



# The Road to Industry 4.0

**EXECUTIVE SUMMARY  
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# Contents

Introduction .....	2
Industry 4.0: Fueled by customer needs .....	3
Modernizing manufacturing operations .....	5
Technology drives Industry 4.0 .....	7
Industry comparisons .....	9
Eliminating barriers, finding solutions .....	13
Small companies take on larger competitors .....	14
Conclusion .....	16

# Introduction



The road to Industry 4.0 is full of challenges. Over-stressed supply chains, workers with out-of-date skills, and customers with expectations that have shifted—sometimes drastically—over the past two years have all served as barriers. Manufacturing companies are rapidly transforming to overcome these impediments, with efforts accelerated substantially by pandemic-era disruptions—but those who fall behind may struggle to get back into the race.

To understand how leading manufacturers are progressing in their Industry 4.0 journey,

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NTT DATA and Oxford Economics surveyed 528 business and IT executives in 2021. We found that manufacturing organizations of all kinds are prioritizing revenue growth, cost reduction, and increased resiliency and innovation for the three years ahead. The resources invested and the progress achieved vary by industry and company size, but the emphasis on digital transformation is observable across the sectors.

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**Industry 4.0 initiatives have become increasingly important to the executive agenda. The unique events of the past two years have piled on top of challenges familiar to the manufacturing sector, making the need for digital transformation—and the full embrace of Industry 4.0 initiatives—paramount for companies pursuing their business aspirations.**

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# Industry 4.0: Fueled by customer needs

Digital technologies are opening up new connections between manufacturers, their end users, and all parties in between. As such, a growing number of manufacturers are rethinking how they interact with customers. Three years ago, more than one-third of respondents said that establishing new business models and revenue streams were important to their strategy and performance, and today almost half expect these transformative efforts to factor into performance in the coming years. Nearly all respondents have started transforming some aspects of their business models, although a majority

have yet to finish the journey: only 24% say they have fully completed this transformation.

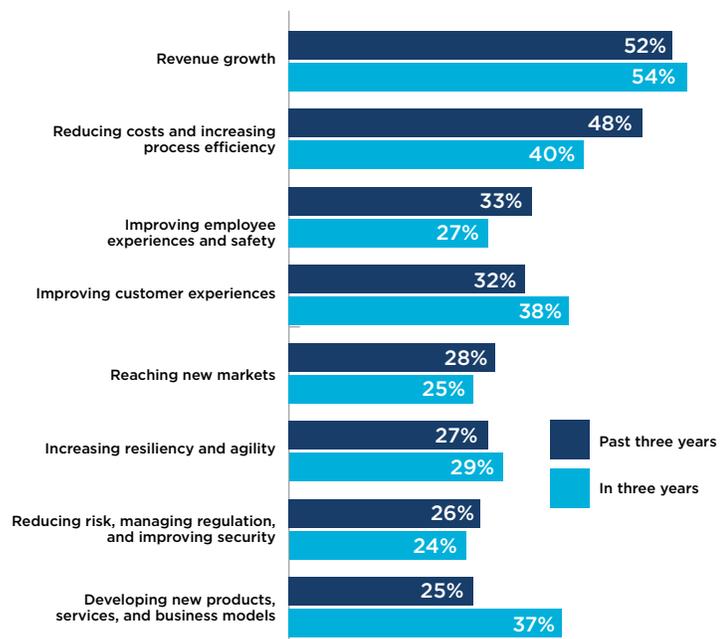
This highlights a strong emerging trend in the manufacturing industry: executives are increasingly focused on their customers. Over the next three years, our survey respondents' strategic goals will shift from the inward-facing initiatives, like reducing costs and improving process efficiency, to market-facing priorities like superior customer experiences and developing new products, services, and business models. Revenue growth will continue to be the highest strategic priority.

**Figure 1. Shifting strategic goals influence decisions**

*Q: Which do you expect to be most important over the next three years?*

*Which of the following strategic goals were most important to your organization over the past three years?*

Source: Oxford Economics





Developing new products and services will become more important over the next three years (25% three years ago, to 37% in three years). But bolstering innovation is not limited to product introductions. While less than half (45%) say improving the quality of existing products and services was a primary desired outcome three years ago, that number climbs to 57% for the three years ahead.

Some respondents are well into their journey to Industry 4.0. Collecting and analyzing customer data will be important to strategy and performance over the next three years—two out of five manufacturers in

our survey say this—and nearly three-quarters of that group have already incorporated this process into at least some operations. Similarly, two-thirds have significantly embedded digital technologies and experiences into products and services; about the same percentage of manufacturers have incorporated better supply chain management and visibility into their transformation efforts as well.

