



Biopharma digital transformation: Gain an edge with leapfrog digital innovation

About the Deloitte Center for Health Solutions

Your source for fresh perspectives: The Deloitte Center for Health Solutions, part of Deloitte LLP's Life Sciences and Health Care practice, delves deeper into your top-of-mind issues and provides fresh thinking around complex challenges. Timely, relevant research and thought-provoking analyses deliver insight to help you see solutions through a new lens.

Connect

To learn more about the DCHS and our research, please visit www.deloitte.com/centerforhealthsolutions.

Subscribe

To receive email communications, please visit www.deloitte.com/us/LSHC-subscribe

To subscribe to our blog, please visit <https://blogs.deloitte.com/centerforhealthsolutions/>

Engage

Follow us on Twitter at: [@DeloitteHealth](https://twitter.com/DeloitteHealth)

Engage with us on LinkedIn via [ConvergeHEALTH by Deloitte](#)

Deloitte's view on digital transformation

Digital transformation is no longer a buzzword—it's a strategic imperative. Life Science companies should tackle enterprise-wide digital transformation head-on with a holistic, business-driven approach. Learn more at Deloitte.com.

Contents

Executive summary	2
Introduction	4
Biopharma companies are now widely using cloud, AI, data lakes, and wearables	5
Digital innovation is a burning priority	8
Leapfrog digital innovation opportunities across value streams	11
Surveyed companies face challenges in executing leapfrog digital innovation	23
Call to action: Winning with leapfrog digital innovation	25
Conclusion: Choosing your path at the digital innovation inflection point	28
Endnotes	29

Executive summary

TRADITIONALLY, BIOPHARMA COMPANIES were slow to incorporate innovative digital technologies such as artificial intelligence (AI), cloud, and the Internet of Things (IoT) in their operations. But as the COVID-19 pandemic began, companies were forced to prioritize investments in digital innovation and instill it into every aspect of work. Digital transformation road maps spanning years were suddenly executed in months, bringing about radical changes in how companies conduct operations.

Deloitte surveyed 150 biopharma leaders to better understand their experience with digital technologies and the industry's approach to digital innovation in this environment of accelerated change. We found that:

- Certain digital technologies such as the cloud (49%), AI (38%), data lakes (33%), and wearables (33%) have been adopted in day-to-day operations; others such as quantum computing and digital twins are still nascent.
- The momentum of digital innovation is likely to continue post pandemic. Eighty-two percent of respondents agree that digitalization of operations will continue even after the pandemic ends.

- Digital innovation is a burning strategic priority. Seventy-seven percent of respondents say their organization views digital innovation as a competitive differentiator.
- Respondents agree that their organizations need to solve fundamental issues, including dedicated funding (59%), a better digital innovation strategy (49%), and the right talent (47%) to scale digital innovation.

Biopharma is now at a digital innovation inflection point. Organizations face an important choice: either decelerate the pace of digital innovation or pursue what we call leapfrog digital innovation (see section, "Leapfrog digital innovation opportunities across value streams"). This involves making focused digital technology investments that come together like a string of pearls to change the status quo and transform activities across functional areas and value streams. Such leapfrog digital innovation could bring transformative benefits, including realizing ambitious goals earlier, engaging patients and partners optimally, and bringing drugs to market faster. Our research suggests that there is now an urgency among biopharma executives to take risks, invest, and innovate faster to gain an edge over the competition, which can be achieved through leapfrog digital innovation.

As organizations attempt to accelerate their digital innovation journey through leapfrog digital innovation, they should consider the following:

- 1. Establish digital innovation north stars** (e.g., patient-centered and seamless development) for each functional area that connect to overarching enterprisewide digital ambitions (e.g., faster time to market). Organizations should consider the business and information technology (IT) transformational shifts (e.g., operational process changes, access to data, and cultural changes) needed to realize these north stars.
- 2. Develop a purposeful portfolio of digital innovation investments** that cohesively build on one another to realize north star aspirations.

- 3. Determine the digital innovation approach** by rethinking traditional IT approaches to evaluate and select one or more digital innovation archetypes (i.e., do-it-yourself (DIY) innovator, incubator, accelerator, crowdsourcer, venture capitalist) best suited to innovation goals.
- 4. Design an operating model** that provides dedicated innovation resources, outlines an overarching innovation process and success factors to measure progress toward north stars. Moving away from legacy budgeting models to iterative project-based financing could help ensure adequate funding for digital innovation.



Introduction

DIGITAL INNOVATION INVOLVES the application of innovative digital technologies that address business needs and create value for patients, the enterprise, and its partners. This includes, but is not limited to, technologies such as AI, data lakes, cloud computing, augmented/virtual reality (AR/VR), wearables, digital twins, the IoT, blockchain, and quantum computing.

“Digital innovation has been accelerated by 10 years by what has happened over the course of the last 18 months.”

— *Manoj Raghunandan, president, global self-care and consumer experience, Johnson & Johnson*

Prior to the pandemic, our research showed that biopharma lagged behind other industries in digital innovation.¹ While approaching digital innovation incrementally, many companies were yet to treat digital innovation on par with other strategic priorities.² When the pandemic began, however, biopharma companies quickly turned to innovative digital technologies to conduct their business remotely or virtually. Digital innovation projects planned for years out suddenly received budgets and support to be implemented immediately.

The pandemic also put biopharma in the spotlight to curb the spread of the virus. Coupled with private and public funding, regulatory support, and extraordinary levels of collaboration, digital technologies provided an advantage as companies raced to develop vaccines and therapies (for more, see our publication, *Seeds of change: Measuring the return on pharma R&D*). Regulatory agencies also provided flexibility to incorporate digital technologies in research and development (R&D) and other parts of the value chain. For instance, the US FDA and European Medicines Agency (EMA) released multiple guidelines on the use of digital technologies in clinical trials while expanding remote or virtual inspection of manufacturing sites.³

Given the accelerated pace of digital innovation across the industry, Deloitte conducted research to better understand biopharma’s approach to digital innovation.

RESEARCH METHODOLOGY

In 2021, Deloitte surveyed 150 executives from large biopharma companies (revenue of US\$1 billion and above) across the United States, Europe, and Asia. Survey respondents included vice presidents (VPs), directors, and C-level executives from functions across the biopharma value chain. Survey questions revolved around the adoption of digital technologies during the pandemic, their strategic importance, the value scaling digital innovation could bring, and capabilities required to do so.

Biopharma companies are now widely using cloud, AI, data lakes, and wearables

SURVEY RESULTS SUGGEST that certain digital technologies are widely adopted and incorporated into biopharma operations.

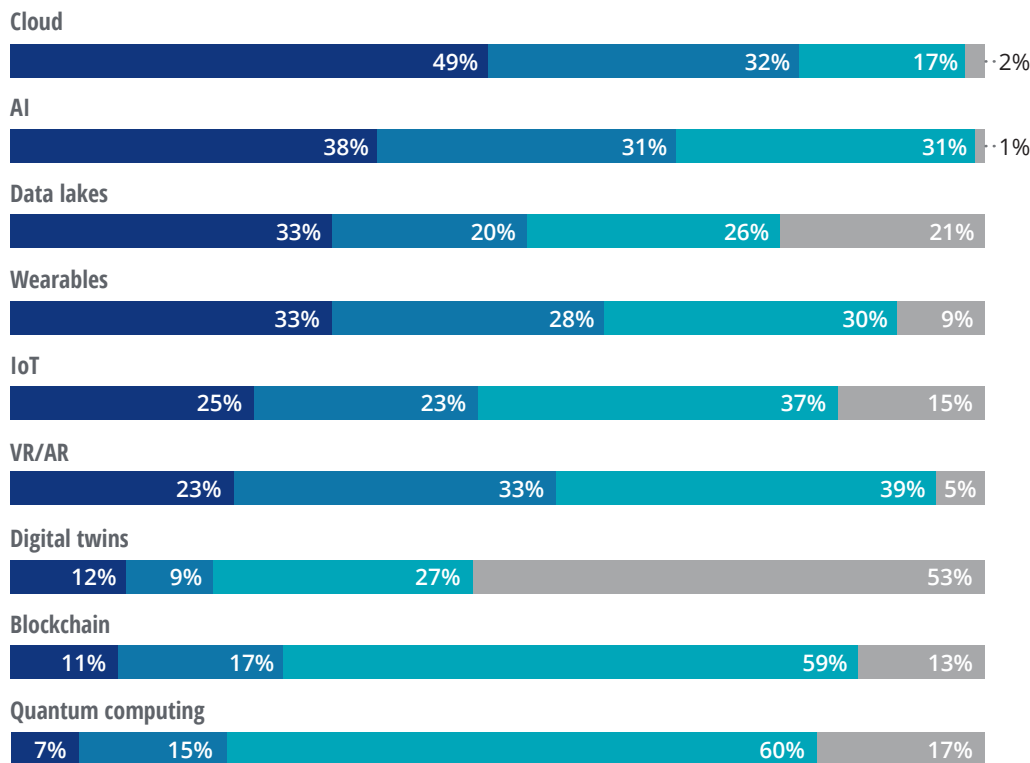
More than a third of survey respondents reported using the cloud (49%), AI (38%), data lakes (33%), and wearables (33%) in day-to-day operations.

FIGURE 1

Biopharma's experience with digital technologies is highest in cloud, AI, and wearables

Q: Which of the following best describes your **experience with each digital innovation technology within your organization?**

- I use this technology to facilitate my day-to-day work
- I have researched/learned about this technology
- I have been part of a project that leveraged this technology
- I have never heard of this technology before



Source: Deloitte's Biopharma Digital Innovation Survey 2021.

