Digital Age of Food Manufacturing

HORIZONS

About this Report

Let's face it: We're all pretty good at collecting data. But what do we do with it all?

We pile receipts, just in case. Our hard drives tirelessly collect this file and that spreadsheet. Emails ping ceaselessly with customer feedback and spam. And over time we've developed sometimes-successful systems to turn that data from noisemaker to storyteller – informing everything from date night to product launches, hiring plans to quarterly performance.

When you have the right information, at the right time, it's a short trip from ambiguity to action. But if the data contained on the pages of CRB's newest *Horizons* report are any guide, you're probably among the many manufacturing leaders who keep hearing about "Industry 4.0" but are hard-pressed to understand what it really means for their business.

That's why I'm so excited to present this new report, built with survey inputs from more than 300 food and beverage leaders and analysis by CRB's industry experts. Here, leaders shared that the journey from committing to digital technology investments to execution is fraught with uncertainty, posing challenges for manufacturers crafting their business strategy.

Some leaders are frozen by the options. Others move haltingly, acknowledging data's power but unsure about how to wield it. Consider this stat from the report's opening pages: A majority of respondents plan to advance their digital maturity over the next three years, citing improved productivity as the key operational advantage. Less than 40 percent, however, have embraced the initial wave of advanced technology offering predictive, real-time data analysis, and nearly a quarter concede they're dealing with isolated digital systems and fragmented automation efforts.

Our report doesn't stop at the chase for digital maturity. Our subject matter experts also dig deep into the challenges and strategies surrounding the implementation of Environmental, Social, and Governance (ESG) initiatives. Operational efficiencies, labor challenges and hamstrung capital budgets are all explored, comprising what we humbly believe is the industry's clearest and most authoritative examination of the most pressing challenges facing the food and beverage C-suite.

We encourage you to read this report and share your thoughts on the advancement of our industry by contacting us, and we wish you a continued safe and thriving 2024.

Shannah Falcone

Shannah Falcone
CRB Vice President, Market Engagement

A new era of food and beverage manufacturing is calling—and we're listening.

Jason Robertson, Vice President, Food & Beverage

Executive summary

I'm tired of hearing about Industry 4.0. You too?

People talk about it a lot without saying very much. What does it *actually* look like? How should you deploy it in your manufacturing plant? What does it mean for your workforce? Your future capacity? Your bottom line?

You won't find many answers in the general conversation about Industry 4.0. The term has become a catch-all for shiny new technologies, making it seem both inevitable and impractical—a difficult combination for any manufacturer trying to figure out exactly how to move their business forward, particularly at a time of high inflation and reduced capital spending.

We offer this report as a searchlight amid that confusion, illuminating the path ahead by exploring Industry 4.0 not as a catch-all term but as a concrete objective enabled by realistic, incremental steps. This is no general conversation—this is a close and specific examination of the digital era, as experienced and reported directly by your peers:

- More than 300 manufacturers from across the industry answered our 65-question survey, generating over **19,000 data points** related to digital manufacturing and its impact on today's food and beverage landscape.
- Survey respondents are equally divided between large companies earning more than **$100M in annual operating revenue** and smaller companies earning below this threshold.
- The survey captured a cross-section of manufacturing departments, from operations and plant engineering teams to procurement divisions to executive leaders in the C-suite.

- 37% of respondents are early adopters of Industry 4.0, with plants that feature technology integrations and predictive, real-time analytics; 22% are at the other end of the spectrum, with digital islands and disconnected pockets of automation.

Together, this diverse chorus of voices reaches beyond the buzz of mainstream conversations, revealing an industry that's applying new solutions to eliminate old problems—but one that is equally worried about the cost and complexity of keeping pace when everyone appears to be moving rapidly, if unevenly, toward digital maturity.

In a world of hot takes from outsiders, this report offers an inside perspective from the front lines of food and beverage manufacturing:

1. Navigating the journey to digital manufacturing

The challenge:

Between planning to invest in digital technologies and following through with strategic, on-the-ground integrations lie numerous unknowns, making it difficult for manufacturers to define and implement a clear long-term roadmap.

How your peers are addressing this challenge:

- 71% of survey respondents aim to reach the highest levels of digital maturity within the next three years.
- Survey respondents are actively familiarizing themselves with the benefits of automation and digital manufacturing, with 70% ranking productivity as the most attractive operational advantage.

2. Streamlining operations

The challenge:

Today's food and beverage manufacturers face multiple overlapping challenges, from process bottlenecks to fluctuations in supply and demand—and throughout it all, they're strategizing to keep up with regulatory change and an unpredictable labor market.

How your peers are addressing this challenge:

- 52% are prioritizing instrumentation, automation and integration as a pathway to improved operations.
- 74% are using or plan to use digital technologies to enable enterprise-level data sharing, helping to bridge decisions in the boardroom with real-time operations on the plant floor.
- Digital tools designed for greater visibility into process bottlenecks and other issues are attracting notable attention. For example, 66% of survey respondents are using or are planning to use digital twin technologies and process simulations.

3. Implementing ESG initiatives

The challenge:

Facing pressure from regulators and retailers to demonstrate progress toward Environmental, Social, and Governance (ESG) objectives, food and beverage manufacturers are hurrying to get policies in place—but with limited capital dollars with which to work and a lack of visibility into real-time metrics, progress is difficult.