Yet business and IT leaders are finding the road to Industry 4.0 challenging. In a world where business decisions are driven by data, customer resistance to the data-sharing needed to enable new business models

has emerged as a barrier: more than one-fourth of respondents cite this as a challenge. To meet customer needs, manufacturing executives must keep digital and business strategies aligned while managing the many other transformation-related changes. This may appear to be a complicated juggling act, but a look inward may shed light on the way forward.

# Modernizing manufacturing operations

Customer needs are a significant motivation behind digital changes, and transforming internal operations to better meet those needs is critical to Industry 4.0 success. While nearly all respondents—more than 95%—are at least in the early stages of implementation, very few have completed the journey. Only about one-quarter have fully implemented proactive manufacturing equipment maintenance (27%); product maintenance and after-sales

service (26%); flexible production lines (24%); and sensor-based process controls (19%).

Although many organizations need to play catch-up in these areas, they expect Industry 4.0 initiatives to deliver value to strategy and performance in the coming years. The same initiatives many are behind on are among those expected to deliver this value: sensor-based process controls (41%), proactive product maintenance

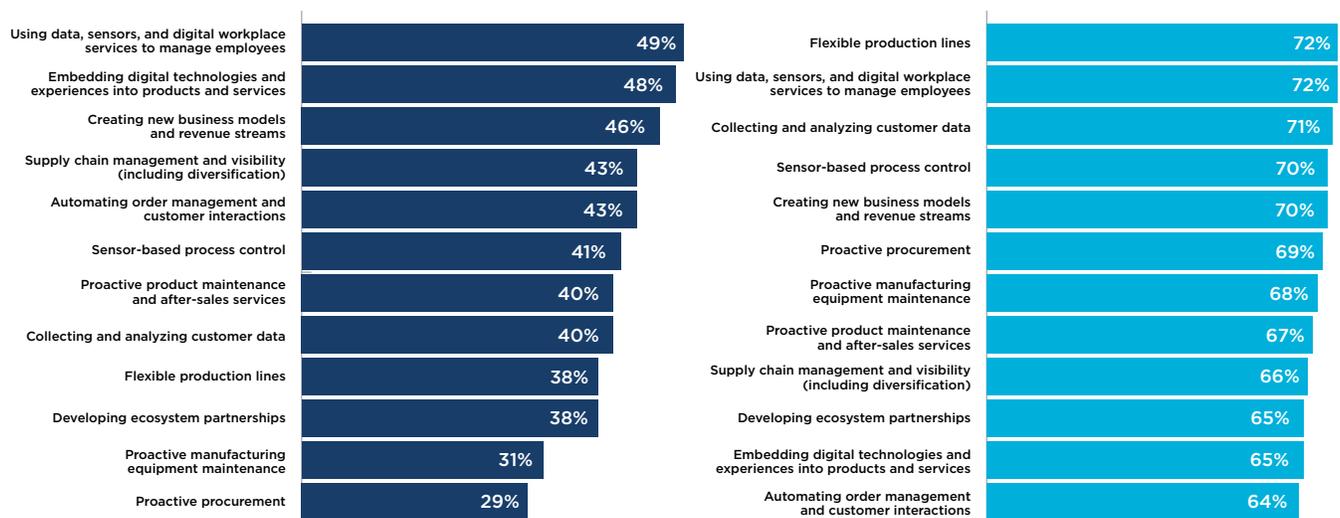
and after-sales services (40%), flexible production lines (38%), and proactive manufacturing equipment maintenance (31%) are viewed as critical to boosting performance. These Industry 4.0 initiatives will help address challenging operational priorities such as reducing costs and increasing efficiency (40%), increasing resiliency and agility (29%), and improving employee experiences and safety (27%).

**Figure 2: Focus is limited, but progress is significant**

Source: Oxford Economics

*Q. Which of the following Industry 4.0 initiatives do you expect to be important to your company's strategy and performance over the next three years? Select up to three. (Left)*

*Q. How far along is your organization in the transformation of these areas? "Implemented in some areas" and "Fully implemented" responses combined. (Right)*





**Talent and business ecosystems play significant roles in Industry 4.0 transformation.**

The success of Industry 4.0 depends on capable workers and a cohesive, enabling business ecosystem. A skilled workforce is a critical part of change that organizations need to manage, and our survey indicates that many are addressing this need. Most manufacturing respondents have reskilled employees for work with digital technologies (70%) and trained their workers around new processes (66%) and technologies (61%). At a time where skilled labor shortages are increasingly prevalent, these efforts indicate manufacturers are doing all they can to avoid a skills crisis.

