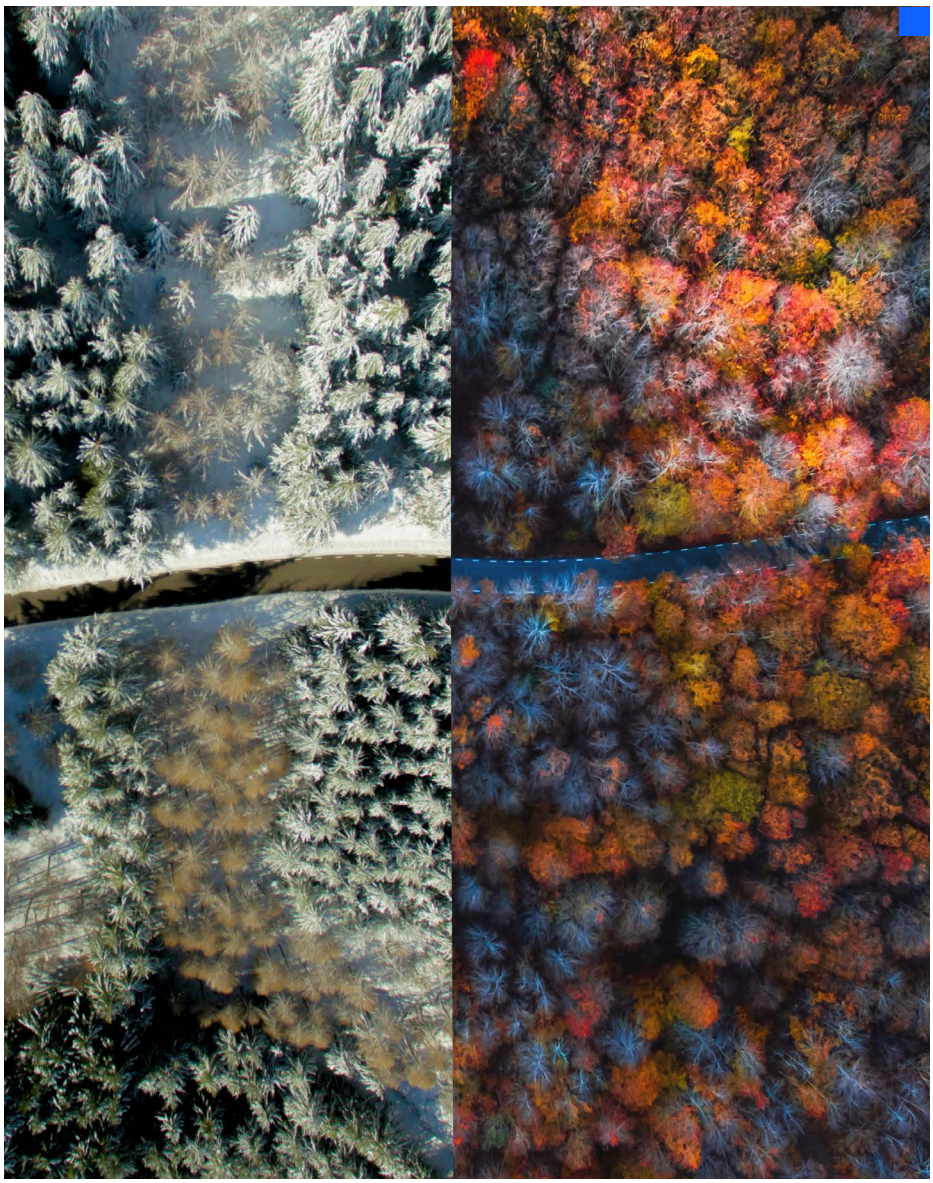


Manufacturing 4.0

From data to decisions

IBM

How IBM can help

Cost-effective digital manufacturing solutions are needed to keep factories and supply chains running smoothly while producing high-quality products–whether delivered by OEM, parts or assembly supplier, contract manufacturer, or manufacturing services supplier.

IBM can help you cocreate a roadmap to a custom solution with a focus on leveraging existing OT investments, improving key metrics, exploiting digital tools, and using the right talent. We help you set your direction based on a proven Industry 4.0 reference architecture and industry standards, achieve scale by consistently deploying advanced shop floor technologies on an open platform, and unleash optimum value by selecting manufacturing process use cases to address immediate needs. For more information, visit ibm.com/industries/manufacturing.

Key takeaways

Digitally mature manufacturers are leveraging Industry 4.0 technologies to achieve new insights—and improve business outcomes.

Untapped manufacturing data

Industry 4.0 is about exploiting the power of data and digital technologies to revolutionize the way products are manufactured and distributed. Yet only 28% of manufacturing organizations are using data from equipment, processes, and systems in any meaningful ways to draw insights for continuous process improvement.

Data-driven culture is linked to operational outperformance

Our recent research identified a group of manufacturing organizations—the "Data Transformers"—that have achieved greater data maturity than their peers—and are reaping benefits as a result. 69% of these Data Transformers are successfully configuring their production lines for switchouts and/or new products or variants in real time.

Data maturity supports Industry 4.0 technologies—and competitive advantage

84% of Data Transformers have significantly integrated artificial intelligence (AI)/machine learning in their data platforms. By leveraging technologies to align business objectives with improved outcomes, these data mature organizations are distinguishing themselves through their insights, cyber resilience, enterprise architecture, manufacturing excellence, workforce capabilities, and digital integration.

Driving business value through Industry 4.0

Manufacturing 4.0 is about unlocking the value of Industry 4.0 or "smart manufacturing," which can help an organization thrive—even amid disruption. It offers benefits that align on two different fronts: On one hand, manufacturers can drive ongoing operational improvements, including increasing production throughput, improving asset utilization, and enhancing product quality. On the other hand, they also have an opportunity to create greater customer value by revolutionizing manufacturing capabilities, delivering design improvements, and optimizing service.

The journey from Industry 1.0 to Industry 4.0 began well over 200 years ago. Around 1780, the First Industrial Revolution enabled the production of finished goods by mechanical equipment powered with water and steam. The Second Industrial Revolution, about 1870, was characterized by the use of oil, gas, and electricity and a division of labor concept, resulting in moving assembly lines and mass production.[1] Beginning in the middle of the 20th century, the Third Industrial Revolution was made possible by the advent of the computer, advanced telecommunications, and data analysis to further automate production.[2] And now we are in the Fourth Industrial Revolution, also known as Industry 4.0. Cyber-physical models and digital integration across the value chain help create high efficiency and provide mass customization capability. The convergence of information technology (IT) and operational technology (OT) systems creates interconnectivity between autonomous manufacturing equipment and broader computer systems. OT data from sensors, programmable logic controllers (PLCs), and supervisory control and data acquisition (SCADA) systems is being further integrated with IT data from manufacturing execution systems (MES) and enterprise resource planning (ERP) systems.[3]

With the infusion of digital technologies in production facilities and operations, manufacturers are redefining possibilities for resource/process efficiency, asset utilization, labor productivity, quality enhancement, time to market reduction, and service value-add.

According to a recent study by The MPI Group, Industry 4.0 is delivering dramatic benefits for manufacturers in terms of productivity and profitability improvements:

– 66% of manufacturers report productivity increases of more than 5% over the past year, and 78% expect increases of more than 5% over the next 5 years.

– 63% of manufacturers report increased profitability of more than 5% over the past year, and 74% expect increased profitability of more than 5% over the next 5 years.[4]

Analysis of data generated by advanced sensors, software, and robotics can lead to improved decision making. Heightened visibility and insights are generated from the combination of production data and operational data within an organization and across ecosystem partners. In addition, the potential value of data sharing in manufacturing process optimization has been estimated at over $100 billion.[5]

To understand where manufacturing companies are with their Industry 4.0 strategies and execution, the IBM Institute for Business Value (IBV) and Oxford Economics surveyed 2,360 respondents in 32 countries. This included 1,630 executives who have overall responsibility for defining or executing their organization's manufacturing strategy and initiatives and 730 benchmarking respondents with a significant understanding of their organization's manufacturing metrics, policies, practices, and operations (see "Study approach and methodology").