How your peers are addressing this challenge:

- 97% of survey respondents are partnering with outside experts to plug knowledge gaps, and 75% are taking advantage of tax credits to help fund ESG initiatives.
- A groundswell of support for energy-storing technologies and other relatively novel solutions is helping to deepen survey respondents' ESG impact.
- Utility tracking and other initiatives aimed at automated data collection are extremely popular, helping manufacturers right-size their ESG projects and measure key outcomes with precision.

4. Addressing labor challenges

The challenge:

Recruiting a skilled workforce remains a persistent challenge across food and beverage manufacturing. Many survey respondents have sheltered themselves from this issue by outsourcing production to contract manufacturers, but that shelter may not hold as those contract manufacturers face their own labor challenges, creating a cascading problem. Meanwhile, retaining and upskilling workers to meet the needs of digital manufacturing requires a long-term strategy—one that many manufacturers have not yet developed.

How your peers are addressing this challenge:

- A third of survey respondents appear committed to transformational change, with initiatives in place to drive cultural shifts and support higher wages as part of an overall movement towards an upskilled workforce.
- Survey respondents with facilities featuring advanced digital technologies, such as Artificial Intelligence (AI) and Internet of Things (IoT) capabilities, are notably more confident than their peers when it comes to facing future staffing challenges, suggesting a correlation between digital maturity and resilience against shifts in the labor market.

5. Stretching limited capital budgets

The challenge:

Just as manufacturers move to embrace a step-change from manual operations to digital manufacturing, along come rising interest rates and steep inflation. More than half of our survey respondents have cut their annual capital investments as a result, though expanding capacity and adding capabilities remain important business drivers.

How your peers are addressing this challenge:

- Although many manufacturers have reduced their capital spending, one out of every two survey respondents plans to spend on automation-related projects in the next three years.
- By prioritizing instrumentation and automation, many survey respondents are positioning themselves to extract accurate, real-time data from their existing assets, which is the key to doing more with less: more efficient scheduling, more uptime and more proactive maintenance. As a result, they may unlock more capacity without necessarily adding new capital assets to the plant.

Specialist solutions for a general challenge

Undaunted by buzzwords, today's food and beverage companies are pursuing Industry 4.0 and automation with their eyes on future efficiencies and business resilience. In these pages, you'll see how that pursuit is paying off for your peers and how they're leveraging outside specialists and other resources to overcome uncertainty and continue moving ahead.

Most importantly, you'll see that wherever you are on your own journey, you are not alone. The challenge of digital manufacturing—understanding it, embracing it, leveraging it for success—is shared across the industry, and among the experts who work with manufacturers to find unique solutions.

The first step toward those unique solutions is a conversation. With that in mind, I invite you to reach out directly to me so we can discuss the experiences and challenges you've faced on the road to digital manufacturing. Along with our team of specialized engineers, consultants and project managers, we can help you find personalized answers to your questions and plan your journey into a new era of food and beverage manufacturing.

Jason Robertson,
Vice President of Food + Beverage

To keep this conversation going, reach out to me directly at jason.robertson@crbgroup.com.

Digital manufacturing: Navigating the journey to value

Getting to the future is a strategic focus for most companies—implementation is next

By Jim Vortherms and Ryan Thompson

Section 1

We already know from client work and our previous *Horizons* reports that food and beverage manufacturers have begun the journey to the digital age of food manufacturing. Our survey confirms that they see the value of automation and other digital technologies in their facilities and are largely planning to invest further in them soon. It's not clear, however, how many of these plans will become reality. The challenges start with the simple need for more education about the benefits. A much more pressing impediment to progress is the pressure on already strained capital budgets, as we note in our exploration of capital spending later in this report. This barrier is amplified when initial technology systems, needed to set a good foundation for digital manufacturing, don't lead to a quick return on investment (ROI). Using the data from our latest survey, we delve into what it will take for food and beverage manufacturers to enter the digital future.

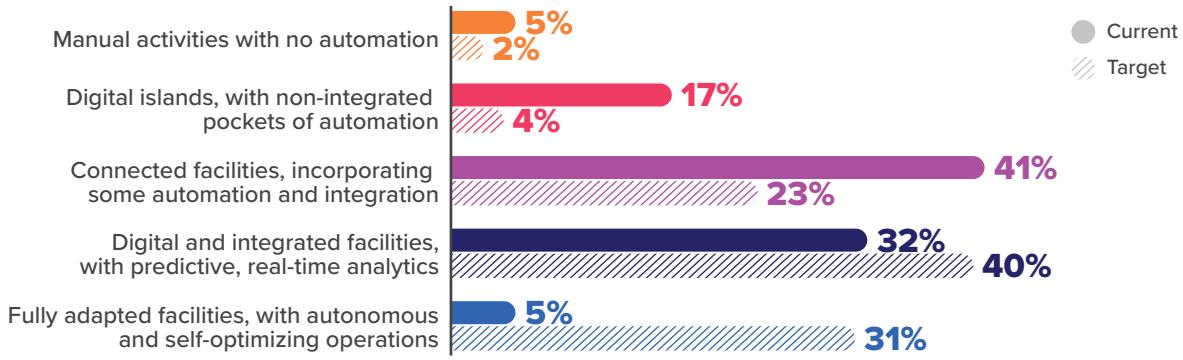
MANUFACTURERS HAVE BIG AMBITIONS TO DIGITALIZE

When asked the current level of automation of their company's facilities, more than three-quarters of respondents said their facilities are connected with at least some automation and integration (Figure 1.1). Of these, 37% of facilities are digital and integrated, with predictive, real-time analytics or fully autonomous, with self-optimizing operations, otherwise known as **lights-out/dark manufacturing**. And when prompted about the level of automation their company aspires to within three years, 71% of respondents aim to reach these two upper levels of digitalization. This means that more than one-third of the industry is looking to quickly transition to digital and connected facilities, a substantial shift in how the industry currently operates.