Cloud: Close to half of the survey respondents said they use cloud computing to facilitate day-to-day work. The cloud has provided scalability and agility for organizations to enable employees to work collaboratively and flexibly from home, securely store and share data, build data lakes, and even run AI and machine learning (ML) algorithms. Companies have also been using cloud to cut costs, improve time to discovery and insight (see sidebar, “Case study 1”), and collate data for greater visibility into manufacturing and supply chain operations.

AI: Our research on [Scaling AI adoption across the life science value chain](#) found that COVID-19 put a spotlight on AI. Biopharma investments in AI have risen, and the breadth of AI application has

CASE STUDY 1: LEVERAGING CLOUD COMPUTING TO ACCELERATE DRUG DISCOVERY⁴

Moderna’s Drug Design Studio, running on Amazon Web Services’ cloud computing and storage infrastructure, enables virtual design of mRNA sequences against protein targets. Moderna scientists can also run queries and discover insights out of data collated from dozens of ongoing experiments stored in the cloud to refine their mRNA sequence designs. The company’s automated manufacturing facilities then convert these sequences into physical mRNA for further experimentation and use in clinical trials. Using its mRNA technology platform and cloud computing capabilities, Moderna could deliver its first batch of COVID-19 vaccine candidates for the phase 1 trial just 42 days after the virus was initially sequenced.

increased.⁵ Companies have used AI to optimize site selection for COVID-19 vaccines and manage the impact of disruptions to their clinical development operations. Novartis, for instance, used AI to analyze data on trial operations housed in data lakes to predict where disruptions (such as staff shortages, enrollment delays) were likely to occur, and intervene early to reduce their impact on trial timelines.⁶ Deloitte’s [2020 Measuring the return from pharmaceutical innovation](#) study found investments in AI and digitalizing trial operations enabled most of the top 20 companies by R&D spend to keep pivotal trials moving without affecting anticipated launch timings.⁷

As biopharma expanded the use of digital channels to engage patients going online for information on their health needs, spending on digital marketing grew significantly.⁸ Implementing AI solutions helped enable better marketing spend analytics and finding the right combinations of digital channels to engage patients and drive conversions (see sidebar, “Case study 2”).

Wearables and AR/VR: Many disrupted clinical trials adopted hybrid study approaches that included delivering medications directly to patients and monitoring and assessing them remotely. Wearables were incorporated into clinical trials to remotely capture metrics such as blood sugar and oxygen levels. As pandemic-related travel restrictions forced manufacturing sites to operate with skeleton crews, wearable and AR/VR technologies were deployed to help on-site staff with configuring equipment, managing processes, and troubleshooting issues.⁹

CASE STUDY 2: ELEVATING RETURNS ON DIGITAL MARKETING THROUGH AI

A large biopharma company implemented ConvergeHealth's CognitiveSpark™ for Marketing, an AI-powered decision-making tool, to optimize its digital media spend. In the past, the company had relied on external vendors to provide attribution insight (i.e., determine which channels and messages had the greatest impact on consumer decision). This approach often provided inaccurate insights due to the complexity of the pharma customer journey.

By implementing CognitiveSpark™ for Marketing, the company was able to make decisions to reallocate spending to high-performing channels and use only the most effective placements and capping frequencies (i.e., decide how many times a patient sees the same content to elicit action). This led to a 20% increase over baseline conversions and drove an 11% increase in budget efficiencies.

CASE STUDY 3: ENSURING VACCINE SHIPMENT INTEGRITY AND TIMELY DELIVERY¹⁰

Pfizer used the IoT to help ensure its mRNA COVID-19 vaccines—which are to be maintained at 94 degrees Fahrenheit—reached vaccine distribution centers and hospitals without losing their potency. The company used temperature-controlled thermal shippers filled with dry ice and fitted with GPS-enabled thermal sensors to store and transport the vaccine. These sensors fed data to Pfizer's control tower to enable tracking the location and temperature of each vaccine shipment across preset routes and help ensure their timely delivery.

IoT: As disruptions to logistics and transportation impacted the timely delivery of products, companies rapidly digitalized their supply-chain operations. IoT solutions tracked and traced product shipments in real time and plugged gaps in supply-chain visibility (see sidebar, “Case study 3”).

Others: Our survey shows that biopharma is exploring other digital technologies, such as digital twins, blockchain, and quantum computing. When connected to a live process, such as fermenting, a digital twin can analyze data from sensors and control systems to model the process in-silico and provide feedback to optimize the physical process. In 2021, GlaxoSmithKline successfully piloted the creation of a digital twin to fine-tune its manufacturing process for vaccine adjuvants.¹¹

Given the authenticity and integrity of data stored in blockchain networks, the technology has the potential to support secure data-sharing, connectivity, and auditability for processes across the biopharma value chain. Some companies are already piloting blockchain networks in parallel with serialization to track products and prevent counterfeiting.¹²

While computational approaches, including AI, are being steadily adopted in drug discovery, today's binary computers can only efficiently simulate simple molecular interactions.¹³ Quantum computers can process data faster to simulate complex interactions between biological molecules, expanding our ability to understand a range of disease mechanisms. Some companies such as Boehringer Ingelheim are experimenting with quantum computing for molecular dynamics simulations.¹⁴

Digital innovation is a burning priority

LARGE-SCALE DIGITAL INNOVATION projects that became commonplace during the pandemic altered mindsets, freed funding, and created an appetite for digital transformation to continue. In our survey, 82% of respondents agreed that digitalization of activities and operations is likely to continue even after the pandemic ends.

“Our strategy is to win the digital race in pharma, recognizing that digital is going to be extremely impactful, and that it is a race. Everybody is trying to [win that race], and one day, someone will—I want it to be us.”

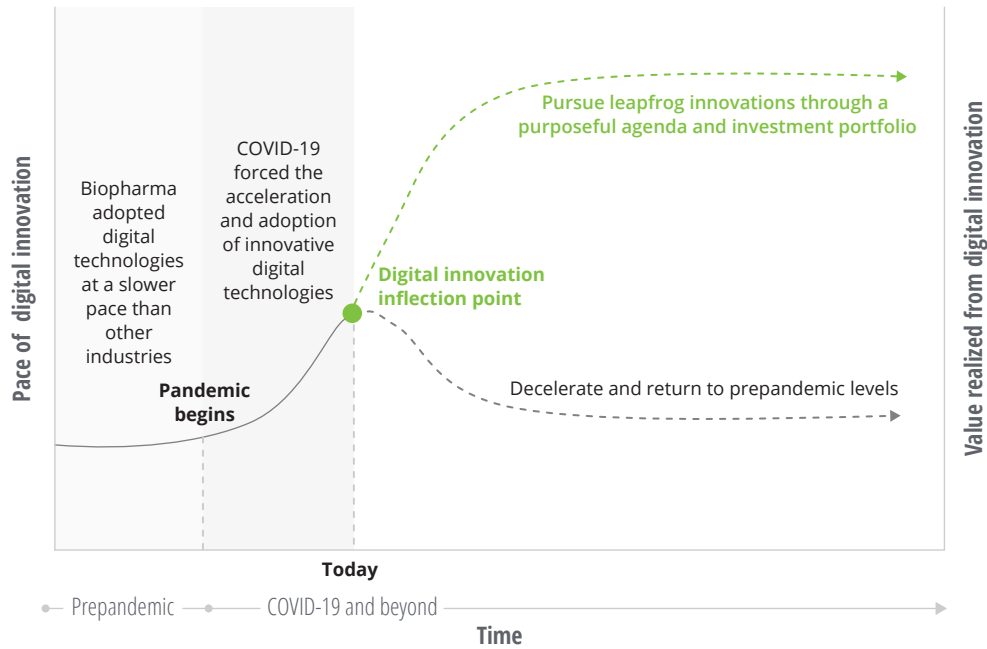
— *Albert Bourla, CEO, Pfizer*¹⁵

However, the industry is now at an inflection point. Organizations, which are already juggling several priorities, now face a critical choice—either decelerate the current pandemic pace of innovation or raise the bar even higher by accelerating the adoption of digital technologies (see figure 2).



FIGURE 2

What is leapfrog digital innovation?



Source: Deloitte Consulting LLC.

Our research and experience with clients point to the likelihood of the latter. Leaders are now willing to invest, take risks, and digitally innovate to stay ahead of the competition: Seventy-seven percent of survey respondents said their organization treats digital innovation as a competitive differentiator. There is a sense of urgency among executives to double down on digital investments to realize long-term business goals as quickly as possible. More than half of our survey respondents view their organizations as fast followers, failing to capture the first-mover advantage of early adopters of digital technologies. Of these executives, most (80%) believe that their organization needs to be more aggressive and adopt digital technologies faster to win in the market.