Many have also planned for inevitable gaps in training efforts by turning to external sources of skills, changing their hiring efforts to acquire these new workers (63%). But fewer manufacturers (two out of five) have changed the way they work with the long line of external partners and providers that make up their ecosystems. Three out of five say they have developed new partnerships with the organizations they work with, but few have taken these efforts further than the first steps: just 18% of manufacturers say they have fully developed these partnerships.

There is currently no industry standard for monitoring the success of reskilling efforts, but correcting that oversight

will be a focus in the future. Over the past three years, only about one-third prioritized using data, sensors, and digital workplace services to manage employees—but almost half will use them going forward. Business leaders must tread cautiously, though, because such monitoring could cause a backlash among employees. Very few manufacturers have insight into the impact of these measures—and the impact of other transformation efforts—on company culture: four out of five manufacturers have yet to take steps to modify culture to improve talent and structure.

# Technology drives Industry 4.0

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## Investments in critical technologies will power the transformation to Industry 4.0.

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Our respondents are almost evenly split, though, on who makes these important decisions, with about half relying on corporate IT to identify and integrate the best mix of technologies and services, while other executives expect business and innovation groups to carry out these responsibilities.

Independent of who leads the charge, manufacturing organizations are investing in cloud, analytics, automated workflows, artificial intelligence/machine learning, and the Internet of Things to achieve specific business outcomes.

**Cloud** is seen as a primary technology lever in Industry 4.0. It is already prevalent across industries, transcending the back office to become a mainstay in daily workforce operations (64%), customer and sales operations (50%), and after-sales services (48%).

**Data and analytics** are also widely used. Nearly two-thirds of manufacturers use data and analytics predominantly in customer-centric areas like

customer and sales operations (48%) and after-sales services (45%). But a smaller group has taken analytics further, into supply chain, sourcing, and order-management responsibilities (40%), as well as production operations and maintenance efforts (35%).

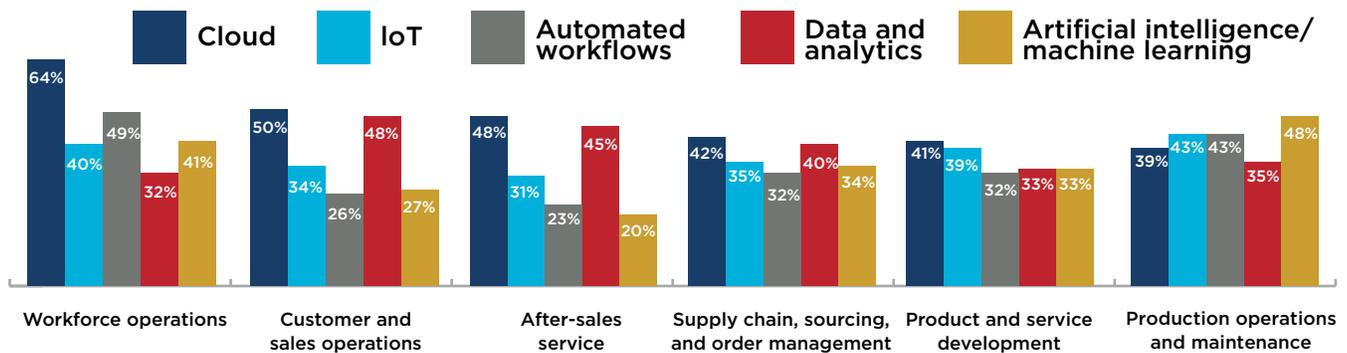
**Automated workflows** are used in day-to-day workforce operations for almost half of manufacturing companies (49%), but fewer are using them in production operations and maintenance duties (43%). Beyond those areas, automated workflow technology lags—fewer than one-third use it for other business purposes, perhaps because anything customer-facing still needs a human touch.

**Artificial intelligence/machine learning** and the **Internet of Things** have gained a strong foothold in production operations and maintenance (48% AI/ML, 43% IoT) and daily workforce operations (41% AI/ML, 40% IoT) but have not found significant purchase in customer-facing business areas.

**Figure 3: Technology in use across manufacturing operations**

Source: Oxford Economics

Q: Which of the following technologies are used within various segments of the value chain? Select all that apply.