FIGURE 1.1 LEVEL OF AUTOMATION

For your company's current automation and control systems, what level of automation most accurately reflects the capabilities of your facilities?

To what level of automation does your company aspire in the next 3 years?



Source: CRB

THE DIGITAL PLANT MATURITY MODEL AS APPLIED TO FOOD AND BEVERAGE MANUFACTURING

This question is borrowed from the Digital Plant Maturity Model (DPMM), a five-stage model of facility digitalization developed for use in the pharmaceutical industry. Each level refers to a stage of evolution from a facility with manual processes to one that is completely automated and adaptive. Applied to food and beverage manufacturing, it gives us a snapshot of the state of the industry now and where experts believe it's headed in the next few years.

5	Adaptive Plant	• Plant of the future • Autonomous • Self-optimizing • Plug-and-play
4	Predictive Plant	• Integrated plant network • Real-time predictive analysis
3	Connected Plant	• High level of automation • Integration • System standardization
2	Digital Silos	• Some manual processes • Islands of automation
1	Predigital Plant	• Manual • Paper-based processes (SOPs batch records)

Artificial Intelligence (AI)
A broad term for using computer-generated algorithms to infer insights or generate content.

Automated Guided Vehicle (AGV)
Driverless mobile vehicles that follow a wire or signal, usually embedded in the floor, to move things in a facility, typically in a warehouse.

Automated Mobile Robot (AMR)
Similar to an AGV but does not require the use of a guide-wire. These robots use tools like LIDAR to build maps and navigate autonomously.

Cobots
Robots that safely perform a task in conjunction with a human or aid a human in their task.

Cybersecurity
Physical and software methods, tools and procedures to protect against the criminal access or control of digital assets.

Digital Twins
Software-generated models of a physical asset that allow simulation, testing and training without the physical asset. A digital twin can be tested for potential outcomes before applying an update.

Internet of Things (IoT)
The connectivity of multiple devices, sensors and other non-computer items. IoT is also used in manufacturing, referring to industrial applications.

Lights-out/Dark Manufacturing
Fully automated manufacturing processes that run without human interaction except in the event of a problem. Without people in an area, there's no need to have the lights on in the facility.

Manufacturing Execution System (MES)
Software used in manufacturing to document, track and analyze the transformation of raw materials into finished goods.

This is an ambitious goal, one that only the most focused and well-funded companies can hope to make. It requires substantial changes to operating infrastructure, including upgrades and installation of operational technology (OT) and a **manufacturing execution system** (MES), as well as a cultural mindset change that typically involves training, new procedures and organizational structures.

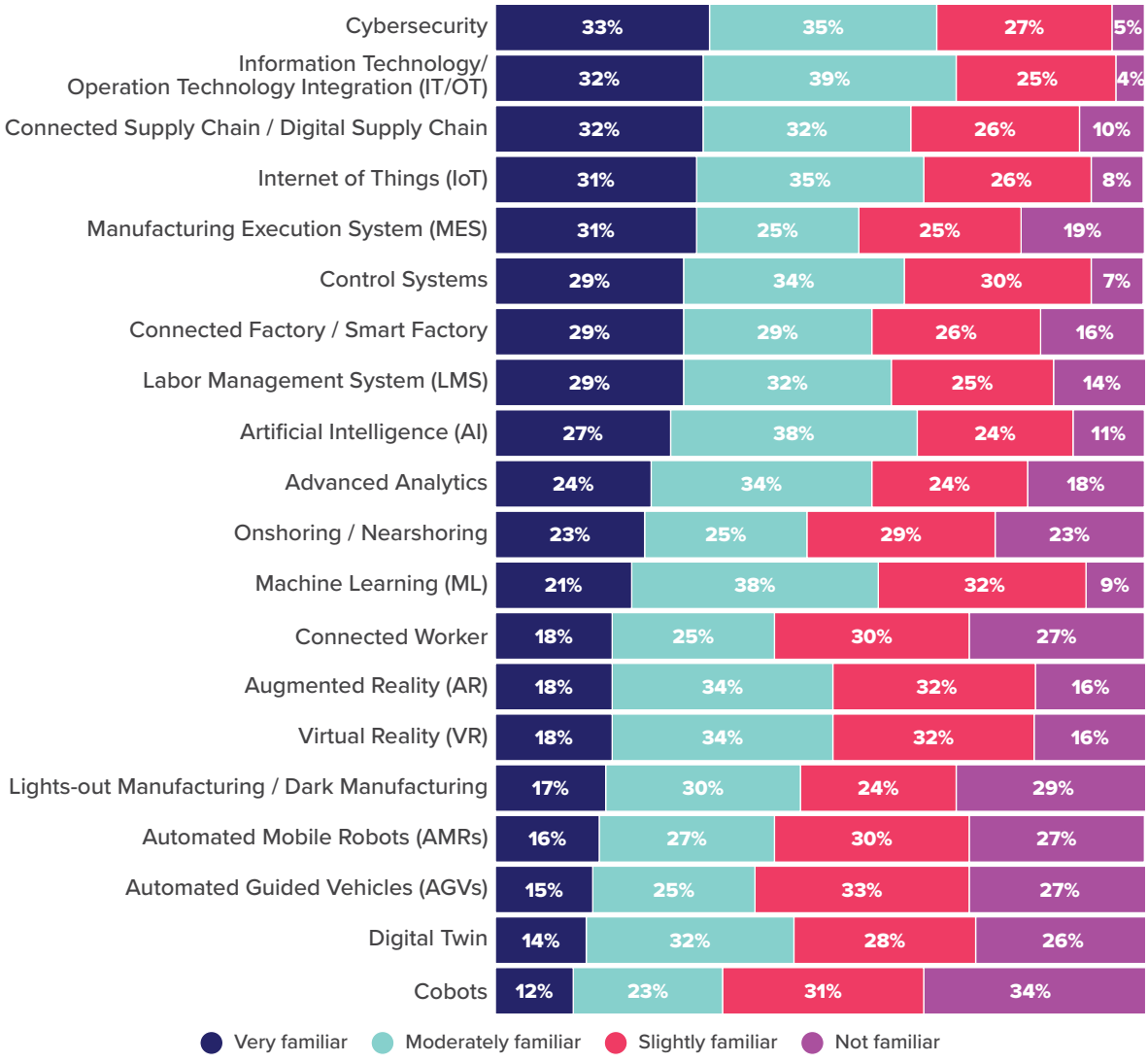
Achieving dark manufacturing within three years is probably neither realistic nor cost-effective for this industry. Setting ambitious goals, however, can positively impact an organization, especially when progress towards them is viewed as a success. It means having an effective roadmap and strategy to achieve the desired outcomes is still necessary; without a plan in place, this won't become a reality.