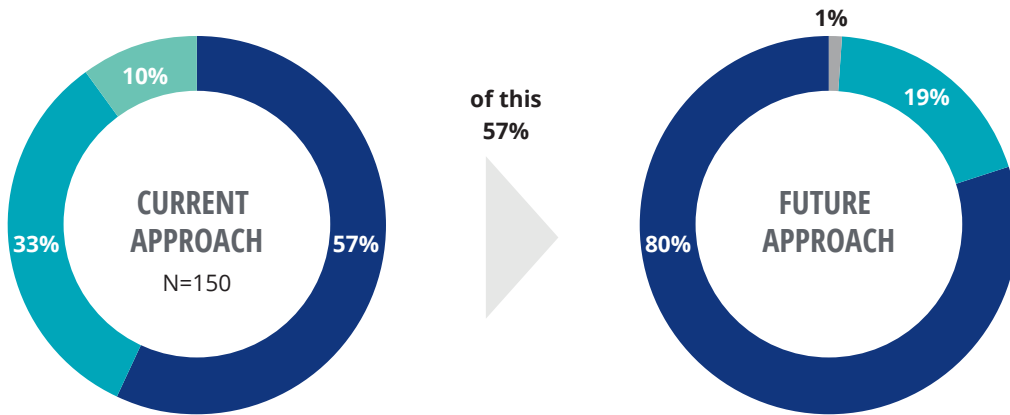
However, merely increasing investments isn't enough. Organizations should move beyond random and duplicative digital technology investments across the enterprise to pursue agenda-driven leapfrog digital innovation. This involves building a portfolio of digital technology investments that come together to achieve innovation north stars within each functional area, tied to an enterprise value stream. A "value stream" is a collection of processes that helps achieve goals; for example, the *molecule to market* value stream focused on creating and launching new drugs or the *procure to pay* value stream focused on purchasing materials and services. Innovation portfolios architected in this manner create capabilities that improve key performance indicators (KPIs) for activities across the value stream to generate enterprisewide impacts.

FIGURE 3

Fast followers believe they should adopt a more aggressive approach to digital innovation

Q. Which of the following best describes your organization's **current approach** to adopting innovative digital technologies?

Q: Do you believe that your organization **should continue with this approach** or does it need to change to win in the market?



57%

Fast followers: We tend to follow the path of competitors after they have proven the value of technologies.

33%

Early adopters: We are visionaries that quickly adopt technologies and set the pace for the industry.

10%

Laggards: We are slow to adopt technologies.

80%

Be more aggressive: We should adopt innovative technologies faster.

19%

Stay the current path: Our current approach works; no need to change it.

1%

Slow down: We're moving too fast without generating benefits.

Source: Deloitte's Biopharma Digital Innovation Survey 2021.

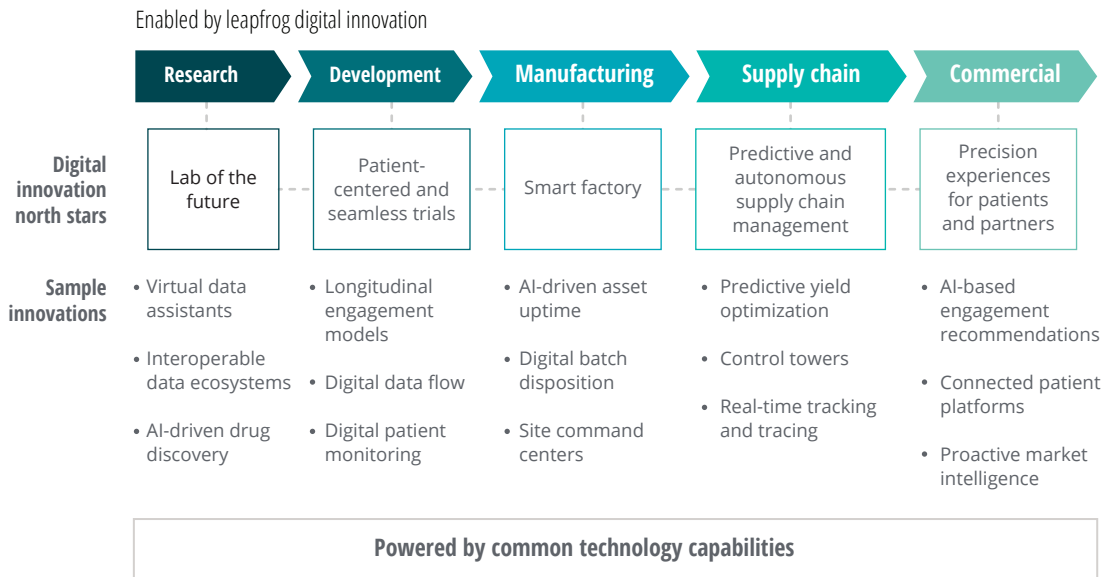
Leapfrog digital innovation opportunities across value streams

WE NOW OUTLINE examples of potential digital innovation north stars across functional areas tied to an overarching

value stream, enabled by leapfrog digital innovation (see figure 4).

FIGURE 4

Value stream “molecule to market”



Source: Deloitte Consulting LLC.

Drug discovery

North star aspiration: Lab of the future

In the R&D lab of the future, an interconnected ecosystem of data, platforms, instruments, and advanced analytical tools supports scientists across teams and geographies to rapidly discover breakthrough therapies. Such a lab could optimize and expedite value-stream processes from target identification to preclinical development—all through leapfrog digital innovation.

Realizing this potential north star ambition will likely require companies to build a purposeful portfolio of digital innovation (see figure 5) while bringing about a series of key transformational shifts within the discovery organization, including:

- **Empowering researchers with machine intelligence:** Changing traditional human-led

scientific methods by embedding machine intelligence into research processes for faster analysis of molecular structures and identification of promising compounds.

- **Building interoperable research ecosystems:** Shifting from the current landscape of isolated scientific instruments, manual data-collection techniques, and fragmented databases to create an interconnected research ecosystem for fluid data generation, sharing, and analysis.
- **Breaking down research barriers:** Moving away from information siloes created from differing organizational priorities and geographical barriers to create a collaborative culture where research inputs and outputs are frictionlessly shared among teams and research partners.

FIGURE 5

Sample digital innovations enabling the lab of the future

Digital innovations	Description
AI-driven drug discovery <i>(AI)</i>	<ul style="list-style-type: none"> • AI applied to knowledge graphs automates target identification and validation and reduces time spent on screening of extensive molecular libraries to identify lead molecules. • AI-based computational chemistry toolkits enable discovery scientists to explore novel spaces and broaden the pool of potential structures to consider as drug candidates, increasing development pipeline size and diversity.
Automated lab processes <i>(robotics and IoT)</i>	<ul style="list-style-type: none"> • Physical and digital robots automate lab processes such as sample preparation, pipetting, and standard analytical testing, managing these activities with high precision and repeatability, reducing manual workloads.
Virtual data assistants <i>(AR/VR, AI)</i>	<ul style="list-style-type: none"> • Digital assistants with AR/VR, NLP (natural language processing), and computer vision facilitate hands-free work by displaying steps of a lab procedure and notes from previous experiments while automatically recording all video and audio observations.
Interoperable data ecosystems <i>(IoT)</i>	<ul style="list-style-type: none"> • Through IoT, research platforms and smart instruments can automatically clean, store, and upload data to cloud platforms to create an interoperable lab ecosystem. • This will ensure connectivity, access, and availability of data and insights from discovery experiments when needed.
Seamless data sharing and access <i>(cloud)</i>	<ul style="list-style-type: none"> • Through creation of seamless and dynamic workflows via cloud data storage, scientists across organizations and geographies can effortlessly share data collected during experiments (such as audio recordings and research notes) and work together to analyze data and strategize follow-up experiments (for more, see our publication on Innovating R&D with the cloud).

The research leaders we surveyed said their organizations are currently prioritizing investments in AI (81%) and cloud (71%). A much smaller percentage believes that over the next five years their organizations are likely to invest in AR/VR (19%) and IoT (24%), both of which are

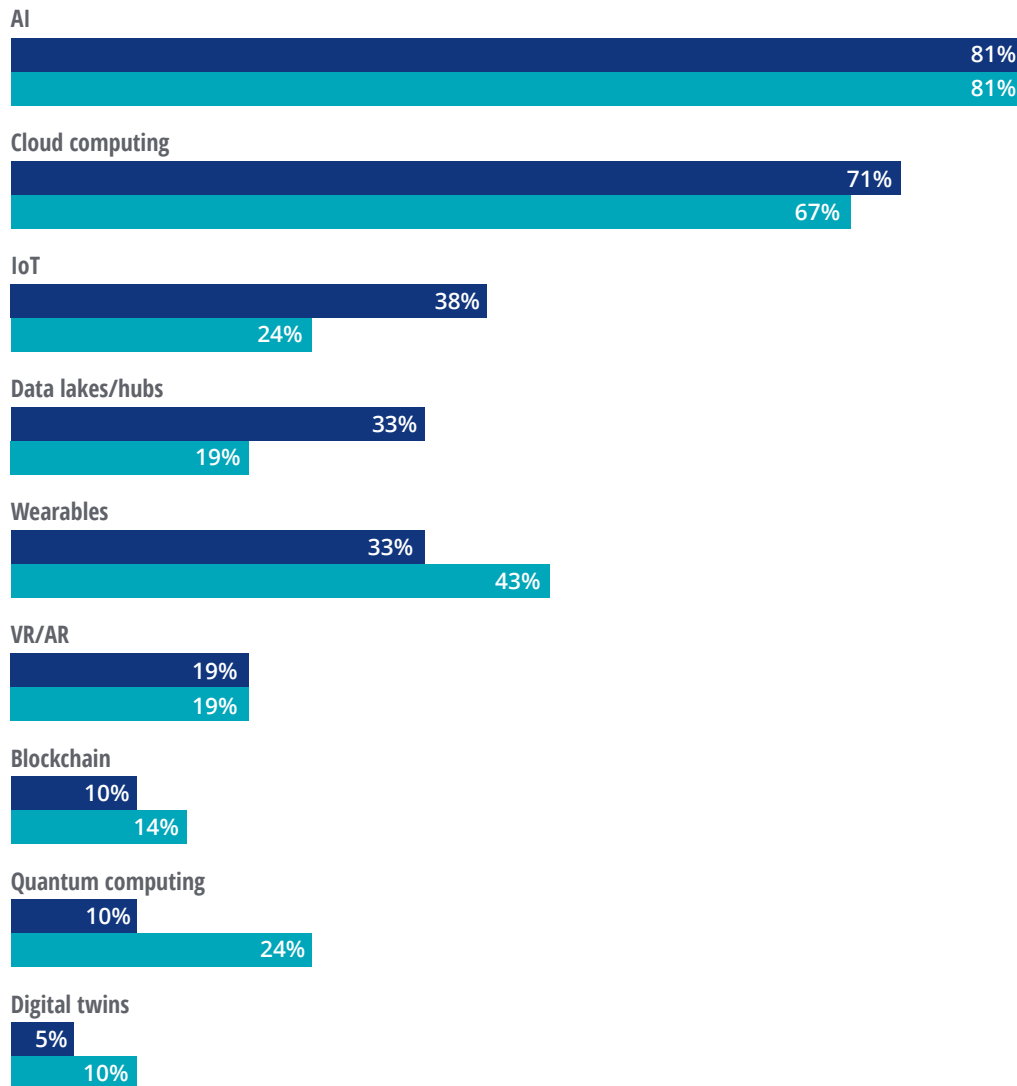
essential for the lab of the future. Additionally, research leaders see improving research productivity (95%), reducing drug discovery costs (76%), and improving pipeline diversity (67%) as the top value levers realizable through digital innovation.