Current state: Data rich, information poor

Not surprisingly, manufacturing respondents say their top objectives are increasing production yield, improving product quality, addressing sustainability, and reducing machine downtime. Such focus helps these companies improve efficiency and meet customer price and quality requirements. Yet, there is a gap between ambition and performance: Despite these objectives, only 36% of respondents are maintaining desired throughput and yield to a significant or very great extent. Why?

Organizations are challenged by 3 primary inhibitors:

— Untapped manufacturing data
— Challenged decision-making capabilities
— Unsophisticated technology environments.

Untapped manufacturing data

Manufacturers are not making the most of their data. 2,200 terabytes of data can be generated each month for a single production line at a modern manufacturing plant with 2,000 different pieces of equipment, each with 100 to 200 sensors that collect data every second.[6] As one example, plants typically use alarm mechanisms that collect data to detect production abnormalities for quality control. However, approximately 90% of manufacturing data remains unused. In addition, there is typically an emphasis on capturing data for historical reporting as opposed to using data to help predict future events or improve decision making.[7]

Our research confirms that only about a quarter of organizations are capturing sensor data and using it for decision making in any meaningful way. For example, predictive maintenance involves the continuous collection and analysis of sensor data to identify faults prior to failures and prompt interventions only when needed. Only a quarter of organizations are optimizing asset/equipment maintenance schedules based on analysis of failure modes and balancing reliability and cost.

Challenged decision-making capabilities

In many instances, decision making is inhibited in manufacturing processes and sustainable operations. Production data can be mined, analyzed, and used to help operators determine anomalous events and detect root causes. However, our research reveals that less than 3 in 10 organizations consistently use data from equipment, processes, and systems to draw insights for continuous process improvement. And only 35% routinely review manufacturing processes.

Fewer than 1 in 5 have real-time access to important manufacturing data across the enterprise, which could include useful unstructured data from spreadsheets, industrial social media, email, text files, video, or CAD. For example, manufacturers could analyze warranty claims to determine breakdowns in the manufacturing process. However, data science expertise and specialized tools are required to prepare, manipulate, and analyze this unstructured data.

While sustainability is a top manufacturing objective, organizations struggle to report on and make decisions about sustainability without proper data and metrics. Less than a third of respondents track and regularly review quantitative environmental sustainability metrics related to their manufacturing/production to a great extent. Similarly, only 32% have enterprise-wide environmental sustainability standards.

Unsophisticated technology environments

The existing technology environment of many manufacturing organizations adds to their woes. Technological barriers and inflexible legacy systems are identified as two of the most significant manufacturing barriers, along with siloed operations, lack of initiative prioritization, and ecosystem complexity. While the majority of respondents have implemented activity automation and automated materials handling, opportunities to add technology like digital twins remain. By using digital twins as virtual replicas of production lines, manufacturers can simulate a production process and find ways to reduce downtime or improve capacity.

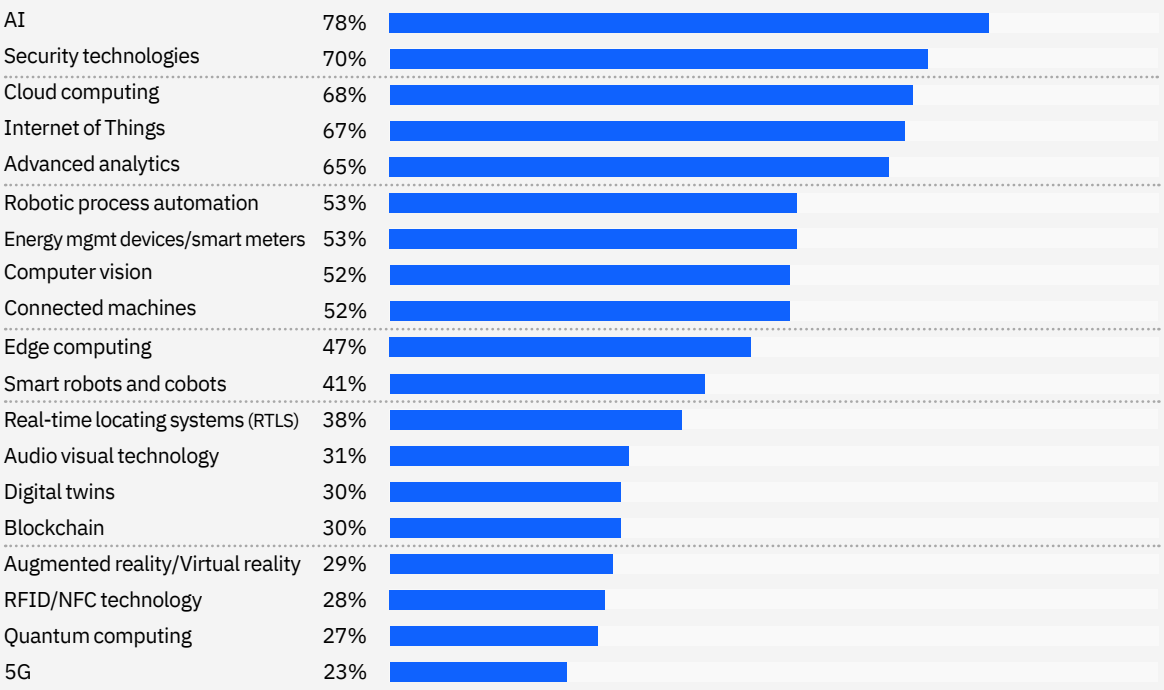
Only 42% of executives surveyed have modernized their MES applications to a large extent, and even fewer, 38%, have modernized their SCADA applications. Real-time production monitoring can improve MES oversight, while additional functionality integrated into SCADA can enhance intelligence and provide some track-and-trace capabilities.

Executives identify a combination of technologies that are important to advancing their manufacturing objectives (see Figure 1). More than three quarters cite AI, which is not surprising given AI-generated insights help improve visibility and predictability of manufacturing operations. Security technologies, cited by 70%, are necessities with the continued risk of cybersecurity attacks in IT and OT environments. According to the IBM Security X-Force Threat Intelligence Index 2022, manufacturing overtook finance and insurance as the top attacked industry in 2021, representing 23% of the attacks X-Force remediated. With manufacturers having a low tolerance for downtime, ransomware actors are taking advantage of manufacturing operations that have been stressed by the pandemic.[8]

Cited by 68%, cloud computing provides connectivity and can run applications and store data. And the Internet of Things (IoT), cited by 67%, connects sensors and devices to networks to take advantage of large amounts of data. The combination of edge- and cloud-computing infrastructure provides localized optimization and connected assets for smart manufacturing. However, only 84% of respondents are in the earlier stages of edge computing maturity, with nearly half at the pilot stage and the rest having advanced to implementation in some production lines.

FIGURE 1

Most important technologies for manufacturing



Percentages show responses of 4 and 5 on a 5-point scale, where 1=not at all important and 5=critical.

With AI as the most critical technology, access to quality data is required –and that is a challenge in manufacturing. Manufacturing data often is biased, outdated, and full of errors due to data collection in extreme conditions, incompatible proprietary systems, and siloed operational data spread across multiple databases in multiple formats.[9] In addition, most manufacturers have not implemented AI at scale. While over three quarters say they have implemented AI in production management, less than 1 in 10 have implemented AI at scale in areas such as production quality management and production planning and scheduling. As a result, these organizations cannot use data from other parts of the enterprise to create deeper insights, such as leveraging sales margins and personnel data to help make production decisions.[10]

Data Transformers: Building a data-driven culture

Given data's importance and potential value in manufacturing, we segmented respondents based on their data maturity, yielding three archetypes (see Figure 2).