MORE EDUCATION IS THE FIRST STEP TO CHANGE

Industry experts displayed a wide range of familiarity with automation, Industry 4.0 and digital manufacturing terms and their application to the future of food and beverage manufacturing (Figure 1.2). On one hand, more than two-thirds of respondents were familiar with **cybersecurity**, **artificial intelligence** (AI) and the **Internet of Things** (IoT), concepts most manufacturers will have experience with or have heard about in the news. That's great news, since these form the basic infrastructure of a digital facility. However, there's low familiarity with some of the more specific technologies, such as **digital twins**, **automated mobile robots** (AMRs), **automated guided vehicles** (AGVs) and **cobots**. This may indicate that the industry is not ready for massive change, and that there's a need for further education on the technologies.

FIGURE 1.2. FAMILIARITY WITH CONCEPTS

How familiar are you with each of the following topics/terms and their application to your company? [Select all that apply]



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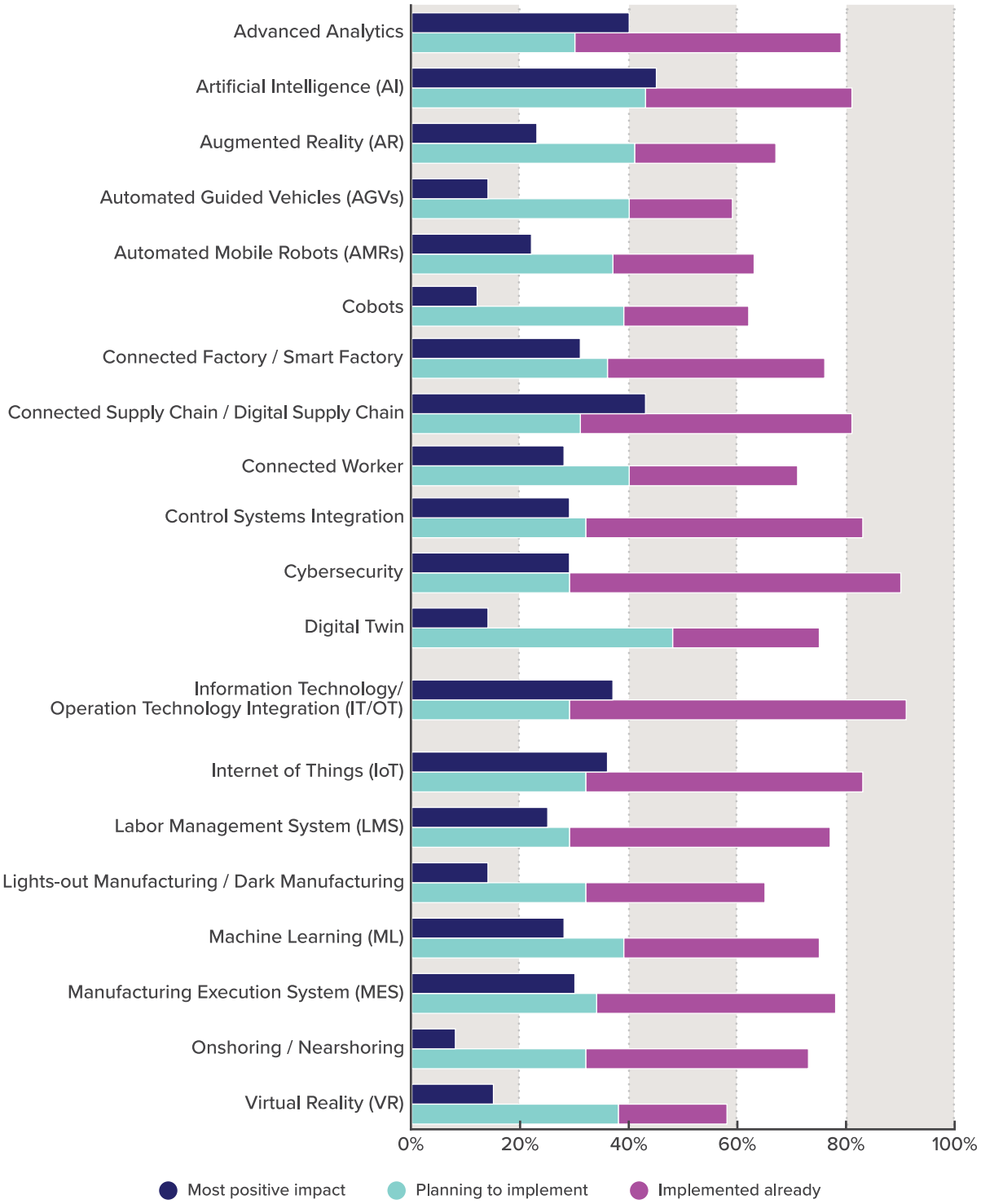
COMPANIES ARE PRIORITIZING THE RIGHT TECHNOLOGIES...