FIGURE 6

Drug discovery: Current and planned investments in digital technologies

Respondents were asked to rank the most innovative technologies in which their function is **currently investing and plans to invest in the next five years.**

■ Current investment priorities ■ Investment priorities over the next 5 years



Note: Percentages indicate options ranked among the top 3 by survey respondents.

Source: Deloitte's Biopharma Digital Innovation Survey 2021.

Drug development

North star aspiration: Patient-centered and seamless clinical trials

Next generation clinical trial protocols will be built to address participants' diverse medical and behavioral needs, with participant engagement extending beyond the life of the clinical trial. At the same time, every aspect of the trial from protocol development, clinical observation to developing a dossier is seamlessly executed digitally. Such a north star could accelerate value-stream processes from study design to closeout, making it easier to attract and retain trial participants and reduce development costs and cycle time.

Achieving the north star described above likely requires creating a targeted portfolio of digital innovations (see figure 7), accompanied by a series of transformational shifts, including:

- **Cultivating deeper patient relationships:** Moving away from short-term relationships with patients focused on trial completion to treating patients as longitudinal partners to better understand their disease, collect long-term safety and efficacy data, and improve care outcomes.
- **Decentralizing trial environments:** Changing the definition of a clinical site from a physical medical center to a virtual or preferred local setting (doctor's office or alternative sites) to ease trial participation.

- **Infusing digital agility into study deliverables:** Rethinking the nature of study deliverables (e.g., protocols, dossiers) from static documents that need to be rewritten for every trial to living collections of digital elements that can be assembled and disassembled based on the needs of the trial.
- **Digitizing trial processes:** Shifting away from inefficient processes that clinical researchers struggle with today by creating end-to-end digital workflows across the trial life cycle using digital tools, automation, and machine intelligence.

“Every aspect of the trial from protocol development, clinical observation to developing a dossier is seamlessly executed digitally.”

Survey results suggest that organizations are currently prioritizing investments in the cloud (80%) and AI (76%) for drug development. Future investments in wearables and IoT will likely be needed to shift toward trial decentralization and modernizing the trial data environment. Reducing time to market (76%), decreasing time to analyze data (65%), and reducing study execution costs (57%) are the top value levers surveyed clinical leaders believe can be realized through digital innovation.

FIGURE 7

Sample digital innovations for patient-centered and seamless clinical trials

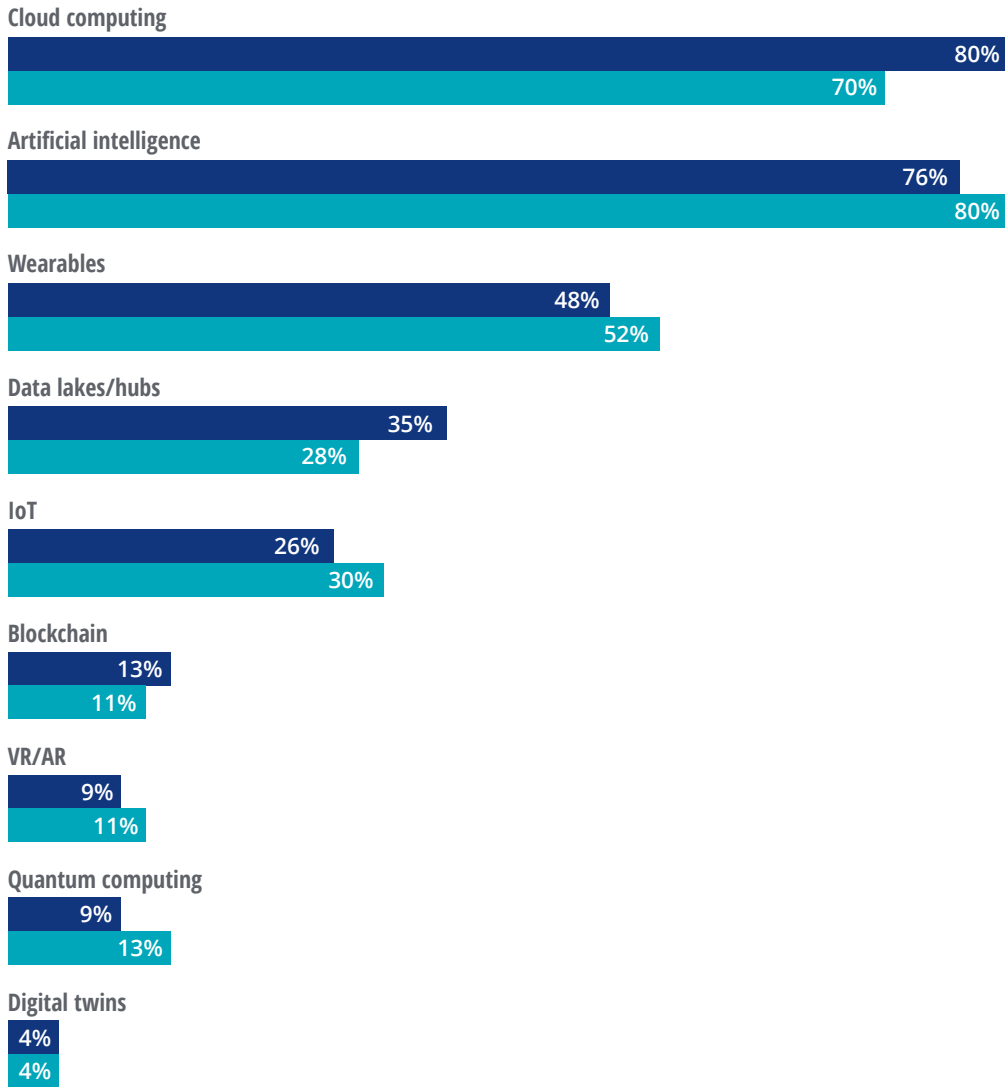
Digital innovations	Description
Precision patient recruitment <i>(AI)</i>	<ul style="list-style-type: none"> • AI-driven analysis of aggregated clinical, real-world data (RWD), and socioeconomic information enables segmenting patients based on: <ul style="list-style-type: none"> – Disease characteristics and health outcomes to accurately identify and match patients to trial opportunities. – Socioeconomic, racial, and ethnic makeup to ensure representative participation. – Behavioral characteristics to predict their propensity to participate and stay engaged through a trial.
Longitudinal engagement models <i>(AI and wearables)</i>	<ul style="list-style-type: none"> • Pretrial segmentation of patients based on behavioral factors enables more flexible trial designs (e.g., more virtual checkins than site visits for participants with busier schedules). • Mid trial, behavioral nudges delivered through coaches to struggling patients improve trial retention and adherence. • Post trial, participants are engaged with information that matters to them (e.g., insights into how a treatment is impacting their overall health).
Bilateral data exchange <i>(AI, blockchain, and wearables)</i>	<ul style="list-style-type: none"> • Trial data is democratized as sponsors provide participants access to their own trial data (e.g., testing/lab results) to share with physicians or donate to other research studies or initiatives. • In exchange, companies are allowed access to patient digital data (EHR, wearable data) to collate long-term RWD on drug safety and effectiveness across patient cohorts, which can be fed back into the R&D process.
Digital patient monitoring <i>(wearables, IoT)</i>	<ul style="list-style-type: none"> • Using wearable and IoT-enabled devices, clinicians continuously monitor patient health indicators that automatically highlight signs of risk. • Through these devices and telemedicine platforms, patients can be engaged for virtual check-ins, coaching sessions, and remote testing.
Digital data flow <i>(AI, IoT, and cloud)</i>	<ul style="list-style-type: none"> • AI-driven digital data flow solutions integrate trial data from numerous structured and unstructured data sources and create standardized data elements that can be leveraged to digitally author study artifacts and auto-populate downstream systems. • Data captured through IoT-enabled devices and instruments is tracked and managed on the cloud, creating a collaborative environment for medical writers, biostatisticians, and clinicians to analyze data and derive insights quickly.
Seamless data sharing and access <i>(cloud)</i>	<ul style="list-style-type: none"> • Real-time, secure, and rolling exchange of data between sponsors and multiple regulators through cloud platforms streamlines the application, submission, and approval process for new drugs. Some large pharma companies have already come together to build such a cloud platform for exchange of data between sponsors and the US FDA.¹⁶

FIGURE 8

Drug development: Current and planned investments in digital technologies

Respondents were asked to rank the most innovative technologies in which their function is **currently investing and plans to invest in the next five years.**

■ Current investment priorities ■ Investment priorities over the next 5 years



Note: Percentages indicate options ranked among the top 3 by survey respondents.