While well-established technologies have found wide use across industries, **emerging technologies** have not yet significantly penetrated manufacturing, and investments are minimal. More than one-quarter of respondents use **edge computing** for product and service development (28%), but fewer use it for manufacturing areas such as supply chain, sourcing, and order management (23%), or customer and sales operations (21%).

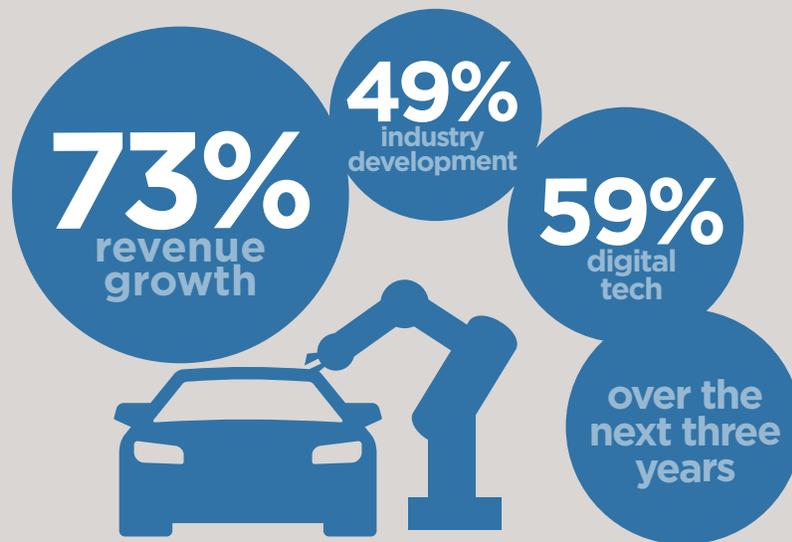
Just over one-fifth are using **augmented reality/virtual reality** and **digital twins** to make the most of their product

and service development (22%), but the simulation and predictive capabilities of these technologies may help manufacturers solve the persistent and thorny challenge of teleproximity when working with partners across the globe.

Elsewhere, **blockchain** adoption is mostly limited to supply chain, sourcing, and order management (17%) or production operations and maintenance (15%). Just 9% of respondents use blockchain for after-sales services.

# Industry comparisons

Not all manufacturers are on equal footing when it comes to digital transformation. Sub-industries within the manufacturing sector vary widely regarding how products are made, where products are shipped, and what services can be provided to which customers. These differences demand unique approaches to Industry 4.0 transformation—and our research shows that specific needs determine the path an organization follows.



**Automotive** executives are prioritizing revenue growth over the next three years (73% next three years, compared with 59% three years ago), but are also more focused than any other industry on developing new products, services, and business models (49% next three years, vs. 23% three years ago). Automating order management and customer interactions was a top priority three years ago (56%), but going forward many expect to prioritize embedding digital technologies and experiences into products and services (59% next three years, vs. 37% three years ago) and using data, sensors, and digital workplace services to manage employees (56% next three years, vs. 28% three years ago).

Industry 4.0 initiatives are aimed at providing customer value. Three-quarters of automotive respondents have mostly or fully embedded digital technologies and experiences into products and services (75%, vs. 65% all respondents); 65% have changed their ways of working with customers, a higher percentage than any other industry (vs. 43%).

Transformation starts with skills, and nearly three-quarters have trained employees around new processes to boost Industry 4.0 initiatives. Auto manufacturers are the most likely of all industries to have invested in automation (57%, vs. 48% all respondents)—and most expect it to improve their responsiveness to changing demands (61%, vs. 51%).

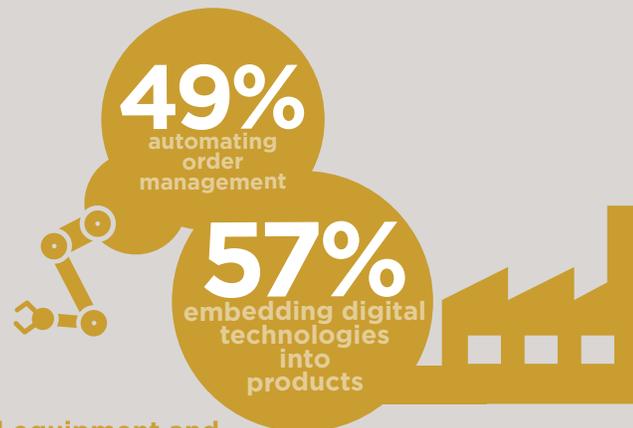


Three years ago, **high-tech** firms were looking to grow revenue (61%), but increasing resiliency and agility (42% next three years vs. 30% three years ago) and improving customer experiences (41%, vs. 29% three years ago) are increasing in importance. Becoming more resilient and agile is critical for the 71% who say the pandemic has permanently changed how they operate.