When we asked respondents to identify which elements of an automated, integrated and digital factory would have the most positive impact on their company, AI, a connected supply chain, **advanced analytics**, IT/OT and IoT topped the list (Figure 1.3). We take this as a positive sign, especially when combined with the number who have already implemented those elements fundamental to achieving the goal of a digital factory—IT/OT (62%), cybersecurity (61%) and control systems integration (51%). You can't have AI without IT/OT and control systems integration.

FIGURE 1.3. POSITIVE IMPACTS AND IMPLEMENTATION

Which concepts will provide the most positive impact to your company once implemented? [Choose up to five]

Has your company implemented, or planned to implement, these concepts in manufacturing facilities?



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Advanced Analytics
Using complex data analysis and visualization tools to gain better insights.

Augmented Reality
Computerized, heads-up displays that provide additional context and visual queues overlayed with a field of vision.

Connected Supply Chain
A horizontally integrated business in which information from suppliers, manufacturers and consumers is integrated and shared.

Connected Workers
Workers directly connected to manufacturing processes via software to improve their productivity.

Control Systems Integration
The removal of islands of automation to connect disparate systems to a larger ecosystem. See an introduction to CSI.

Information Technology/Operational Technology (IT/OT)
Refers to the connectivity between information technology (IT) and operational technology (OT) systems, allowing an exchange of information.

Labor Management System
A system to track and manage employee schedules and productivity.

Machine Learning
A subset of AI that uses computer algorithms to learn from experience instead of something pre-programmed. It trains computers based on real-world data.

Onshoring/Nearshoring
The relocation of manufacturing to the United States or in proximity within North America.

Smart Factories
Factories using various Industry 4.0 and automation technologies to achieve a more connected operation.

Virtual Reality (VR)
A computer-generated environment allowing immersion in an experience without being in the actual environment.

There were a few concepts of future facilities that most respondents did NOT pick as having the most positive impact, including **virtual reality (VR)** (15%), AGVs (14%), digital twins (14%), cobots (12%) and **onshoring/nearshoring** (8%). While these may have large impacts for certain manufacturers, they're not foundational to achieving connected, digital factories and may not fit into the operations of certain manufacturers. In either case, this is good news—the industry is focused on technologies with the biggest impact.

Well over half of respondents said their companies have implemented, or plan to implement, all the technologies and procedures that will take them into the future (Figure 1.3). Top of the heap is the integration of **information technology and operational technology (IT/OT)** (91%), allowing manufacturers to use IT to solve OT problems. Not far behind are **control systems integration** (83%), IoT (83%), a **connected supply chain** (81%), AI (81%) and **digital twins** (75%). This marks considerable progress towards achieving **smart factories** and digitalization.

CYBERSECURITY

Cybersecurity is crucial to protect manufacturers, including their physical assets, intellectual property (e.g., formulations), food safety, and quality. This explains why 90% of respondents said their company has implemented or plans to implement cybersecurity measures.

DIGITAL TWINS

Despite only 14% choosing digital twins as providing the most positive impact, three-quarters of respondents said their company has either implemented or plans to implement use of this technology. While some of this response can be tied to market hype, this is powerful technology with serious benefits.

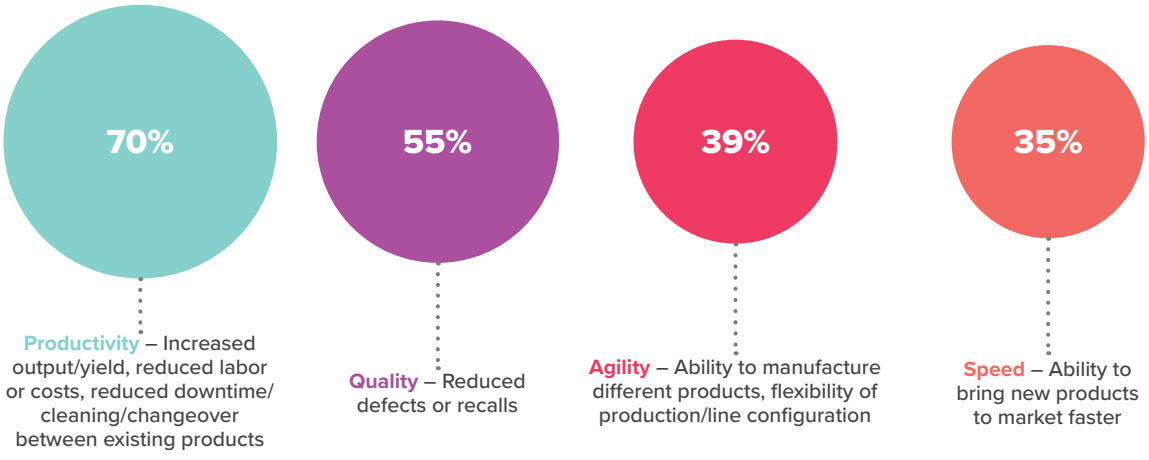
EXTENDING BUY-IN BEYOND THE MANUFACTURING FLOOR WILL IMPROVE CHANCES OF SUCCESS

While the industry seems focused on the right areas, we're concerned they may lose motivation before digital manufacturing concepts are fully implemented. We asked industry experts how they expect these technologies to benefit their company.