Source: Deloitte’s Biopharma Digital Innovation Survey 2021.

Manufacturing

North star aspiration: Smart factories

Smart factories seamlessly connect disparate manufacturing systems and processes for enhanced visibility into shop floor operations,

as machine intelligence monitors processes and provides actionable insights for floor staff to reduce errors, deviations, and production losses. Such smart factories could streamline processes from raw material procurement to quality control to improve yield and asset uptime,

reduce manual oversight costs, and bring greater efficiency to manufacturing processes. Show-and-tell centers such as [Deloitte’s Smart Factory@Wichita](#), with smart production lines, prototyping simulators, and experiential labs, enable exploring possibilities through smart factory investments.¹⁷

Our research on the [biopharma factory of the future](#) shows building smart factories not only requires enabling digital innovations (see figure 9) but also transforming the infrastructure and culture within the manufacturing organization including:

- **Building connectivity:** Shifting away from siloed manufacturing systems and processes to create a connected manufacturing ecosystem for free flow of information, data, and actionable insights.
- **Changing innovation mindsets:** Adopting a think-digital-to-be-digital mindset to consider how digital technologies augment human capabilities and change execution of processes.
- **Encouraging the art of the possible:** Changing the innovation-averse DNA within the manufacturing organization by encouraging digital innovation pilots to convince executives about the tangible value of plant floor innovations.
- **Productize and scale digital innovation:** Transition from disparate digitalization efforts and viewing digital innovation as an in-house engineering problem to productize or standardize digital innovation across manufacturing sites by accessing external capabilities through ecosystems and alliances.

FIGURE 9

Sample digital Innovations powering smart factories

Digital innovations	Description
Connected manufacturing ecosystems <i>(IoT, data lakes)</i>	<ul style="list-style-type: none"> • Disparate manufacturing execution systems, laboratory information systems, on-floor sensors, and partner/supplier systems are connected through IoT to enable aggregation and contextualization of data for greater visibility across the manufacturing ecosystem.
Predictive yield optimization and proactive quality control <i>(AI)</i>	<ul style="list-style-type: none"> • AI-based solutions model the impact of changing parameters during manufacturing to suggest timely corrective actions to reduce deviations and production losses. • By analyzing data from multiple batches and product lines, ML algorithms identify process deviations to predict quality issues. This can direct staff to investigate only those batches most likely to have quality issues, saving time and resources.
AI-driven asset uptime <i>(AI, cloud)</i>	<ul style="list-style-type: none"> • AI predicts asset maintenance requirements based on operational and maintenance history data stored in the cloud to prevent disruptions and loss of expensive APIs.
Digital batch disposition <i>(AI)</i>	<ul style="list-style-type: none"> • Coupled with RPA, AI can generate a comprehensive and auditable data trail to meet regulatory and compliance requirements.
Site command centers <i>(digital twin, AI)</i>	<ul style="list-style-type: none"> • Using AI or digital twins, companies analyze data from the manufacturing ecosystem to model or simulate the impact of upstream, midstream, and downstream disruptions on manufacturing operations (e.g., simulate the impact of downtime on production schedules or the ability of sites to handle increased demand).
Virtual assistance <i>(AR/VR)</i>	<ul style="list-style-type: none"> • Using AR/VR, on-site staff seek virtual assistance from technicians and experts to troubleshoot issues. Paired with privileged security clearance, off-site staff access equipment and change settings to minimize production disruptions.

Surveyed manufacturing leaders said their organizations are prioritizing investments in IoT (75%) and data lakes (50%) that could lead to greater connectivity across the manufacturing ecosystem. However, less than 45% expect their organization to invest in VR/AR and digital twins

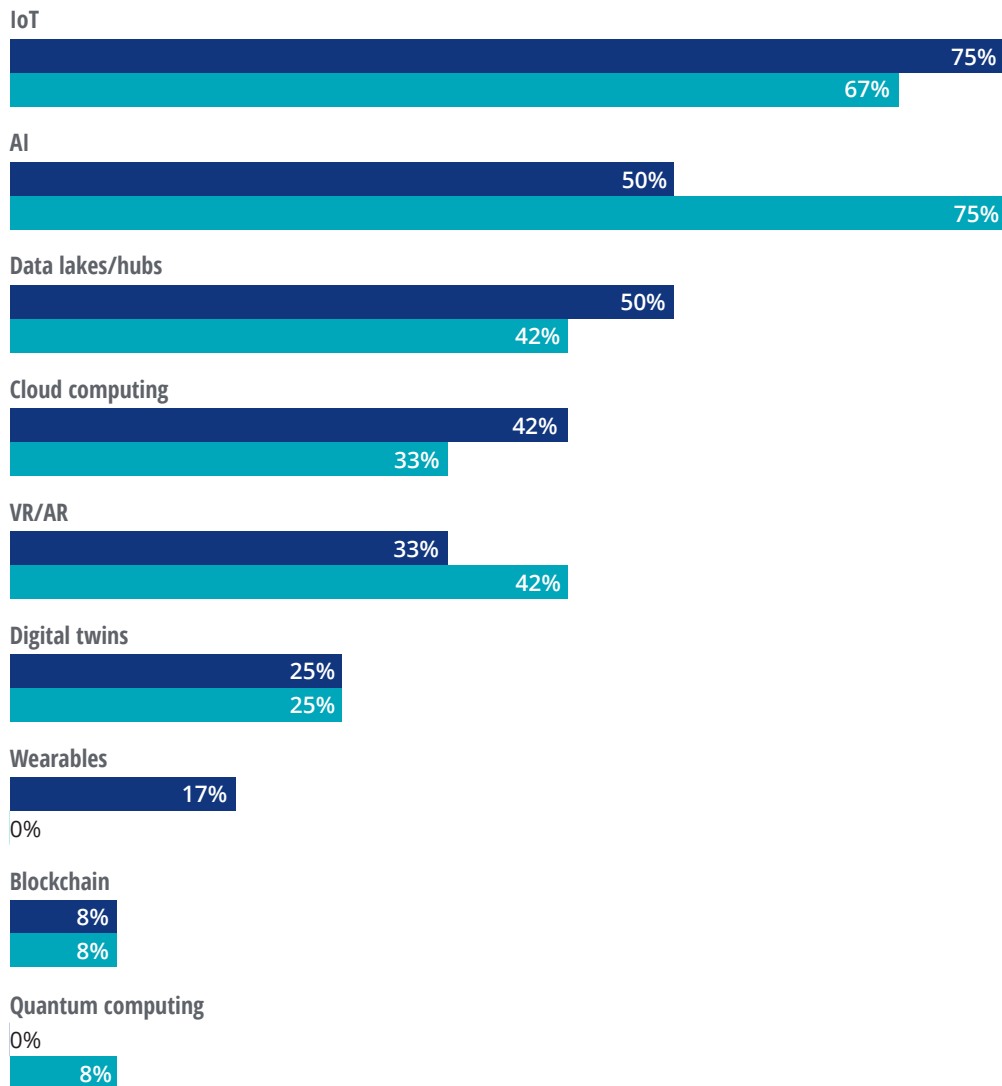
over the next five years. Improving asset efficiency (100%), yield rates (67%), and safety and sustainability (50%) are the top value levers manufacturing leaders say could be realized through digital innovation.

FIGURE 10

Manufacturing: Current and planned investments in digital technologies

Respondents were asked to rank the most innovative technologies in which their function is **currently investing and plans to invest in the next five years.**

■ Current investment priorities ■ Investment priorities over the next 5 years



Note: Percentages indicate options ranked among the top 3 by survey respondents.

Source: Deloitte's Biopharma Digital Innovation Survey 2021.

Supply chain

North star aspiration: Predictive and autonomous supply chain management

Adaptive and flexible biopharma supply chain networks can enable real-time visibility into material and product flow, allowing for the prediction of issues and disruptions and autonomous mitigation of risk. Such predictive and autonomous supply chain management can improve processes across the value stream from forecasting demand to tracking products in transit. This could reduce lead times, process and oversight costs, and optimize supply chain planning.

Enabling such a north star requires targeted investments in digital technologies such as AI, IoT, and others (see figure 11), coupled with a series of transformative shifts including:

- **Championing proactivity:** Enabling free flow of information, data, and insights across

supply chain processes to shift away from linear and reactive supply chain management and create proactive and adaptable supply chain networks.

- **Enhancing data usability:** Moving toward an environment where digital tools and solutions enable data accuracy, latency, and relevancy for cross-correlation, insight generation, and decision-making.
- **Embracing machine intelligence:** Replacing human effort in managing supply chain operations by using machine intelligence to augment human decision-making and autonomously mitigate risks.
- **Building connectivity to other functions:** Moving away from siloed supply chain operations by connecting supply chain data to data from other functions to synchronize business planning and decision-making for greater business resilience.