High-tech firms are slightly less likely than others to say that using data, sensors, and digital workplace services to manage employees will be important in the next three years. But those that see this as important are more committed. A higher percentage of high tech firms have implemented these tools in some or all areas of the business (88%, vs. 69% others).

Just over half (55%) have decentralized processes with common technologies (vs. 40% all respondents) or changed the way they work with vendors and ecosystem partners (51%, vs. 40%).

Efforts to become more efficient in process and automation are paying off for 87%, by far the highest of any sector, well above the overall average (68%). They also outperform the total when it comes to customer experience, loyalty, and share of wallet (72%, vs. 60% all respondents).

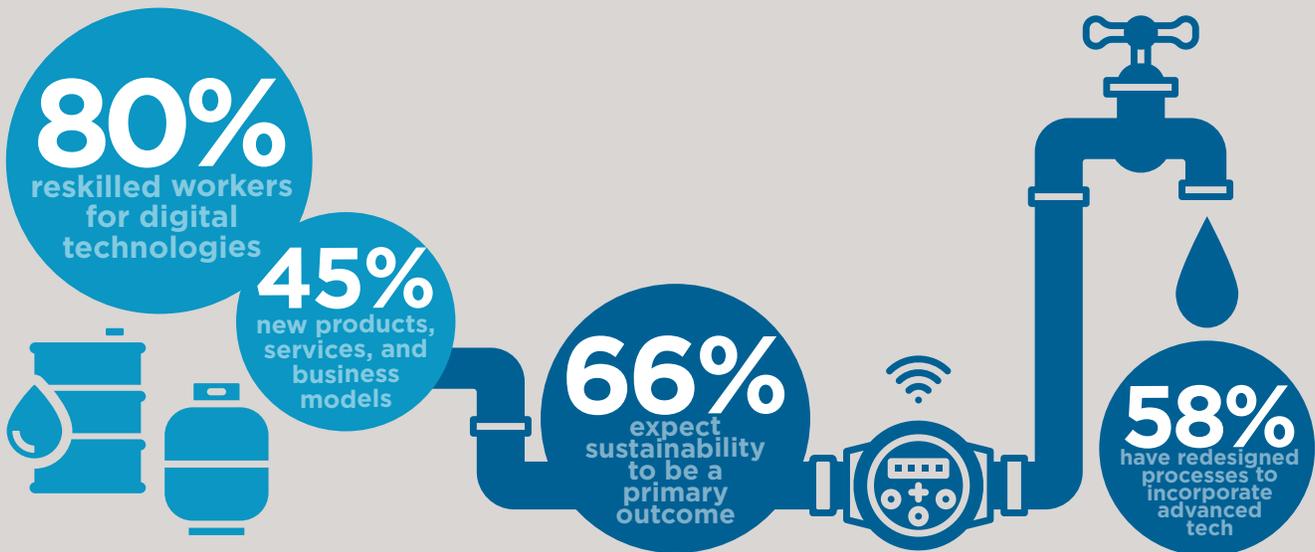


**Industrial equipment and supplies** manufacturers want to grow revenue and reduce costs but are turning their sights to resiliency and agility. Half of industrial equipment executives say automating order management and customer interactions was important three years ago (50%, vs. 39% all respondents). And while this will still be a priority in three years (49%), it will take a back seat to improving products and services (57%). Elsewhere, nearly half expect to focus on creating more flexible production lines (47%) and proactively maintaining manufacturing equipment (47%).

Reskilling workers for digital technologies has been a slower climb (49%, vs. 70% all respondents), although they have been more likely than their counterparts in manufacturing to follow alternative talent tactics, like changing locations to access talent (58%, vs. 33%) and changing leadership structure (42%, vs. 33%). And while they may lag in training employees around new technologies (45%, vs. 61%), they lead in changing up their mix of technology

**Manufacturers have not seen impressive results. Less than half have performed above average when it comes to sustainability, customer experience and loyalty, responsiveness to changing demands, or getting value from captured data. Still, most (72%) say product and service quality are above average.**

vendors (53%, vs. 41%) and improving internal data-sharing (50%, vs. 39%).



**Oil and gas** respondents have their sights set on what is one of their long-standing priorities: developing new products, services, and business models (45%, vs. 38% of all respondents) and creating new business models and revenue streams. They are the most likely of all sectors to focus on strategic, growth-oriented goals (70%, vs. 59%).