Productivity, which pertains to operations, was ranked highest (70%) among benefits of automation and Industry 4.0 (Figure 1.4). It was ranked significantly higher than quality (55%), agility (39%) and speed (35%). While these were selected less often, they can be viewed as major benefits for food safety, supply chain management, R&D and marketing functions at a company. This raises two concerns for us.

FIGURE 1.4. BENEFITS OF AUTOMATION AND INDUSTRY 4.0

Rank benefits of automation and Industry 4.0 on potential impact to your company. [Top 2 rank]



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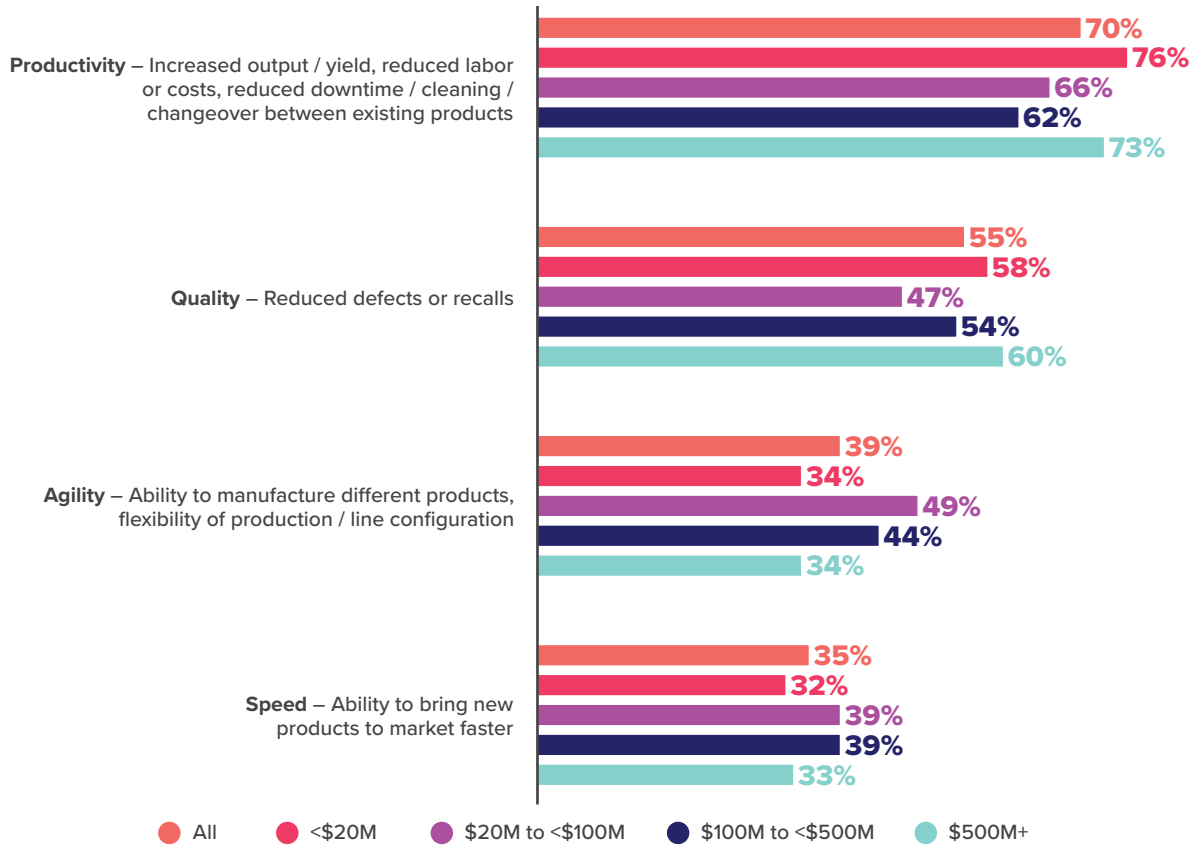
First, we're concerned that the benefits aren't being recognized by all areas of the organization. Beyond productivity gains, it's clear that quality, agility and speed have business benefits, yet not all survey respondents appeared to recognize this. For example, speed means the ability to put new products on the shelf faster based on shifting consumer sentiment. Being able to quickly launch new flavors of an existing product can take advantage of rapidly changing consumer tastes and allow food companies to capture market share and loyalty. The percentages for each benefit category were largely the same regardless of company size (Figure 1.5).

FIGURE 1.5. THE BENEFITS OF AUTOMATION AND INDUSTRY 4.0 BY COMPANY SIZE

Rank the benefits of automation and Industry 4.0 on potential impact to your company.