FIGURE 11

Sample innovations driving predictive and autonomous supply chain management

Digital innovations	Description
Control towers <i>(data lakes)</i>	<ul style="list-style-type: none"> • By building control towers or data hubs, organizations can merge internal data (such as production and inventory data) with data from intermediaries and partners to provide real-time longitudinal visibility into material and product flow.
Machine-assisted business response <i>(AI)</i>	<ul style="list-style-type: none"> • As part of day-to-day operations, self-healing AI solutions analyze supply chain, manufacturing, and market data to highlight potential issues (e.g., stockout of a raw material), analyze their root causes (inability of a vendor to make a delivery due to logistics issues) and suggest next steps to supply chain operators (ordering from an alternative supplier or changing production schedules).
Machine-driven resilience management <i>(AI)</i>	<ul style="list-style-type: none"> • AI predicts or forecasts events (such as logistics challenges, geopolitical issues, and supply disruptions) to execute actions either autonomously or recommend actions to stakeholders to respond to long-term risk/disruptions.
Market and product tracking <i>(AI, IoT, blockchain)</i>	<ul style="list-style-type: none"> • Companies track and analyze nontraditional data such as consumer sentiment, competitor, product user, and experience data along with traditional data (such as order patterns, demand signals) to optimize supply chain planning. • As more next generation therapies enter the market, IoT, and blockchain are increasingly applied to track and trace product movement and temperature and coordinate timely delivery of such therapies to treatment centers.

Most (76%) supply chain leaders we surveyed report that their organizations are already prioritizing investments in AI today and are likely to continue to do so. However, less than 50% see investments in IoT and data lakes—likely essential for enhancing supply chain visibility—as a priority

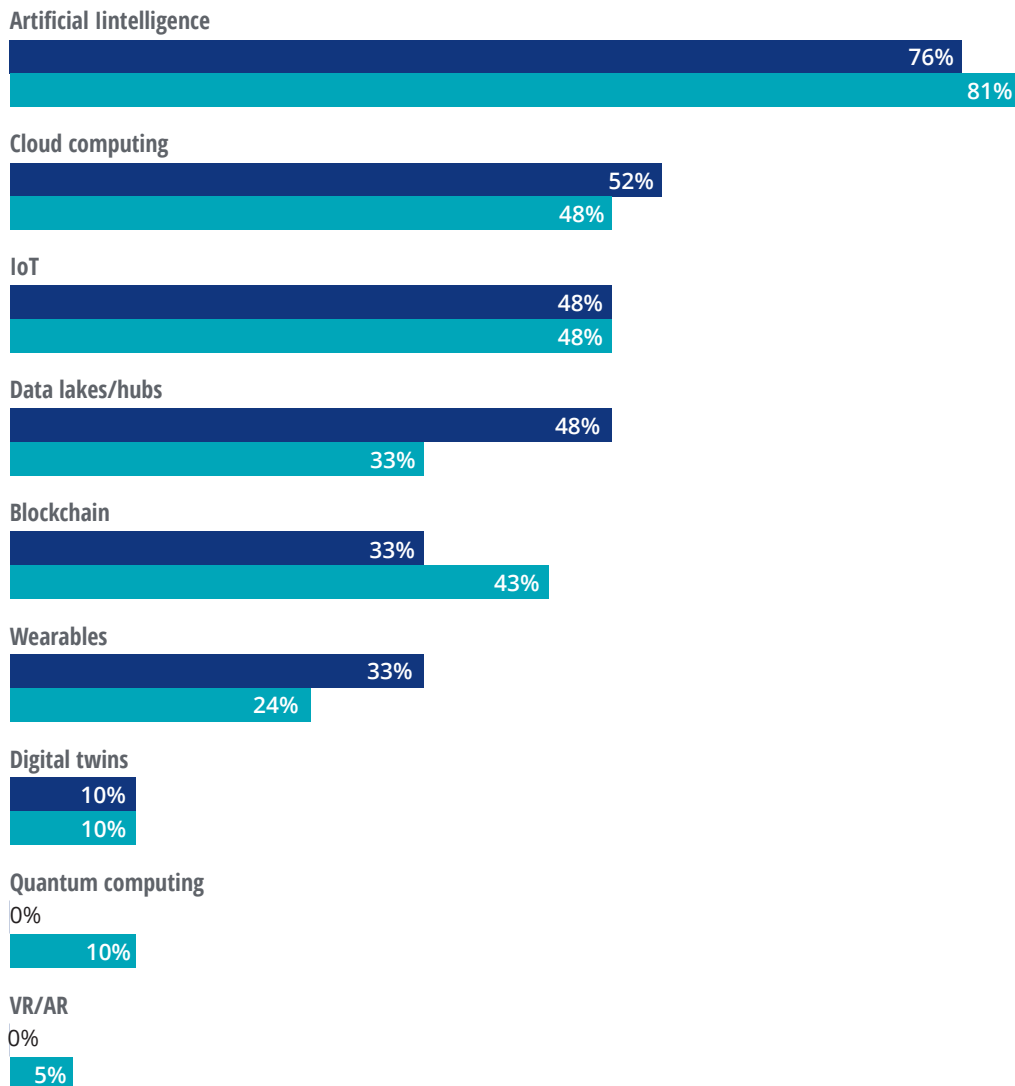
over the next five years. Supply chain leaders also highlighted lowering customer cycle time (67%), reducing lead times (57%), and improving delivery time accuracy (52%) as the top value levers realizable through digital technology investments.

FIGURE 12

Supply chains: Current and planned investments in digital technologies

Respondents were asked to rank the most innovative technologies in which their function is **currently investing and plans to invest in the next five years.**

■ Current investment priorities ■ Investment priorities over the next 5 years



Note: Percentages indicate options ranked among the top 3 by survey respondents.

Source: Deloitte’s Biopharma Digital Innovation Survey 2021.

Commercial

North star aspiration: Precision experiences for patients and partners

AI-driven engagement recommendations, connected patient, and health care provider (HCP) platforms provide patients and partners (e.g., payers, HCPs) timely access to relevant content and treatments. Such a north star could hyperpersonalize value stream processes from drug launch to postmarketing surveillance. This could increase patient conversion and long-term adherence, support virtualized sales forces, and maximize care outcomes.

Bringing to life precision experiences for patients and partners (HCPs and payers) requires biopharma companies to undertake purposeful digital innovation (see figure 13), accompanied by a series of transformative shifts within the commercial function, including:

- **Tailored engagement:** Moving away from high-frequency engagement models that bombard patients/partners with information to providing customized information based on distinct needs and behavioral and health characteristics.
- **Expanding access and affordability:** Pivoting from the current environment, where patients that could benefit the most from a treatment lack timely access to value-added information, to one where information and care can be accessed at the speed of need.
- **Proactively sensing marketplace dynamics:** Shift from a retrospective understanding of market dynamics such as competition, patient sentiment, and marketing impact, to a predictive approach founded on proactive sensing and continuous learning.

FIGURE 13

Sample innovations powering precision experiences

Digital innovations	Description
360-degree view of patients and partners <i>(cloud/data lakes)</i>	<ul style="list-style-type: none"> • By combining behavioral and socioeconomic patient data (e.g., buying propensities, workout tendencies) with marketing data (interactions with online ads, impressions, conversions) in data lakes or the cloud, companies create a 360-degree view of patient behavior across digital and physical footprints. • Similarly, data on how physicians interact with the company and affiliate web ads, email, and social media content is aggregated to provide a view of their engagement across channels and platforms and can be cross-referenced to specific patients.
AI-based engagement recommendations <i>(AI)</i>	<ul style="list-style-type: none"> • AI marketing solutions analyze patient datasets to recommend how, when, and with what customized content to engage patients and partners (such as personalized ads, tailored medication regimens, and adherence programs) across channels and the patient journey.
Next gen HCP portals <i>(chatbots, NLP)</i>	<ul style="list-style-type: none"> • Next generation HCP portals with NLP and AI chatbots enable on demand access to information and seeking peer opinion to improve care delivery, while broadening access opportunities for companies.
Connected patient platforms <i>(cloud/wearables)</i>	<ul style="list-style-type: none"> • Cloud-based connected patient platforms aggregate data from patient wearables and medical devices, track and analyze patient outcomes, and link patients to physicians and support groups to create longitudinal engagement.
Proactive market intelligence <i>(AI/cloud)</i>	<ul style="list-style-type: none"> • AI enables curation and analysis of unique information sources to sense changes in the marketplace (such as likely changes to reimbursement practices, regulations, competitor tactics) that could affect launch strategies and competitive dynamics.