They put their efforts toward their priorities: four out of five have reskilled workers for digital technologies (80%, vs. 70% all respondents), and nearly two-thirds have hired employees with new types of skills to support Industry 4.0 transformation.

More than half will focus on using data, sensors, and digital workplace services to manage employees over the next three years (57%).

Sustainability has been a priority for one-third, with 65% rating their sustainability efforts as above average. Still, they perform best when it comes to product and service quality (74%), supply chain reliability and transparency (69%), and production capacity utilization (68%).

Sustainability is top of mind for just over one-third (36%) of **utilities** respondents, and two-thirds expect sustainability to be a primary outcome of Industry 4.0 efforts. Nearly three-quarters are satisfied with the results enabled by Industry 4.0: this sector is the clear leader when it comes to sustainability (vs. 63% all respondents).

They also plan to use data, sensors, and digital workplace services to manage employees (59%), more than any other industry. But that is where the attention to data stops. Just

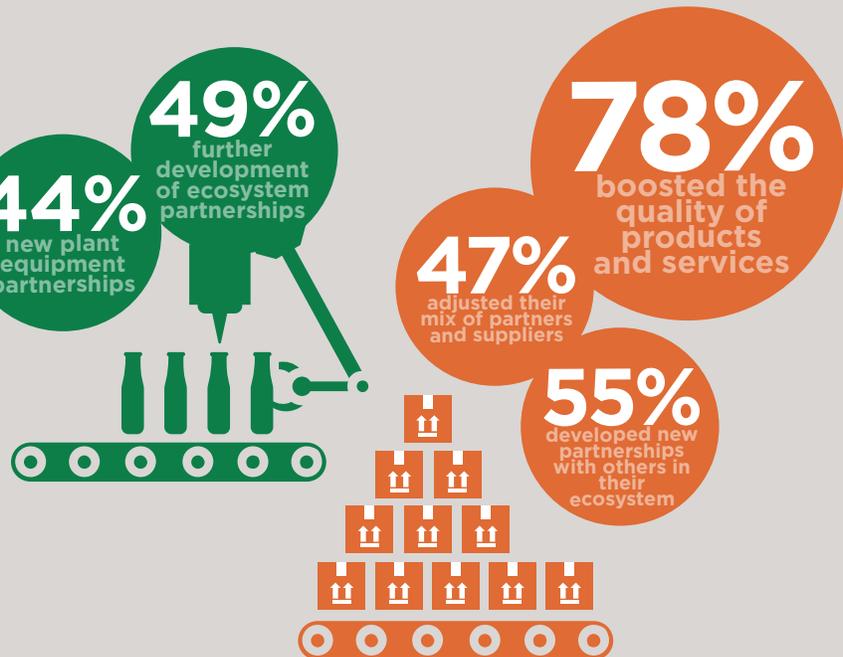
38% of utilities respondents are focused on collecting and analyzing customer data. Perhaps that will change when they address data governance and security barriers that nearly two-thirds say stand in the way of Industry 4.0 transformation.

Well over half (58%) say they have redesigned processes to incorporate advanced technologies, which requires getting workers up to speed. And utilities are taking the right steps to keep employees sharp: three out of four have reskilled workers to use digital technologies, while 60% say they have hired new types of skills to improve Industry 4.0 transformation. Nearly two-thirds have trained employees to work according to new Industry 4.0 processes, on par with the survey average.

COVID-19 added to the woes of **process manufacturing**, which was already under more pressure than other industries to decrease time-to-value from digital investments. They saw the most pandemic changes to the way their companies operate and expect those to be permanent (48%). The pandemic accelerated Industry 4.0 plans for more than half (58%), but few have taken significant steps to mitigate challenges. They are well behind all industries in redesigning processes or training employees around new technologies.

Process manufacturers are turning to partnerships with plant equipment facilities and systems integrators (44%) to identify and integrate the best mix of Industry 4.0 technologies, rather than IT as other industries do. Over the next three years, they will place a premium on further developing ecosystem partnerships.

Many have focused heavily on sustainability (39%, vs. 26% all respondents), and their efforts have paid off, with two-thirds performing above average in this area. But over the next three years, they want to improve revenue growth (51%), reduce costs (40%), and develop new products, services, and business models (35%).



**Packaging and paper goods** organizations have focused on reaching new markets (42%, vs. 28% all respondents), but plan to build resiliency and agility going forward (34%), although the road will not be an easy one. The sector is among the most likely to have experienced permanent changes to the way companies operate (69%), and feel pressure to decrease time-to-value from digital investments (62%).

