com and on LinkedIn at linkedin.com/in/spencer-lin-35896317/

David M. Womack is the IBM Global Director of Strategy and Business Development for the chemicals and petroleum industries. David is responsible for identifying new market and solution opportunities, managing the development of the industry-specific solution portfolio, implementing go-to-market plans for business growth, and leading alliances with key business partners associated with these strategies. David is a member of the IBM Industry Academy. David can be reached at dmwomack@us.ibm.com and on LinkedIn at linkedin.com/in/david-womack-4b81454/

Study approach and methodology

In cooperation with Oxford Economics, the IBM Institute for Business Value surveyed 460 chemicals leaders in 19 countries between April and May of 2018. We collected responses from Chief Executive Officers, Chief Supply Chain Officers, Chief Operating Officers, Chief Information Officers, Chief Transformation Officers, VPs of Operations and VPs of Supply Chain. The 460 chemicals respondents come from the various chemicals segments and from different-sized enterprises.



For more information

To learn more about this IBM Institute for Business Value study, please contact us at iibv@us.ibm.com. Follow @IBMIBV on Twitter, and for a full catalog of our research or to subscribe to our newsletter, visit: **ibm.com**/iibv.

Access IBM Institute for Business Value executive reports on your mobile device by downloading the free "IBM IBV" apps for phone or tablet from your app store.

The right partner for a changing world

At IBM, we collaborate with our clients, bringing together business insight, advanced research and technology to give them a distinct advantage in today's rapidly changing environment.

IBM Institute for Business Value

The IBM Institute for Business Value (IBV), part of IBM Services, develops fact-based, strategic insights for senior business executives on critical public and private sector issues.

Notes and sources

1 “Supply chain excellence in the chemical industry: Decrease operational costs with superior supply chain optimization solutions.” IBM. May 2018. https://www.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=64015864USEN&dd=yes&

2 BASF website. Accessed July 2018. https://www.basf.com/en/company/about-us/digitalization-at-basf/smart-supply-chain.html

3 Caleb, Henry. “Globalstar Wins Sabic Chemical Transportation Monitoring Contract.” Via Satellite. October 26, 2015. https://www.satellitetoday.com/telecom/2015/10/26/globalstar-wins-sabic-chemical-transportation-monitoring-contract/; “Monitoring transport of hazardous goods from space.” European Space Agency. May 9, 2017. https://business.esa.int/projects/showcases/monitoring-transport-hazardous-goods-space

4 “Monsanto Growth Ventures Investment Profile—A Mutually Beneficial Relationship in Advancement.” Monsanto web site. January 11, 2018. https://monsanto.com/company/ventures/articles/mgv-profile/

5 “Supply chain excellence in the chemical industry: Decrease operational costs with superior supply chain optimization solutions.” IBM. May 2018. https://www.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=64015864USEN&dd=yes&

6 “Supply chain excellence in the chemical industry: Decrease operational costs with superior supply chain optimization solutions.” IBM. May 2018. https://www.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=64015864USEN&dd=yes&; Zhao, Wolfie. “German Chemical Company Pilots Supply Chain Blockchain.” coindesk. July 28, 2017. https://www.coindesk.com/german-chemicals-company-pilots-supply-chain-blockchain/

7 Crozier, Jennifer Ryan, Rashid Davis and David Levinson. “Addressing the skills challenge with P-TECH schools”. IBM Institute for Business Value. February 2018. https://www-935.ibm.com/services/us/gbs/thoughtleadership/ptechschools/; van Zadelhoff, Marc, Lindsey Lurie and David Jarvis. “It’s not where you start – it’s how you finish: Addressing the cybersecurity skills gap with a new collar approach.” IBM Institute for Business Value. May 2017. https://www-935.ibm.com/services/us/gbs/thoughtleadership/newcollarjobs/

© Copyright IBM Corporation 2018

IBM Corporation
New Orchard Road
Armonk, NY 10504

Produced in the United States of America
August 2018

IBM, the IBM logo, ibm.com and Watson are trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the web at “Copyright and trademark information” at: ibm.com/legal/copytrade.shtml.

This document is current as of the initial date of publication and may be changed by IBM at any time. Not all offerings are available in every country in which IBM operates.

THE INFORMATION IN THIS DOCUMENT IS PROVIDED “AS IS” WITHOUT ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING WITHOUT ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND ANY WARRANTY OR CONDITION OF NON-INFRINGEMENT. IBM products are warranted according to the terms and conditions of the agreements under which they are provided.

This report is intended for general guidance only. It is not intended to be a substitute for detailed research or the exercise of professional judgment. IBM shall not be responsible for any loss whatsoever sustained by any organization or person who relies on this publication.

The data used in this report may be derived from third-party sources and IBM does not independently verify, validate or audit such data. The results from the use of such data are provided on an “as is” basis and IBM makes no representations or warranties, express or implied.

56018956USEN-00