Data Transformers, representing 20% percent of our survey sample, are the most mature, having implemented a data-driven culture. These organizations also stand out due to superior business and operational performance. The next group is the Data Optimizers, which represents 42% of respondents. The least mature, 38% of our sample, are the Data Explorers.

Data Transformers self-report better financial performance than their peers: 71% say they outperformed their competitors in revenue growth over the last 3 years versus 60% of Data Optimizers and 54% of Data Explorers. For profitability, 62% of Data Transformers tell us they outperformed the competition compared to 48% and 44% of Data Optimizers and Data Explorers, respectively. Data Transformers' success is also reflected in their outperformance in agility, with 79% saying they surpassed competitors compared to just 58% of Data Optimizers and 50% of Data Explorers.

FIGURE 2

Manufacturing 4.0 archetypes

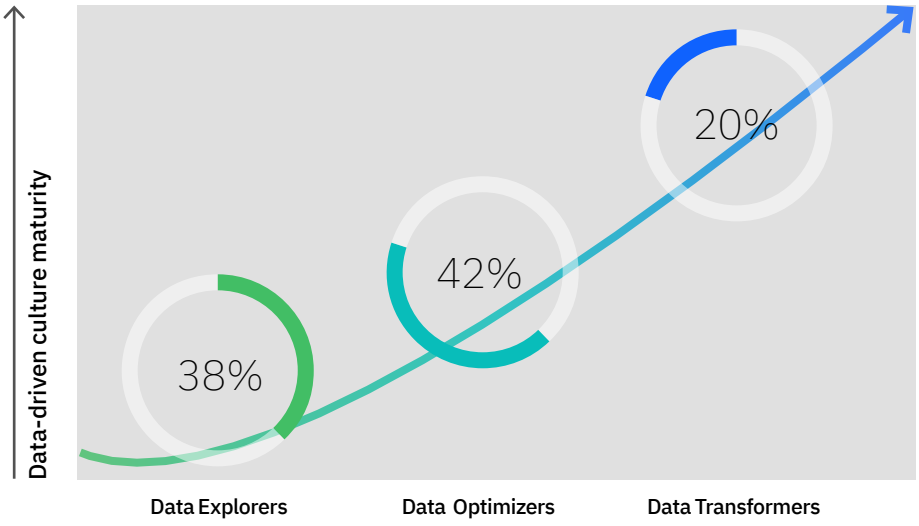
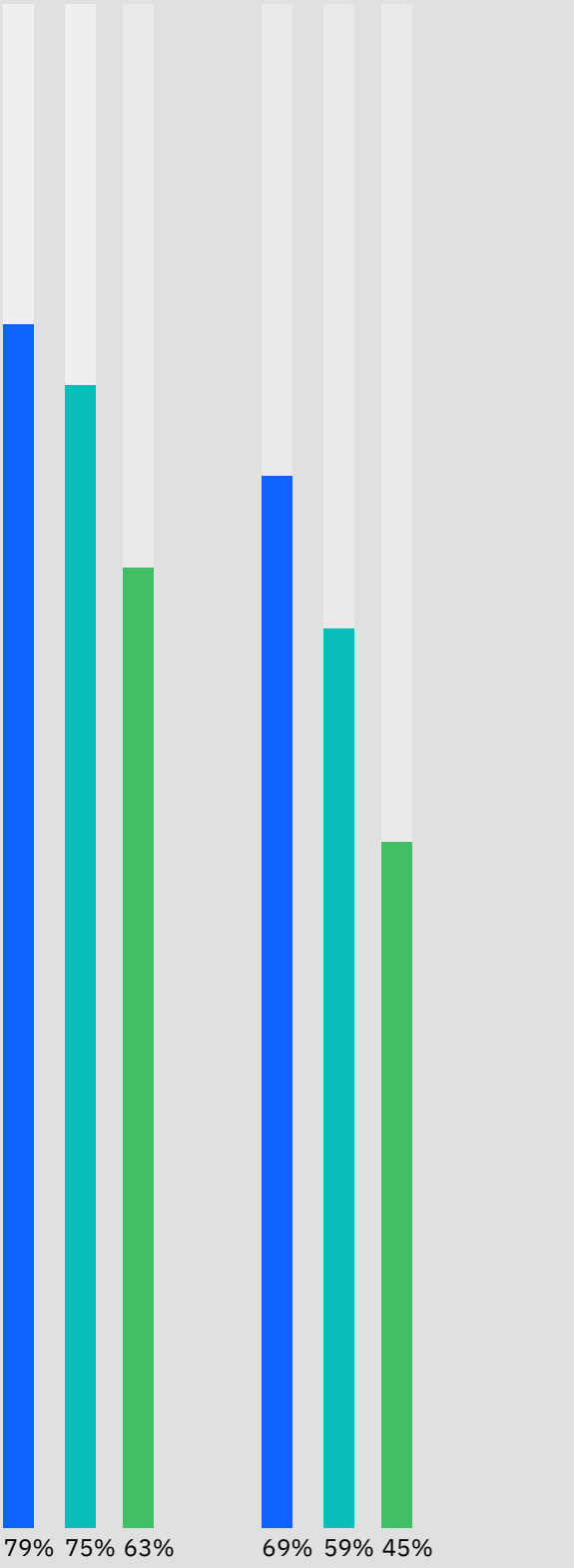


FIGURE 3

Driving plant operations success



Percentages show responses of 4 and 5 on a 5-point scale, where 1=highly unsuccessful and 5=highly successful.

In terms of manufacturing performance, distinctions are visible across the three archetypes. With their data-driven decision making, both Data Transformers and Data Optimizers do a better job than Data Explorers at maintaining desired throughput and yield to a significant or very great extent. Data Transformers exhibit both decision making and mass customization success (see Figure 3).

Crucially, organizations that create a data-driven culture in manufacturing generate win-win situations that align business objectives with improved operational outcomes. This culture is difficult to create, but Data Transformers stand out in six primary areas (see Figure 4):

— Tap the potential of data.
— Achieve cyber resilience.
— Create an enterprise architecture connecting the plant floor to business systems.
— Increase manufacturing excellence with technology.
— Embrace the manufacturing worker of the future.
— Integrate digital with manufacturing operations and management.