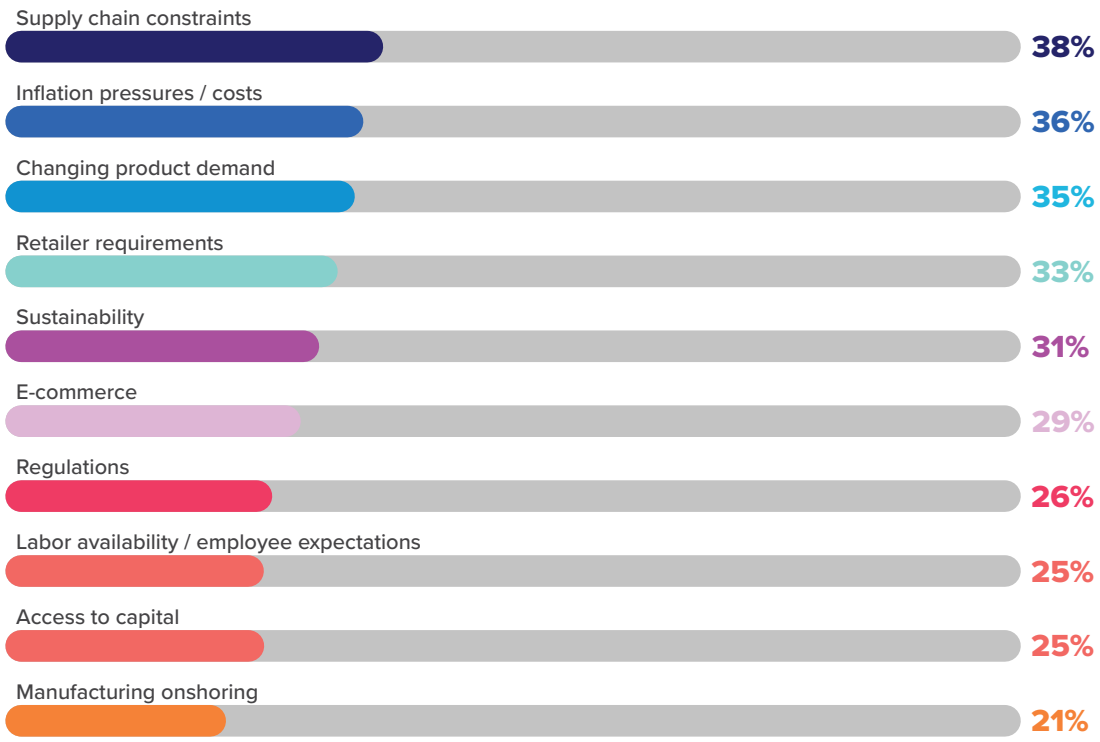
Source: CRB

This data points to a lack of understanding and appreciation of automation regardless of the size of a company. We weren't expecting this, given that larger companies have teams of experts dedicated to ensuring supply chain agility and speed in new product launches. It points to an industry-wide problem in helping all stakeholders recognize the benefits of this technology. On the plus side, the benefit seems to be resonating with those in operations.

Second, companies are overlooking an opportunity to address supply chain constraints and changing product demand, which were ranked among the highest business drivers for company spending (Figure 1.6). By using digital and connected facilities to create more agile manufacturing environments, companies will get more benefit from their efforts. For example, a snacks facility will typically need to make multiple product formats, such as a pretzel facility that switches its packaging formats between smaller, convenience-store sizes to club store sizes, depending on consumer demand.

FIGURE 1.6. BUSINESS DRIVERS

Rank the top 5 business drivers for your company's spending. [Top 3 rank]



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FINANCIAL SUCCESS OFTEN REQUIRES A LONG-TERM OUTLOOK

Recognition of the benefits and the rate of implementation of most of these elements indicates positive aspirations for the industry. Despite this positive outlook, some survey data suggests companies may not be quite ready to boldly march toward the food facility of the future.

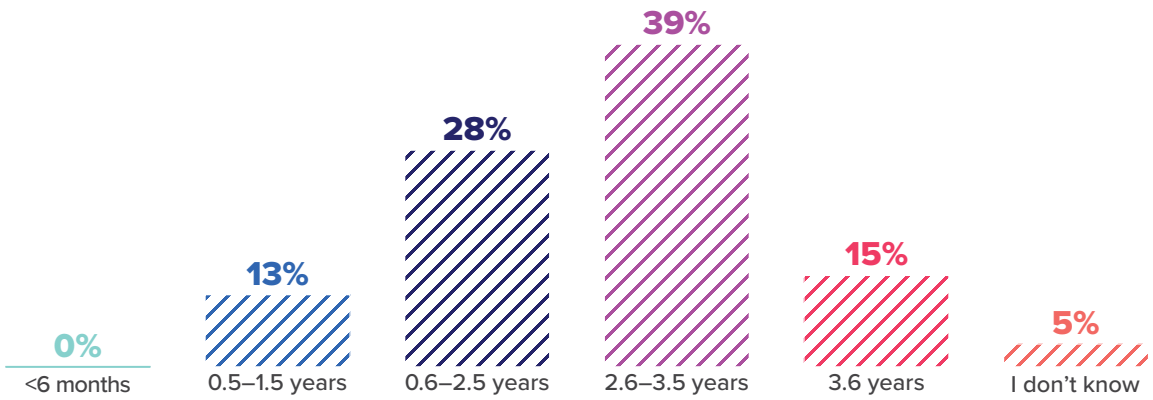
Desire for a quick payback

Companies are typically looking for a quick ROI on capital projects, with 80% requiring payback within 3.5 years (Figure 1.7). This may be an unrealistically short timeframe in which to recoup the necessary investments.