Not surprisingly, management and visibility of supply chain processes and partners are top of mind: more than three-quarters have somewhat or fully implemented supply chain management and visibility, including diversification. Those objectives will be important to strategy and performance going forward for more than half of respondents.

They are more likely than any other industry to have adjusted their mix of partners and suppliers (47%, vs. 36% all respondents), with more than half (55%) having developed new partnerships with others in their ecosystem. These partners will play an important role in their Industry 4.0 planning—organizations in this sector are most likely to turn to plant equipment and facilities companies to recommend and implement solutions supporting Industry 4.0 platforms (60%, vs. 45%).

Their efforts to date have yielded results—boosting the quality of products and services (78%) and improving responsiveness to changing demand (64%).

# Eliminating barriers, finding solutions

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**Despite the promise of Industry 4.0 and the considerable resources put toward it, manufacturing organizations still struggle to overcome pain points. Chief among them are challenges in implementing technology, mitigating disruptions caused by the pandemic, and addressing workforce needs.**

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Failing to follow through in these areas brings negative consequences: Roughly half of respondents say their performance fell below or well below average when it comes to reducing inventory levels and costs (53%), reducing the cost of after-sales service (47%), and reducing production costs (46%).

## **Oversight and entrenched legacy technology hobble data's power**

Organizations have praised the transformative power of data on their businesses and operations but continue to struggle with managing and securing it. More than half of manufacturers say data governance and security stand in the way of Industry 4.0 transformation, and nearly two out of five grapple with updating their legacy IT infrastructure. And while manufacturers claim that customer needs drive Industry 4.0 transformation, just 40% expect collecting and analyzing customer data to be a priority over the next three years.

## **Pandemic disruption takes a toll**

COVID-19 continues to significantly disrupt Industry 4.0 initiatives. Pandemic-driven urgency has not been fully addressed. Well over half of

executives surveyed prioritize growth, but nearly two-thirds say that the significant reduction in transformative investments stands in the way of those goals. And because of the pandemic, more than half are feeling the pressure to increase time-to-value from digital investments.

## **Industry 4.0 transformation fails to support talent efforts**

Building a digital workforce is critical to Industry 4.0 transformation. While the decisions made around skills are promising, many organizations have not yet made supporting decisions to get the most out of their workforce efforts. Only one-third of manufacturers have changed leadership to match new strategic goals, and just 36% have adjusted their mix of partners and suppliers. All parts of the business ecosystem impact success—and failing to reassess these partnerships is a misstep manufacturers cannot afford to make.

# Small companies take on larger competitors

For the purposes of our research, smaller companies are defined as having less than \$2 billion in annual revenue.

Companies of all sizes in our survey share similar visions of how to achieve Industry 4.0 success, but size matters when it comes to their end goals.

Progress is relatively even for large and small manufacturers, and their plans and use of technology and plans are remarkably in sync.



## Agility vs. adaptation.

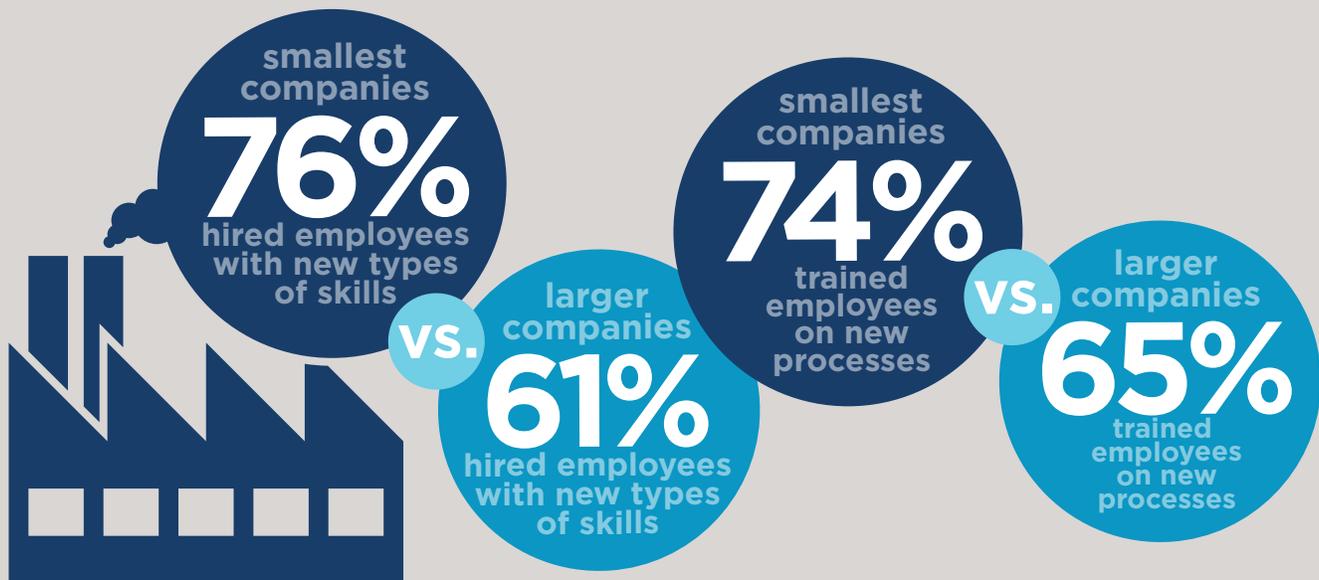
Coming into the pandemic, smaller organizations were focused on agility, while larger ones prioritized innovation. The smallest companies in our study were significantly more likely to have flexible production lines (50%, vs. 36%) while larger companies created new business models and revenue streams (58%, vs. 38% total, and just 29% of the smallest companies).