FIGURE 4

Blueprint to instill a data-driven culture in manufacturing

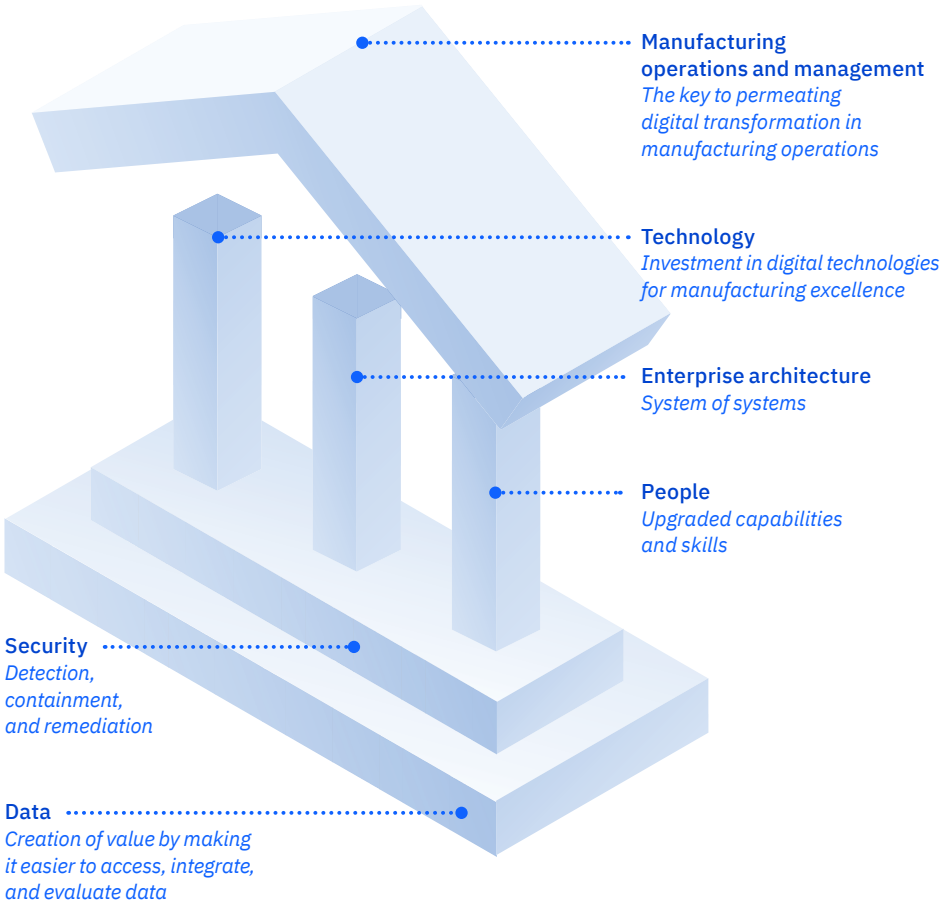
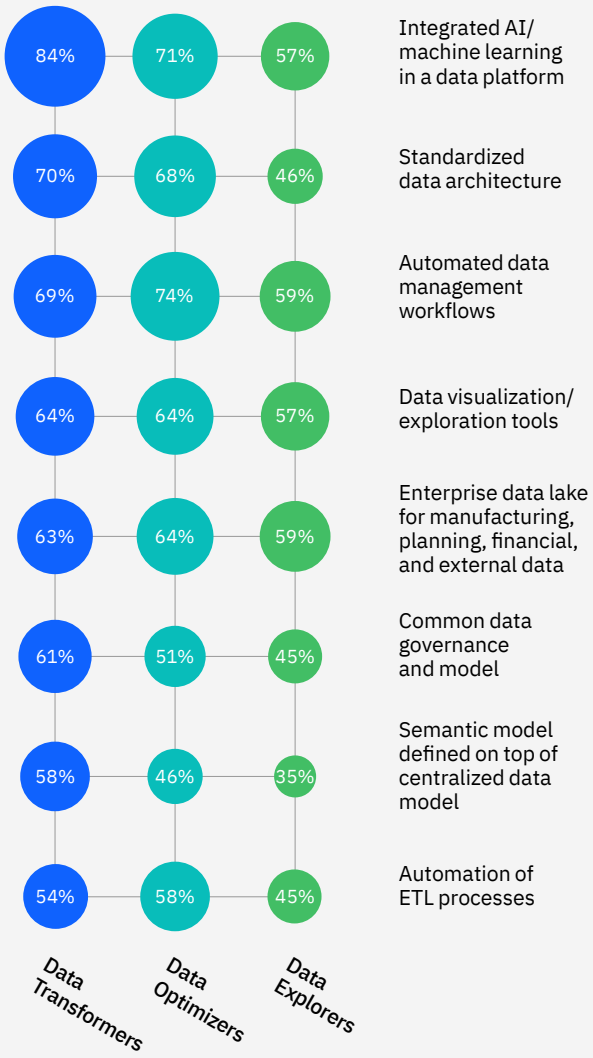


FIGURE 5

Developing a data doctrine



Percentages show responses of 4 and 5 on a 5-point scale, where 1=not at all and 5=to a very great extent.

1. Tap the potential of data.

The ability of Data Transformers to explore the technology frontier is underpinned by strong data management and governance (see Figure 5). Advanced data management capabilities are critical to effectively use digital technologies to improve manufacturing processes for enhanced outcomes. Reduced complexity in data structures is driven by a standardized data architecture, an enterprise data-governance framework, central data repositories, and automation of data loads. Data Transformers are ahead of the pack, having moved beyond centralized data models by defining a semantic model, a method of organizing data that reflects the basic meaning of data items and the relationships among them.

Both Data Transformers and Data Optimizers have also reduced the time needed to prepare, validate, and cleanse data. Nearly two thirds have implemented an enterprise data lake, which allows them to curate their existing data and apply it to decision making. Finally, 64% of these two archetypes are leveraging data visualization/ exploration tools. Empowered staff teams can dive into data, process information faster, and take advantage of insights to improve performance.

Perspective

Data fabric simplifying data access

An integrated data strategy and architecture that overcomes data complexity challenges is required to become fully data driven. Data fabric is an architecture that simplifies data access in an organization.[11] It facilitates the end-to-end integration of various data pipelines and cloud environments through the use of intelligent and automated systems. By leveraging data services and APIs, data fabrics can pull together data from legacy systems, data lakes, data warehouses, Structured Query Language (SQL) databases, and apps. A data fabric architecture helps improve productivity, eliminate silos across data systems, centralize data governance practices, enhance overall data quality, facilitate self-service applications, and provide better data protection.[12] As an example, data fabrics could be used for predictive maintenance that is scheduled as needed, based on asset conditions and predictions of failures, and requires advanced analytics tools/processes.

L’Oréal

Delivering personalized cosmetics with AI and IoT

L’Oréal is a leader in beauty, offering women and men worldwide cosmetics, haircare, and perfume with a focus on quality, efficacy, and safety. L’Oréal faces increasing demands from customers who expect cosmetics that are perfectly tailored to their skin type, skin color, and personal preferences. The company sought a technology solution to gain more insight into the wishes and purchasing behaviors of consumers, which manufacturers could then use to adjust production accordingly.

To address the challenge, L’Oréal turned to an AI IoT platform that includes sensors, laser measurements, cameras, and advanced conveyor belts in a new production line in its Belgian plant in Libramont. The redesigned production line processes dozens of different products simultaneously, delivering highly personalized products tailored to individual skin.[13]

2. Achieve cyber resilience.

With IT-OT integration, the OT network and connected OT devices are exposed to security threats, and remote access to OT networks by outside vendors further expands vulnerabilities. The top infection vectors for manufacturing are vulnerability exploitation (47%), removable media (7%), phishing (40%), stolen credentials (3%), and brute force (3%). About 1 in 4 attacks in manufacturing are from ransomware.[14]

The 3 archetypes in our study have made progress on their OT security, with Data Transformers being the most mature (see Figure 6). Beyond prioritizing vulnerabilities, opportunities exist to link security metrics and processes. Across the archetypes, organizations are using audits, response planning, and monitoring to provide security.

To protect people, assets, and information involved in the monitoring and/or control of physical devices, processes, and events, manufacturers need to look across all levels of their organization: basic controls and instrumentation, area operations and supervisory control, DMZ (a perimeter network located between networks to improve security of an organization's network by preventing direct access from the insecure network to a protected network), and enterprise/site network.

Also, today's modern manufacturing cybersecurity (for both IT and OT) requires a "zero trust" approach, in which there is no such thing as a trusted source behind the firewall. This means that cybersecurity teams need to assume that there are potential attackers present both inside and outside of their networks and, therefore, treat all traffic as suspect. This, in turn, suggests that no communications should be allowed until each party is properly authenticated and authorized (users and their devices) and continuously validated for security configuration and posture before being granted or keeping access to applications and data.