Within the commercial function, survey results suggest that most organizations are already prioritizing investing in AI (82%) and cloud computing (68%), key digital innovations to create a foundation for precision experiences. Surveyed

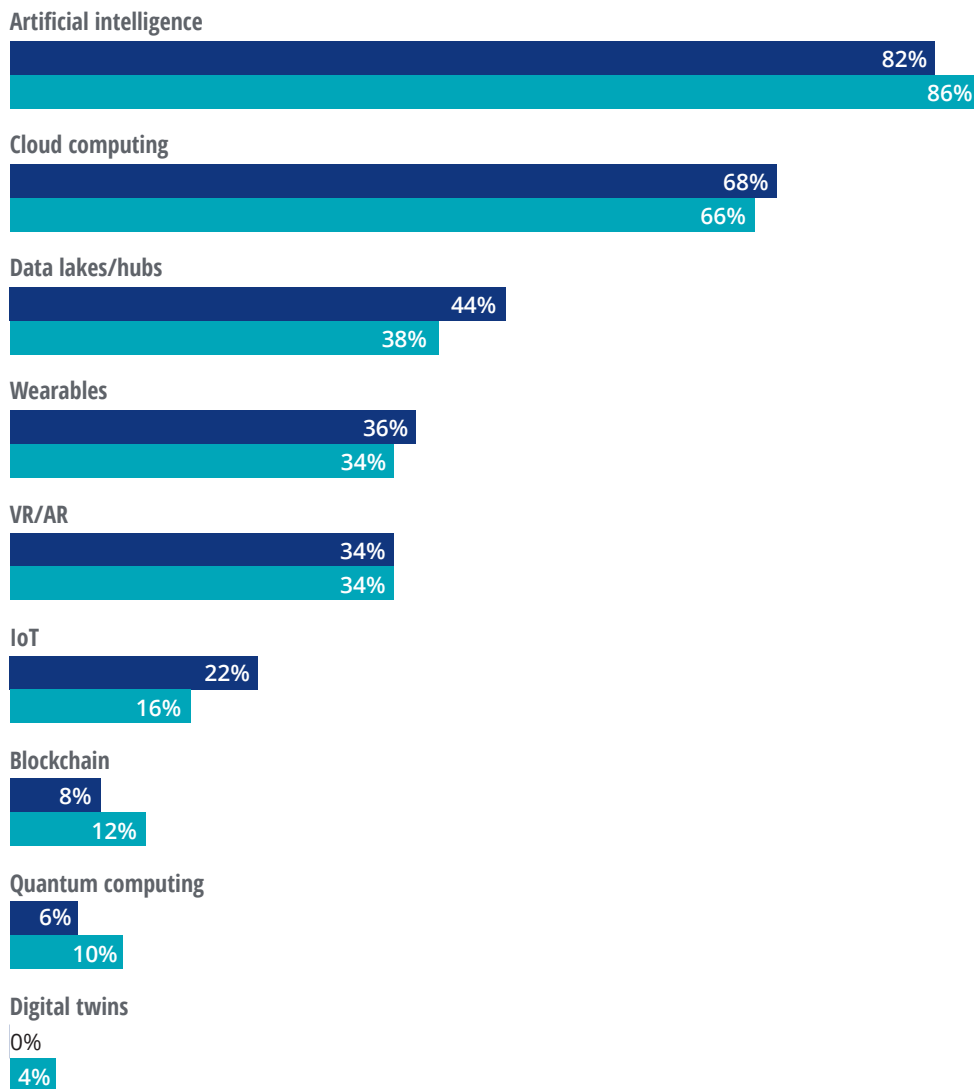
leaders from this function believe digital could positively impact sales team effectiveness (80%), increase customer conversion rates (76%), and broaden access channels (64%).

FIGURE 14

Current and planned investments in digital technologies for commercial

Respondents were asked to rank the most innovative technologies in which their function is **currently investing and plans to invest in the next five years.**

■ Current investment priorities ■ Investment priorities over the next 5 years



Note: Percentages indicate options ranked among the top 3 by survey respondents.

Source: Deloitte's Biopharma Digital Innovation Survey 2021.

Surveyed companies face challenges in executing leapfrog digital innovation

OUR RESEARCH SHOWS that, before attempting leapfrog digital innovation, organizations should solve fundamental issues around funding, strategy, and talent. Today, funding for digital innovations comes from sources such as organizational leadership, functional area budgets, innovation groups, or a mix of those. Close to 60% of survey respondents say dedicated funding is needed to accelerate their organization's digital innovation efforts. Also, most respondents (55%) say their organization lacks a centralized group to remit funds to proliferate digital innovation. Simply investing in individual projects or sustaining existing investments is likely to only power incremental innovation. There is a need to change the old ways of thinking and put in place new budgeting processes to help enable leapfrog digital innovation.

Almost half of our respondents believe their organization needs a better strategy to support digital innovation. Leaders need to shift away from viewing technology investments as part of five-year strategic road maps and think more cohesively about these technologies as they can facilitate enterprisewide digital transformation (for more, see Deloitte's research on [enterprise digital transformation a competitive necessity](#)).

Close to half (47%) believe that their organization needs to acquire the right talent to accelerate digital innovation—especially, data engineers, cloud specialists, data scientists, and other technology experts. Biopharma companies are

competing not only with innovative technology brands but incumbents in other industries—which are also undertaking digitalization—to attract and retain such talent. A few organizations have set up digital innovation hubs in nontraditional locations to access digital innovation capabilities, solutions, and talent. Takeda, for instance, set up an innovation hub in Helsinki to support startups and companies creating AI and digital health solutions.¹⁸

“Well, you’re never going to have as many data scientists as you want. And it’s not just those specializing in data science—it’s data engineering, cloud engineering, and domain expertise.”

— *Jim Swanson, chief information officer, Johnson & Johnson.*¹⁹

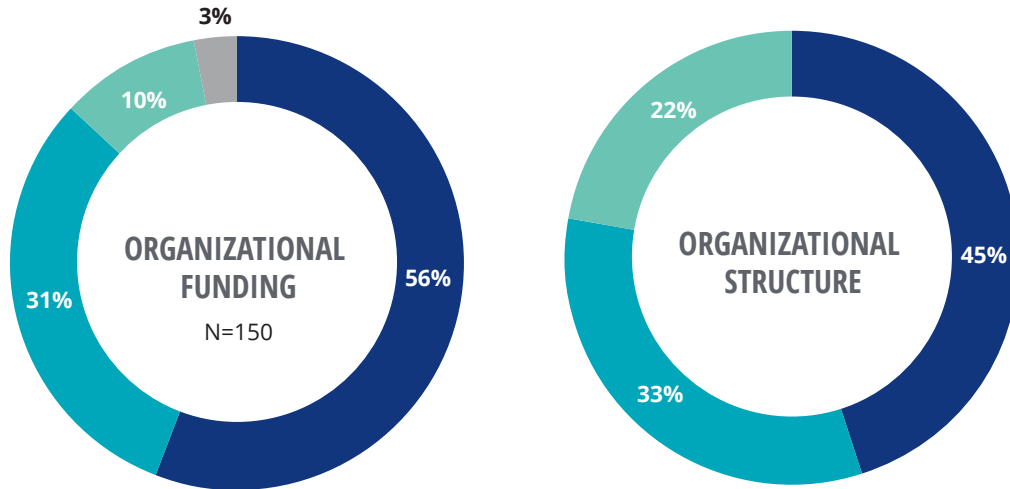
Deloitte's 2020 Global Human Capital Trends cross-industry survey found that while 74% of organizations recognize that reskilling of the workforce is important for their success, only 10% are ready to address it.²⁰ Like organizations across other industries, biopharma companies may also be struggling with the significant effort involved in reskilling the workforce as digital technologies are integrated into business operations.

FIGURE 15

Most organizations lack a dedicated innovation center to fund and proliferate digital innovation

Q: How are your organization's digital innovation initiatives usually funded?

Q: Does your organization operate a digital innovation center of excellence (CoE)? If so, which of the following best describes it?



56%

By my **organization's leadership**

31%

By each **functional area**

10%

By a **dedicated innovation group**

3%

Other

45%

Yes, my organization has an innovation CoE with the remit to fund

33%

Partially, my organization has a digital innovation community, but it does not have dedicated resources and funds.

22%

No, my organization does not have an innovation CoE or community of practice.

Source: Deloitte's Biopharma Digital Innovation Survey 2021.

Call to action: Winning with leapfrog digital innovation

PURSUING LEAPFROG DIGITAL innovation, weaving it into the fabric of business operations, and using it to gain an edge in the market is easier said than done. While there is no one-size-fits-all answer, we have captured some insights from our experience in helping biopharma organizations with digital innovation, which we believe could help organizations win with leapfrog digital innovation.

Establish your leapfrog innovation value streams and north stars

What is your winning aspiration?

To navigate in the changing environment, it is important to identify value streams and functional north star aspirations to serve as building blocks for an enterprisewide digital innovation blueprint.

Key actions

- Assess industry, technology, regulatory, and patient trends affecting your business to identify enterprise value streams that can benefit from leapfrog innovations.
- Create north stars across every function in the value stream that describe aspirational future states and potential impact.
- Break down north stars into a series of transformational operational shifts that business and IT will need to address.

Develop a purposeful digital innovation portfolio

What will it take to achieve your north stars?

Every north star aspiration is different. It is critical to understand the myriad of operational, environmental, and technological factors at play, to develop a successful portfolio of digital innovation investments. Our experience suggests that successful portfolios do not reflect random acts of innovation that result in countless proofs of concept, but a series of purposeful investments that cohesively build on each other to create transformational experiences and value to realize north star aspirations.

Key actions

- Outline how individual capabilities combine to support a transformational operational shift, such as interconnected information flows, processes, or business applications.
- Perform a fit/gap assessment to identify existing capabilities that can fulfil requirements versus gaps that need new investments to fill.
- Develop a unified view of common digital capability needs across value streams, north stars, and enterprise functional areas.
- Build a comprehensive business case highlighting investment needs, enablement of north stars, and traceability to enterprise value opportunities.

Determine your innovation archetype

How will you develop the innovation portfolio?

Most technologies and talent behind the latest digital innovations are nurtured by startups, academic institutions, big technology companies, and consultancies. Biopharma companies should rethink their IT approach to access innovation at its source. They could employ one or more the archetypes to help drive speed and scale of execution.

- 1. *DIY innovator*:** Builds digital innovation capabilities within the organization (either centrally or at a functional level) to take innovative ideas from concept to prototype to full-scale deployment.
- 2. *Crowdsourcer*:** Solicits the best thinking and solutions from an ecosystem of startups, academics, and technology companies through design challenges, hackathons, etc.