## Smaller organizations have a longer list of goals.

Going forward, smaller organizations are putting a priority on sustainability (66%, vs. 55%), product and service quality (65%, vs. 56%), and process efficiency as targets (60%, vs. 51%) while large companies are focused on being more responsive to changing demands (56%, vs. 48%).

## COVID-19 did not disproportionately affect different revenue bands.

Smaller companies are just as likely as larger ones to say COVID-19 affected their Industry 4.0 transformation plans; 37% of smaller companies say the pandemic caused them to reduce investments in Industry 4.0, while 28% of the largest organizations (more than \$10 bn) experienced a similar reduction, as did 38% of organizations with \$2 bn to \$5 bn in revenue.



**Organizations of all sizes are transforming operations.** Smaller and larger manufacturers have undertaken Industry 4.0 transformations at similar rates, with some exceptions. Smaller companies are significantly more likely than larger organizations to have hired new types of skills (76%, vs. 61% of larger companies), trained employees on new processes (74%, vs. 65%), automated production processes (56%, vs. 47%), and increased investment in cloud (63%, vs. 54%).

**Smaller organizations face challenges updating technology.** While manufacturers of all sizes share the same list of top challenges, smaller organizations are far more likely than larger ones to say they face difficulties with data governance and security (58%, vs. 50%) and updating legacy IT infrastructure (50%, vs. 36%).

**Partnerships are an important aspect of Industry 4.0 transformation at smaller organizations.** Three years ago, organizations of all sizes put a premium on developing ecosystem partnerships. Going forward, nearly half of smaller organizations say developing ecosystem partnerships is important, compared with 37% of larger organizations. Smaller manufacturers are slightly more likely than their larger counterparts to say they rely on business and innovation groups to identify the best mix of technologies and services and integrate them to implement Industry 4.0 platforms (53%, vs. 45% of organizations with revenues between \$2 bn and \$5 bn, and 44% of organizations with more than \$10 bn in revenue).

# Conclusion

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**Piloting the route forward after emerging from a world on lockdown may seem a daunting task, but manufacturers have strong momentum on their side. Years of preparation for Industry 4.0 have inadvertently prepared the sector for today's challenges, and most should be confident they can handle them. But those who lag behind can follow the lead of their successful peers:**

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**Let customers drive Industry 4.0 strategy.** Crafting a game plan around the end users of products and services is an industry trend, and those who follow suit could benefit greatly. Using data to determine which new products and services best serve consumers is a good first step—and one many have already taken on the path to Industry 4.0.

**Keep workforce development in focus.** The global health crisis shook established work processes and created new ways to get work done. To avoid losing workers to other industries, manufacturers must continue to invest in skills. Building a culture of innovation that gives workers purpose is another critical step to avoiding a skills gap.

**Think beyond the enterprise and integrate business partners.** Manufacturers work with a wide array of providers, from those that produce raw materials to trusted resellers. The way business partners operate in a digital world is changing; tightening business and operational relationships will lead to product and service innovation and ensure customers get the very best.

**Leverage technology investments to maximize the benefits of Industry 4.0 decisions.** Industry 4.0 capabilities promote success, but an advanced infrastructure of technologies is required to make them work. Organizations must assess their strategic goals, review the capabilities of existing partners in the business ecosystem, and determine the tools and resources that push innovation forward—then invest accordingly.



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