FIGURE 6

Protecting the OT environment

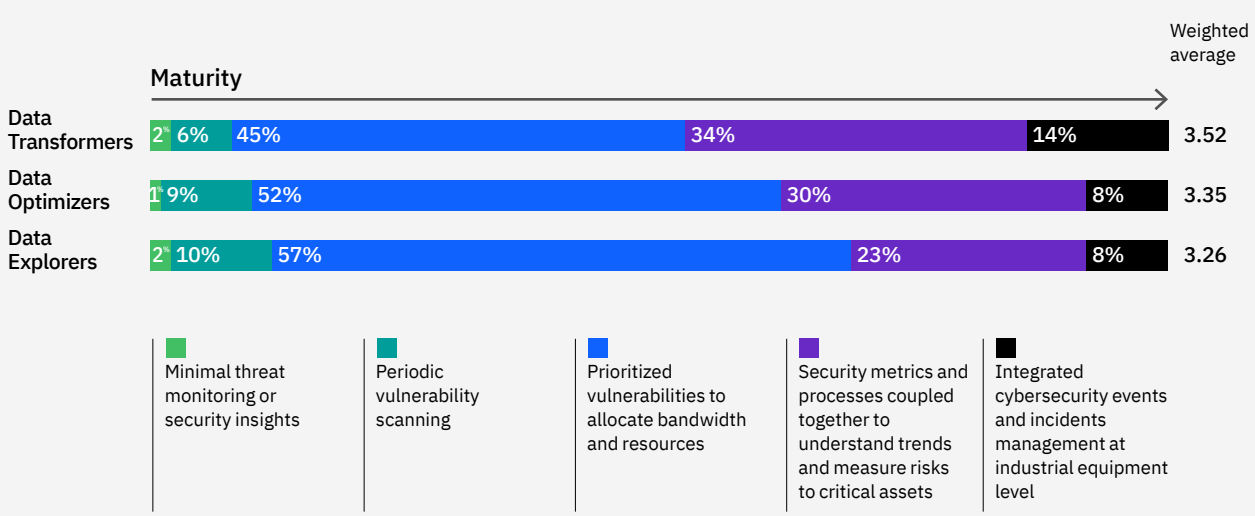


ABB and IBM

Bolstering cybersecurity for industrial operations

ABB, a leading global engineering company, is collaborating with IBM to connect cybersecurity and OT. As part of the effort, ABB has developed a new OT Security Event Monitoring Service that combines its process control system domain expertise with IBM's security event monitoring portfolio to help improve security for industrial operators. To better connect OT data with the broader IT security ecosystem, this new offering allows security events from ABB to be sent to IBM's security information and event management platform. This collaboration marks the first time that OT data and process industry domain expertise is being brought directly into a security information and event management (SIEM) system, allowing threats to be managed as part of an organization's broader cybersecurity operations and strategy.[15] One industrial company using the service is reaping the benefits of real-time security monitoring based on events from OT control systems. The company also has access to a wide range of security information and event management (SIEM) capabilities–from single event alerting to device configuration tracking.[16]

3. Create an enterprise architecture connecting the plant floor to business systems.

A hybrid multicloud IT infrastructure is necessary for manufacturers to take full advantage of Industry 4.0, with interconnectivity and the ability to optimize workloads across cloud environments. Real-time data collected from sensors, devices, and machines on the factory floor can be used by other factory assets, as well as shared across other components in the enterprise software stack, including ERP and other business management software.[17]

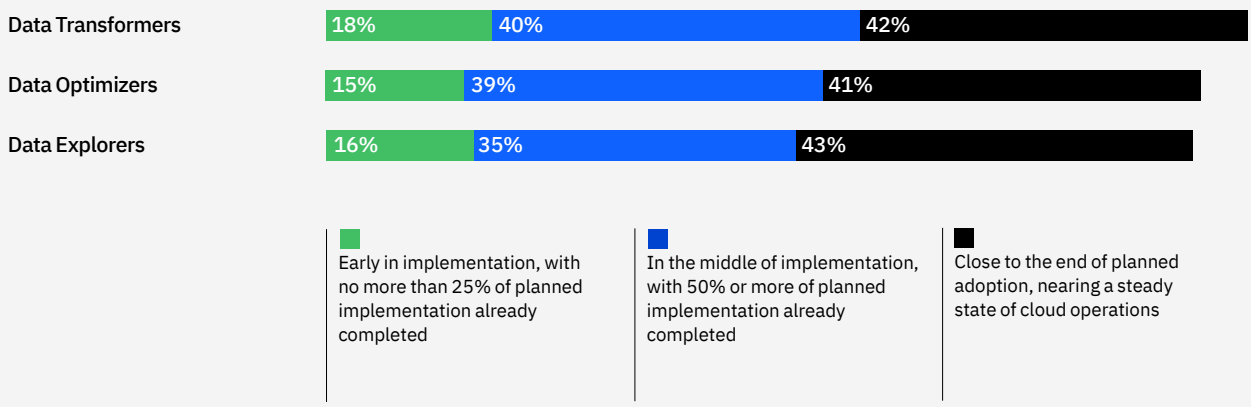
A standardized hybrid cloud infrastructure at the shop floor manages the required IT workload, such as OT-IT integration, edge analytics, OT security, and new and traditional applications that are managed by hyperscalers' best practices. The collection of the aggregated, cleansed, and controlled data from different plants can be pulled together in a central place. This hybrid cloud approach allows cross-factory insights, KPI comparison, and optimization and enforces full control and sovereignty of the exchanged data across factories and even companies, suppliers, and clients.[18]

The three archetypes have all made progress in adopting cloud as part of their manufacturing operations, with the Data Transformers the farthest along (see Figure 7).

In addition to embracing cloud computing, Data Transformers are taking advantage of a new approach to network management. Software-defined networking technology enables dynamic, programmatically efficient network configuration to improve network performance and monitoring, making it more like cloud computing than traditional network management. 57% of Data Transformers have implemented such a network to a large extent compared to 49% of Data Optimizers and 39% of Data Explorers.

FIGURE 7

Benefitting from cloud



AT&T and IBM

Bringing hybrid cloud to enterprise 5G

AT&T and IBM are collaborating to enable enterprises to manage open hybrid cloud computing in a low-latency, private cellular network edge environment. With new hybrid cloud services, enterprises can tap the power of 5G for uses like factory safety and efficiency, real-time health monitoring, or autonomous vehicle operation. In manufacturing, 5G-connected automated operations can help reduce costs and control quality on production lines through robotics and near real-time visual analysis. By making it easier for businesses to manage open hybrid cloud computing in a low-latency, private cellular network edge environment, IBM and AT&T are helping businesses across industries quickly and more securely build applications using regional or on-premises edge computing. [19]

For example, the collaboration helped an industrial company deploy wireless connectivity across vast areas, with significant redundancy, resulting in 30% lower costs. The power of 5G and hybrid cloud also provides a reliable foundational network to expand capabilities to include personal safety alerts, asset tracking, production and quality, and turn around operations.[20]