- 3. *Venture capitalist*:** Invests in early-stage companies to access or acquire emerging digital technology capabilities and new business solutions.
- 4. *Incubator*:** Provides mentorship and funding and enables sharing of expertise to help entrepreneurs, academics, and others refine and launch their ideas.
- 5. *Accelerator*:** Guides startups to scale up their minimum viable products through proofs of concept, pilots, and other targeted experiments.

Key actions

- Evaluate innovation archetypes, understand their advantages/disadvantages and implications on enterprise strategy.
- Select the combination that best suits your needs.
- Develop an ecosystem engagement plan to build relationships with innovation partners in specific technological, therapeutic, and geographic domains.

Design your operating model

How will you execute and scale?

Weaving digital innovation into the fabric of the business requires lockstep coordination between IT, business, and innovation partners. This necessitates an operating model built on the chosen innovation archetype or archetypes.

Many successful organizations have established operating models where dedicated digital innovation resources are situated in between business and IT, often in a center of excellence. This has helped translate business north stars into technological needs, agilely manage investment portfolios, and rapidly collaborate with external partners. Organizations may also need to make important trade-offs on business priorities to help ensure adequate funding for digital innovation while also reimagining traditional IT budgeting processes.

Key actions

- Design an innovation development life cycle that describes all incubation processes from digital capability sourcing and funding to prototyping and scaling.
- Outline roles and responsibilities within this life cycle across IT, business, and dedicated innovation resources.
- Move away from legacy budgeting models to iterative project-based financing to ensure adequate funding for digital innovation.
- Establish success factors to ensure that portfolio operation is driven toward north star aspirations.
- Focus on enabling areas that will be critical determinants of portfolio success such as stakeholder buy-in, data access, digital talent recruitment, and retention.

Conclusion: Choosing your path at the digital innovation inflection point

THE PANDEMIC FORCED biopharma companies to prioritize digital innovation, instill it into every aspect of work, and use it to transform the experiences of patients and partners. However, the momentum and importance of digital innovation isn't slowing down—it's accelerating to become a new competitive advantage for organizations.

The industry is at an inflection point where enterprises can either choose to meet the moment and double down on digital innovation investments through leapfrog digital innovation or decelerate and accept the risk of digital inferiority.



Endnotes

1. Mike Standing and Greg Reh, *Survey finds biopharma companies lag in digital transformation: It is time for a sea change in strategy*, Deloitte Insights, accessed November 11, 2021.
2. Ibid; Deloitte, *Enterprise digital transformation as a competitive necessity: The leadership imperative for life sciences*, accessed November 11, 2021.
3. Deloitte, *Seeds of change: Measuring the return from pharmaceutical innovation 2020*, May 2021.
4. Amazon, "AWS powers Moderna's digital biotechnology platform to develop new class of vaccines and therapeutics," press release, August 5, 2020.
5. Aditya Kudumala and Wendell Miranda, *Scaling up AI across the life sciences value chain: Enhancing R&D, creating efficiencies, and increasing impact*, Deloitte Insights, November 4, 2020.
6. Deloitte, *Seeds of change*.
7. Ibid.
8. Beth Snyder Bulik, "The top 10 ad spenders in Big Pharma for 2020," *Fierce Pharma*, April 19, 2021.
9. Pari Sanghvi and Jim Lehane, "Four ways life sciences manufacturing must change after COVID-19," *European Pharmaceutical Manufacturer*, June 18, 2020.
10. Pfizer, "Manufacturing and distributing the COVID-19 vaccine," accessed October 22, 2021.
11. Fraiser Kansteiner, "After triumphant pilot, GSK eyes 'digital twins' to fine-tune vaccine production, development," *Fierce Pharma*, June 23, 2021.
12. Phil Taylor, "Despite benefits, blockchain adoption is slow in life sciences, says report," *Pharmaphorum*, January 17, 2020.
13. Francesca Properzi et al., *Intelligent drug discovery: Powered by AI*, Deloitte Insights, accessed November 11, 2021.
14. Boehringer Ingelheim, "Quantum computing: Boehringer Ingelheim and Google partner for pharma R&D," press release, January 11, 2021.
15. Youtube, "The Purpose Blueprint: Q&A with Albert Bourla, video, 7:15–7:50, accessed November 11, 2021.
16. Deloitte, *Seeds of change*.
17. Deloitte, *The Smart Factory @ Wichita: Driving the evolution of smart*, accessed October 22, 2021.
18. Health Capital Helsinki, "Takeda's Nordic innovation hub is seeking health startups with patient-first mindset," August 11, 2020.
19. Wall Street Journal, "J&J CIO: Embed data science across the enterprise," May 5, 2021.
20. Eric Volini and Jeff Schwartz, *The Worker employee relationship disrupted*, Deloitte Insights, November 20, 2020.

Acknowledgments

Project team: **Clifford Zhang** has made invaluable contributions including analyzing survey data, interpreting results and providing his expertise and experience to crafting sections of the whitepaper. **Apoorva Singh** wrote up case studies and created graphs and charts.

The authors would also like to thank **Tom Yang, Neil Lesser, Jonathan Fox, Clifford Zhang, Amy Cheung, Lakshman Pernenkil, Andy Bolt, Lynn Sherry, Richa Malhotra, Laura DeSimio, Zion Bereket**, and the many others who contributed to the success of this project.

This study would not have been possible without our research participants who took part in the 2021 Biopharma Digital Innovation Survey.

About the authors

Aditya Kudumala | akudumala@deloitte.com

Aditya Kudumala is a principal in Deloitte's Life Science and Health care practice with more than 15 years of experience in leading and delivering strategy, cognitive solutions, business analytics, and technology-enabled transformation initiatives within R&D, safety, medical, commercial, and IT domains to improve patient outcomes. He has expertise in leveraging strategy, cognitive/AI, blockchain, and other exponential technologies combined with sciences to deliver strategic results. He holds a master's degree in information management.

Todd Konersmann | tkonersmann@deloitte.com

Todd Konersmann is a principal in Deloitte Consulting LLP's Life Sciences practice and is the national leader for the Life Sciences Information Technology practice. With more than 20 years of experience, he has led large global technology and business transformation programs for some of our largest and most notable clients. Konersmann has a passion for collaborating with clients to understand where and how to start adopting new technologies that help result in real value and improve the lives of patients worldwide.

Adam Israel | adisrael@deloitte.com

Adam Israel is a manager in Deloitte Consulting LLP's Life Sciences practice. He is a digital innovation strategist who advises leaders in the identification and implementation of novel technologies to realize business transformation goals and positively impact patient lives. He studied finance and marketing at the University of Colorado.

Wendell Miranda | wmiranda@deloitte.com

Wendell Miranda is a senior analyst with the Deloitte Center for Health Solutions, Deloitte Services LP. For the past five years he has conducted research and authored multiple thought wares on emerging trends, challenges, and opportunities in the life science industry. Prior to Deloitte, he was worked at consulting firm serving life science clients across multiple geographies. He holds an MBA in finance and pharmaceutical management.

Contact us

Our insights can help you take advantage of change. If you're looking for fresh ideas to address your challenges, we should talk.

Industry leadership

Todd Konersmann

Principal | Deloitte Consulting LLP | Dallas, TX
+1 214 840 1993 | tkonersmann@deloitte.com

Todd Konersmann is a principal in Deloitte Consulting LLP's Life Sciences practice. He has more than 20 years of experience, leading large global technology and business transformation programs for some of our largest and most notable clients.

Center for Health Solutions

Sonal Shah

Senior manager | Deloitte Center for Health Solutions | Deloitte Services LP
+1 212 653 6025 | sonshah@deloitte.com

Sonal Shah is a senior manager with the Deloitte Center for Health Solutions within Deloitte Services LP and leads the center's life sciences research. Through her research, she helps inform Deloitte's health care, life sciences, and government clients about emerging trends, challenges, and opportunities. Her research focuses on R&D and innovation, the impact of the ongoing health care transformation to life sciences companies, and value-based care.

Deloitte.

Insights

Sign up for Deloitte Insights updates at www.deloitte.com/insights.



Follow @DeloitteInsight

Deloitte Insights contributors

Editorial: Ramani Moses, Hannah Bachman, and Arpan Kumar Saha

Creative: Kevin Weier and Yashita Vedi

Audience development: Nikita Garia

Cover artwork: Steffanie Lorig

About Deloitte Insights

Deloitte Insights publishes original articles, reports and periodicals that provide insights for businesses, the public sector and NGOs. Our goal is to draw upon research and experience from throughout our professional services organization, and that of coauthors in academia and business, to advance the conversation on a broad spectrum of topics of interest to executives and government leaders.

Deloitte Insights is an imprint of Deloitte Development LLC.

About this publication

This publication contains general information only, and none of Deloitte Touche Tohmatsu Limited, its member firms, or its and their affiliates are, by means of this publication, rendering accounting, business, financial, investment, legal, tax, or other professional advice or services. This publication is not a substitute for such professional advice or services, nor should it be used as a basis for any decision or action that may affect your finances or your business. Before making any decision or taking any action that may affect your finances or your business, you should consult a qualified professional adviser.

None of Deloitte Touche Tohmatsu Limited, its member firms, or its and their respective affiliates shall be responsible for any loss whatsoever sustained by any person who relies on this publication.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee ("DTTL"), its network of member firms, and their related entities. DTTL and each of its member firms are legally separate and independent entities. DTTL (also referred to as "Deloitte Global") does not provide services to clients. In the United States, Deloitte refers to one or more of the US member firms of DTTL, their related entities that operate using the "Deloitte" name in the United States and their respective affiliates. Certain services may not be available to attest clients under the rules and regulations of public accounting. Please see www.deloitte.com/about to learn more about our global network of member firms.