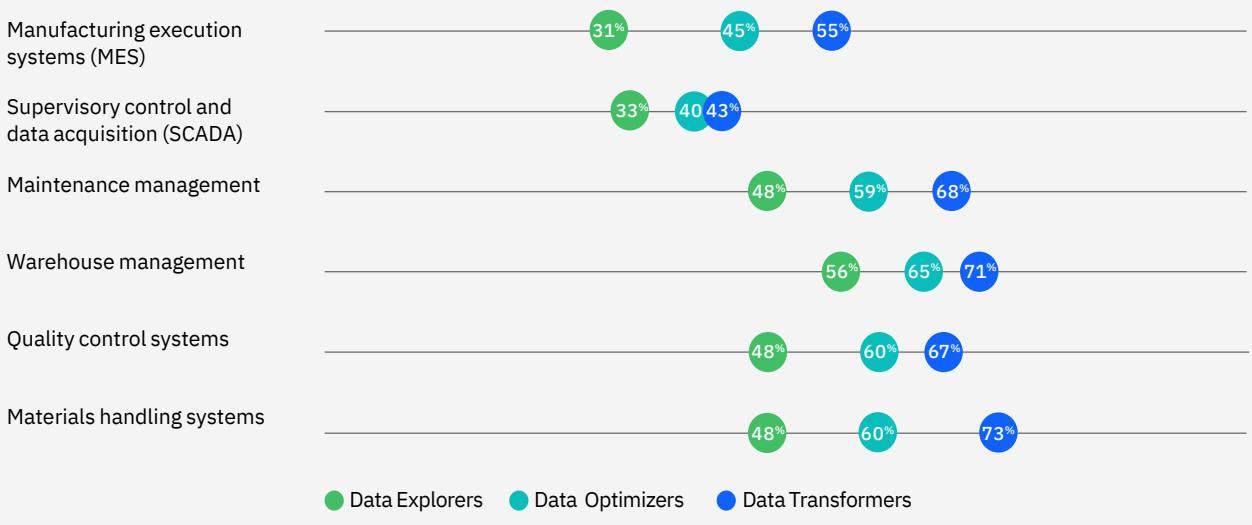
4. Increase manufacturing excellence with technology.

With respect to technology, Data Transformers have modernized their plant applications and are further along in implementation of select technologies and AI. Data Transformers have modernized materials handling systems, warehouse management, and maintenance management applications (see Figure 8). Nearly two-thirds are exceling at using DevOps for development and containers for application deployment. 55% of Data Transformers have implemented digital twins in their manufacturing lines to a large extent as opposed to 38% of Data Optimizers and 33% of Data Explorers. They have also implemented activity monitoring and automated materials handling at a much higher level.

Dependent on a transparent, efficient supply chain, Data Transformers have implemented AI to a greater degree than their peers for procurement and logistics. 50% have fully implemented or implemented at scale raw material/component/subassembly procurement, and 41% have done so for logistics. AI is embedded in spend analysis, contract management, and strategic sourcing to provide better prediction on resourcing raw materials. Logistics processes are transformed by AI to make demand predictions, modify orders, and change product deliveries. If an assembly line is experiencing a disruption, products can be rerouted or delayed to help reduce wasted time and cost. By analyzing weather, transportation partner, and retailer data, companies can use predictive shipping to send finished goods at just the right time to meet consumer demand.[21]

FIGURE 8

Replacing legacy applications

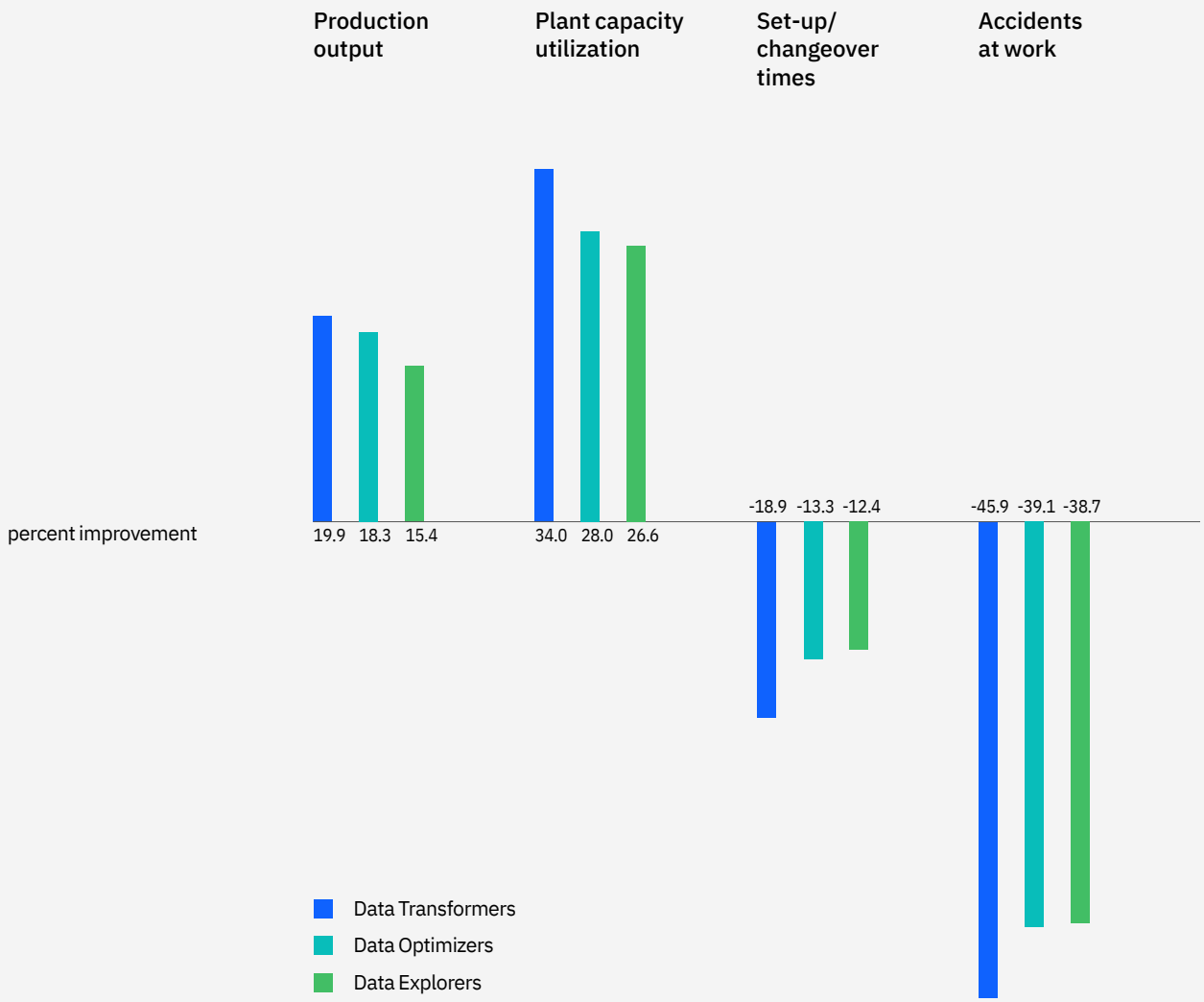


Percentages show responses of 4 and 5 on a 5-point scale, where 1=not at all and 5=to a very great extent.

Where the Data Transformers really stand out is the value derived from their digital initiatives. They have been more successful than their peers in leveraging digital investments to help increase productivity, drive efficiency, and improve safety (see Figure 9).

FIGURE 9

Realizing the impact of digital



Kyocera

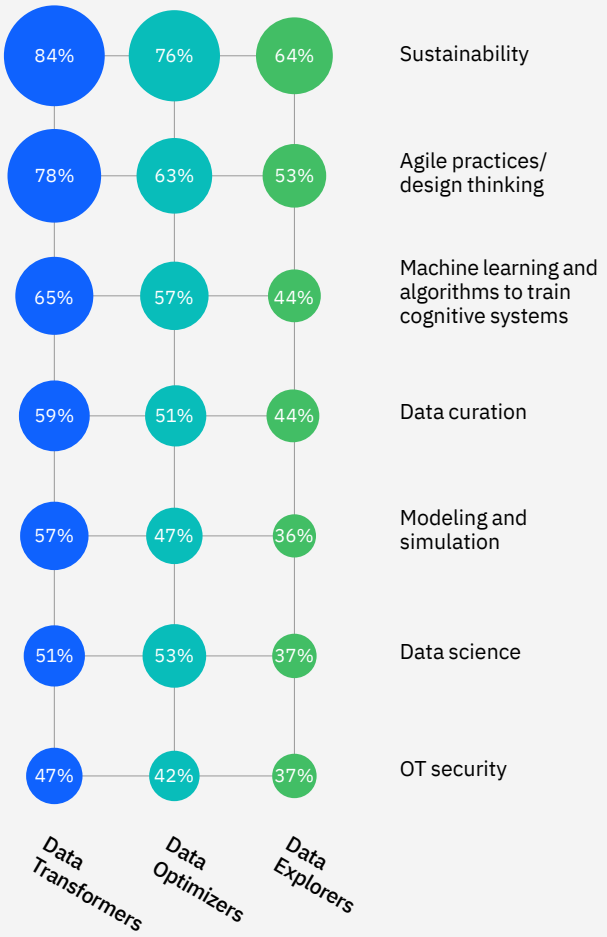
Doubling productivity using autonomous technology

Kyocera has expanded beyond its initial focus as a specialized manufacturer of fine ceramics, diversifying into new areas such as communications, automotive, environmental energy, and healthcare. As part of a sales expansion plan, the company launched the "Productivity Doubling Project" to double manufacturing productivity, reduce costs, and drive competitive advantage.

Since April 2019, Kyocera has been promoting the deployment of unmanned production lines using AI and robots at all its plants. An AI digital platform solution analyzes various data collected in real time. If the system determines that a defective product is likely to be produced, it automatically changes the processing conditions and handles it. If the system determines that the line is likely to stop, it alerts operators or those in charge before the machine breaks. The digital platform, which integrates production planning and scheduling with the production operating system, has provided quality improvement results for the production lines in many of Kyocera's plants.[22]

FIGURE 10

Investing in new ways of working skills



Percentages show responses of 4 and 5 on a 5-point scale, where 1=not at all and 5=to a very great extent.

5. Embrace the manufacturing worker of the future.

As the manufacturing industry digitally transforms, the worker of the future will be redefined. Understanding that employees with the right skills who can embrace intelligent automation, the use of data, and digital technologies are needed, Data Transformers are preparing their workforce. 61% say they are enhancing employee understanding of intelligent machines/devices to a large extent, compared to 56% of Data Optimizers and only a third of Data Explorers. And this training isn't just coming from within the organization. Nearly 7 in 10 Data Transformers are learning from other manufacturing industries to a large extent, allowing them to better understand the benefits of digital capabilities and shift responsibilities to intelligent automation.

Respondents also tell us they are investing in new skills. Data Transformers are placing their bets on the need for capabilities that support sustainability (for example, lean manufacturing or carbon emission minimization), as well as agile and design thinking, data management, and use of technology. With the right combination of talent and digital technologies, these companies can generate prescriptive insights that recommend next-best actions for closing performance gaps in manufacturing. Investments in agile skills allow modifications based on real-time feedback from testing, iterating, and making improvements throughout operational processes. Data Transformers recognize that navigating a continually evolving manufacturing environment requires people who can change course quickly, apply problem-solving capabilities to drive digital transformation, and draw and act on insights from vast amounts of data.

İsdemir

Modernizing steel production

One of the OYAK Mining Metallurgy companies, İsdemir is Turkey's third oldest integrated iron and steel plant and the largest by its long product manufacturing capacity. Producing millions of tons of steel is an asset-intensive business. Seeking innovative technology to keep equipment running at full capacity across dozens of production sites, the company chose a common platform for managing assets at İsdemir and its Erdemir subsidiary.

The platform's dashboard provides the company a single point of control to monitor, manage, and report on all phases of the asset lifecycle in its facilities. The platform solution assigns equipment classifications—critical, important, or normal—to every asset, allowing the company to apply different strategies to different assets based on classification. For example, the company uses preventive or predictive maintenance along with online monitoring for critical assets.

The platform also helps manage human resources, allowing İsdemir to assign the right person in accordance with maintenance instructions. It also helps the company monitor efficiency and analyze data to decide when to assign a team member and when to bring in a specialist.

In addition, the solution is integrated with the financial, maintenance, and warehouse departments at Erdemir and İsdemir, providing visibility into spare parts inventory by asset criticality. This helps ensure that the right materials for scheduled maintenance are on hand.[23]

6. Integrate digital with manufacturing operations and management.

Both Data Transformers and Data Optimizers understand the inherent opportunities that digital transformation provides, and they leverage the power of data and digital technologies to drive change and innovation in manufacturing. 44% of Data Transformers and 39% of Data Optimizers have aligned their digital/IT strategy with their manufacturing strategy to a large extent, compared to a little over a quarter of Data Explorers. This alignment, in turn, positions them to modernize their plant applications and network; connect data, applications, and processes to streamline operations; create a platform for plant data and analytics; and scale edge analytics/AI applications. For use in overseeing operations, digital command centers facilitate real-time process tracking, management of KPIs, and application monitoring. Across the three archetypes, the majority are using these control centers for production management and inventory management. Data Transformers and Data Optimizers stand out in using them for production quality management and logistics/supply chain. Integrating the supply chain with production operations transforms the way manufacturers resource their materials/components and deliver products.

Reckitt

Building the factory of the future

Consumer goods company Reckitt produces some of the world's most recognized hygiene, health, and nutrition products for the global market. For the company's IT and manufacturing teams, Industry 4.0 technologies that digitize and automate operations present an opportunity to drive change to outperform the competition. But first, they have to overcome obstacles like siloed data, different operating systems, a lack of interconnectivity across factories, and varying levels of plant technological maturity are obstacles.

Reckitt set out to build its "Factory of the Future," implementing a scalable cloud foundation and data backbone that it could extend and replicate from its Nottingham factory to others around the world. The solution was tailored for three use cases: overall equipment effectiveness (OEE), factory maintenance, and energy efficiency and sustainability.

To enhance and improve operational and manufacturing efficiency, Reckitt deployed its "Connected-OEE" solution, which automatically collects productivity data and provides asset monitoring of factory machines. Maintenance activities are automatically triggered based on actual machine conditions. Energy meters are connected to the cloud platform so site managers can use dashboards to track energy use, spot trends or anomalies, and track their progress toward Reckitt's ambitious sustainability targets.

The Nottingham plant became Reckitt's first operational Factory of the Future in May 2021. By June, the company was already projecting a reduction in plant maintenance costs of 10% and a 3% decrease in electric power consumption.[24]

Action guide

Manufacturing 4.0: From data to decisions

Reaching Manufacturing 4.0's full potential requires concerted action across the enterprise. There are both strategic and operational implications in the pursuit for greater customer value and ongoing operational improvements. How you approach the Manufacturing 4.0 imperative depends on your level of data maturity.

First comes an honest appraisal of your manufacturing organization's current state. Have you modernized your plant legacy apps? How far along are you with converging enterprise IT and plant systems (OT)? What data initiatives are in place to take advantage of your vast amounts of data? Where are you in the journey to enhance your plant infrastructure? Have you added data management skills? The answers to these questions can help you determine your organizational archetype and progress toward creating a data-driven culture in manufacturing.

For each of the 3 archetypes, the focus is different:

Data Explorers. Build an aligned digital and manufacturing strategy. Create a standardized data architecture. Modernize plant applications–including quality control and maintenance; utilize DevOps for development. Deploy intelligent workflows for production management. Converge IT-OT environments. Enhance employee understanding of intelligent machines. Extend cybersecurity to OT.

Data Optimizers. Implement common data governance and a semantic data model on top of your centralized data model. Modernize your MES application. Implement digital twins and automated materials handling. Utilize DataOps for creating data pipelines (see sidebar "Perspective: Embracing DataOps for improved data management and delivery"). Continue to modernize plant infrastructure. Add modeling and simulation skills. Replicate blueprint/reference architecture across plant sites.

Data Transformers. Further modernize applications–MES, SCADA, laboratory information management systems (LIMS), production information management systems (PIMS), warehouse management systems (WMS). Shift to open and standardized OT systems. Utilize data fabric. Continue to modernize plant infrastructure. Leverage 5G and process data at the industrial edge. Add OT security skills. Replicate across sites and partners with same blueprint/reference architecture.

While manufacturers need to create their individual Manufacturing 4.0 narratives, they also must focus on three common priorities:

01

Execute a digital manufacturing blueprint

Set a manufacturing strategy linked with your digital/IT strategy, with initiatives by manufacturing area, coordinated technology investments, necessary resources, and ecosystem alignment.

Assess current operations to understand the main pain points and challenges of existing processes and their supporting systems. Involve key plant stakeholders from production, operations, maintenance, quality, and safety teams.

Define the to-be business processes and map all changes that need to be made, including in-shop floor units (retrofits), inventory locations, properties associated with the products/materials, production routing, production processes, recipes, quality parameters, IT/OT supporting systems, and roles/personnel involved in the to-be processes.

Define the architectural requirements and decisions and operational design of your cloud/edge solutions; define the total cost of ownership, return on investment, business value, or full business case.

Tap into new data sources and ecosystem partners to drive new insights and efficiency plays.

Leverage relationships with other manufacturing organizations to gain access to broader ideas and opportunities.

02

Infuse manufacturing with new technologies

Modernize legacy and deploy new applications with open and agile principles; centrally manage application lifecycles.

Deploy an application integration architecture capable of connecting through multiple communication protocols/interfaces, trigger automatic workflows, enable functional domain-specific services to expose/ingest data, and be capable of accommodating future needs of additional functionalities to be rolled out at later stages with low-cost integration of new sub/systems at the enterprise and/or plant levels. Leverage open standards such as OPC Unified Architecture (a standard for data exchange from sensors to cloud applications developed by the OPC Foundation) and MQ Telemetry Transport (MQTT) (a standard messaging protocol for the IoT).

Establish data commonality and governance to engender trust in data.

Automate discovery, linking semantic enrichment and understanding of business-ready data.

Design and deploy a supporting data fabric architecture that provides data-based services (dashboards, reports, self-service business intelligence) built on reliable data and enables transparently processing data from different sources supporting various data delivery styles (streaming, ETL, data virtualization and data microservices, etc.), active metadata management, and embedded machine learning capabilities.

Deploy and manage edge analytics/AI applications at scale. For example, process advisors assist process engineers to further optimize critical operations to improve energy efficiency and throughput. AI-powered automated inspections augment manual inspections and technical assistance to help reduce product defects, improve efficiency, and reduce false positives.

Deploy hybrid cloud and implement the management framework for the operational environment.

Extend secure multicloud software-defined networks to modernize your plant with 5G and edge computing.

Automate security, privacy, and usage policies enforcement across a hybrid cloud data ecosystem.

Perspective

Embracing DataOps for improved data management and delivery

DataOps is a collaborative management discipline based on practices and technologies that operationalize data management and data integration to help ensure resiliency and agility in the face of constant change. Using the power of automation, it helps companies tease order and discipline out of chaos and solve the big challenges of turning data into business value.

DataOps includes automation in 5 critical areas of the data pipeline: data curation services, metadata management, data governance, master data management, and self-service interaction.[25] It offers numerous benefits, including the potential to decrease the cycle time in deploying analytical solutions, lower data defects, reduce the time required to resolve data defects, and reduce data silos.[26]

03

Establish a new employee experience

Put in place a manufacturing digital transformation leader to align multiple initiatives and break down traditional silos.

Frame your manufacturing strategy to engage staff in different manufacturing areas and at all levels of the organization with an understanding of how operations will change, the value that will be created, and opportunities for employee development.

Reflect on your organization's ability to embrace new technologies effectively and at speed, and develop proactive change management associated with your digital initiatives.

Add data and tech-savvy skills to supplement existing resources.

Adopt agile principles, determine digital initiative outcomes with clarity, and set milestones.

With more fluid decision making and more reliance on technology, adjust training, promotion, and talent management accordingly.

Enable self-service analytics.

Enable collaboration between data consumers and data providers at speed and scale.

Deploy a supporting infrastructure capable of meeting all nonfunctional requirements such as performance, availability, scalability, and resiliency since these requirements heavily affect the user experience and acceptance of new systems.

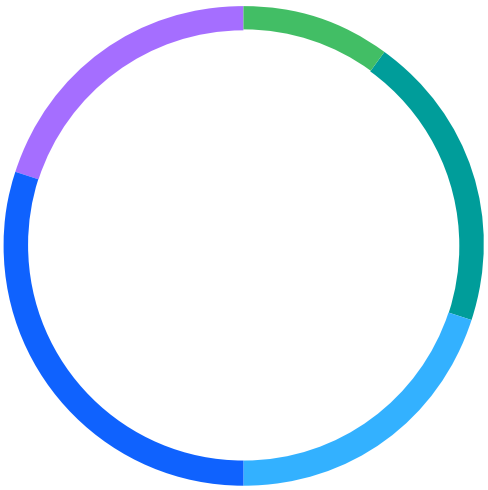
Study approach and methodology

In cooperation with Oxford Economics, the IBV conducted two surveys: 1,630 executives from 32 countries between October and December of 2021 and 730 benchmarking respondents from 32 countries between November 2021 and January 2022. We collected executive responses from Chief Operating Officers, Chief Manufacturing Officers, and Vice Presidents/Directors of Manufacturing. Benchmarking respondents had a significant understanding of manufacturing metrics in their organization and their organization's manufacturing policies, practices, and operations. Participants were from companies located in the Asia Pacific, Europe, the Middle East, North America, and South America. The 2,360 respondents represent different industries and different-sized organizations. All data is self-reported.

Industry

- 15% Automotive
- 10% Chemicals
- 10% Consumer Products
- 10% Downstream Oil and Gas (refining only)
- 17.5% Electronics
- 7.5% Engineering and Construction (building materials manufacturing only)
- 10% Industrial Machinery/Heavy components
- 10% Life Sciences/Pharmaceutical
- 10% Metals

Enterprise size
(annual revenues)



- 10% $250 million to $500 million US Dollars
- 20% $501 million to $1 billion US Dollars
- 20% $1+ billion to $5 billion US Dollars
- 30% $5+ billion to $20 billion US Dollars
- 20% More than $20 billion US Dollars

About
the authors

José Favilla

jfavilla@us.ibm.com
linkedin.com/in/josefavilla

José Favilla is Director, Industry Use Cases for Global Manufacturing & Energy Industries, for IBM Technology. He has over 30 years of experience helping global clients drive major business transformation programs. José is a member of the IBM Industry Academy.

Spencer Lin

spencer.lin@us.ibm.com
linkedin.com/in/spencer-lin-35896317

Spencer Lin is the Global Research Leader for Chemicals, Petroleum, and Industrial Products for the IBM Institute for Business Value. He has more than 25 years of experience in financial management and strategy consulting.

Marcelo Sávio

msavio@br.ibm.com
linkedin.com/in/msavio/

Marcelo Sávio is an Industry 4.0 Architect with a focus on the Industrial Sector in IBM Consulting. He works with Industry 4.0, digital transformation, and the integrated operations approach, helping industrial companies make better and more rapid decisions across business operations through real-time integration; perform sophisticated analysis through new business insights, collaboration, and connectivity; and leverage the large and complex array of existing disparate assets over the value chain. Marcelo is a member of the IBM Industry Academy.

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IBM Corporation
New Orchard Road
Armonk, NY 10504

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