Choosing appropriate technologies for a specific business requires an analysis of the level of investment needed and the potential benefit—not every technology will make sense for every company. Funding approval for any technology will require balancing ROI against potential benefits. For example, investments to get to level 3 of the DPMM, or a connected plant, are heavy on infrastructure that provide minimal ROI on their own, including networking equipment, upgrading systems lacking connectivity and implementing a data platform. The value of data is unlocked after this phase.

FIGURE 1.7. CAPITAL UPGRADES PAYBACK PERIOD

What payback period does your company typically require for capital upgrades?



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Capital cost, risk and security top barriers to implementation

The need for payback within a relatively brief time is in keeping with the top barrier noted to implementing automation and digital manufacturing technologies—capital expense, chosen by 44% of respondents (Figure 1.8). Other significant barriers included risk management (42%), cybersecurity concerns (39%) and organizational reluctance (35%). The latter, which is perhaps the most difficult to overcome in the short term, seems to indicate that aspirations are at odds with internal alignment.

Capital cost was chosen significantly more often by those whose companies have annual operating revenue less than $20M (58%) than those with revenue greater than $500M (32%) (Figure 1.9). Organizational reluctance was less of a factor for those larger companies (28%) than for smaller ones (41%). This makes sense given that companies with lower operating revenue have less capital available to spend on improvements, the benefits of which are not easy to quantify or have a longer ROI. Of course, you can't directly measure the value of becoming a data-driven, digital-first manufacturing organization the way you can calculate the benefit of an improvement in something like overall equipment effectiveness. Providing additional education on the technologies, their benefits and their application to manufacturers should alleviate some of the resistance to implementation. In the end, though, it still comes down to available capital.

FIGURE 1.8. BARRIERS TO AUTOMATION AND INDUSTRY 4.0

Please rank your company's top barriers to implementing automation and Industry 4.0 technologies. [Rank top 3]

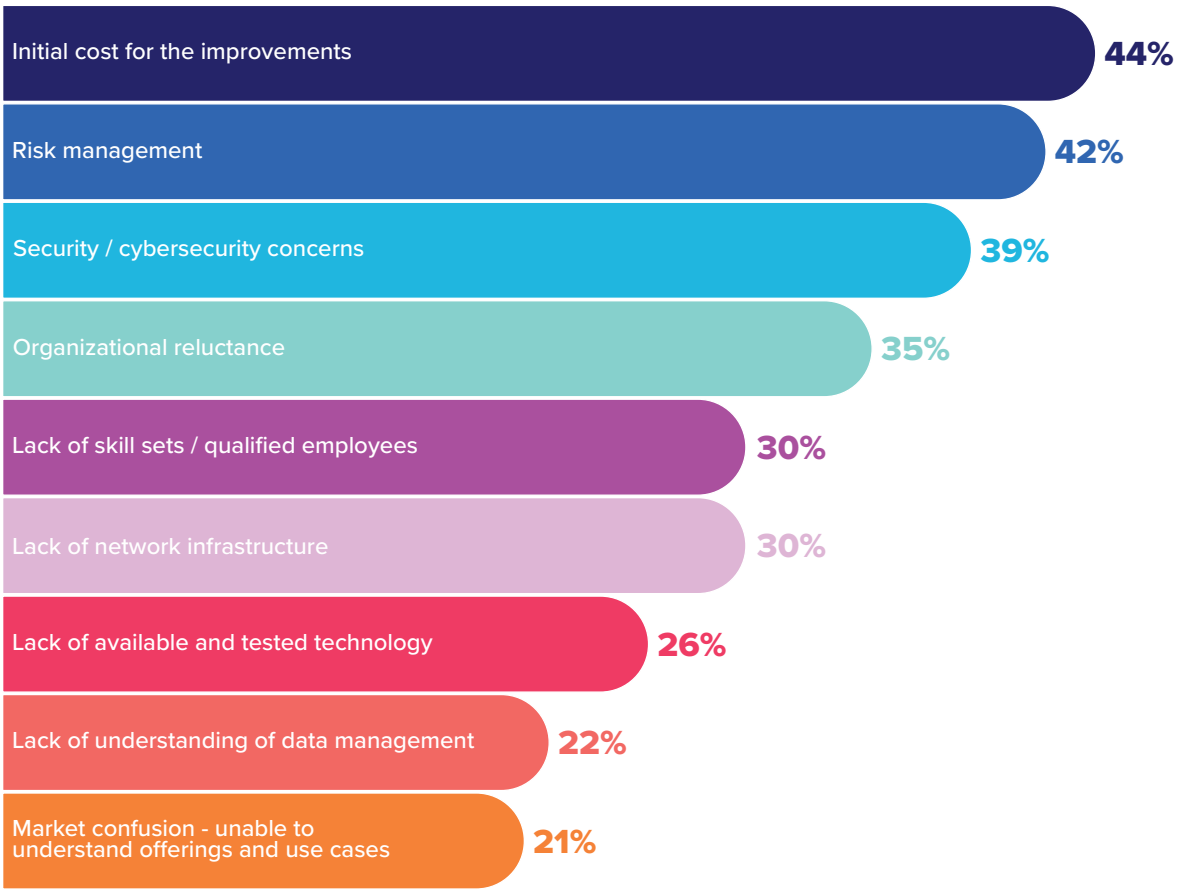

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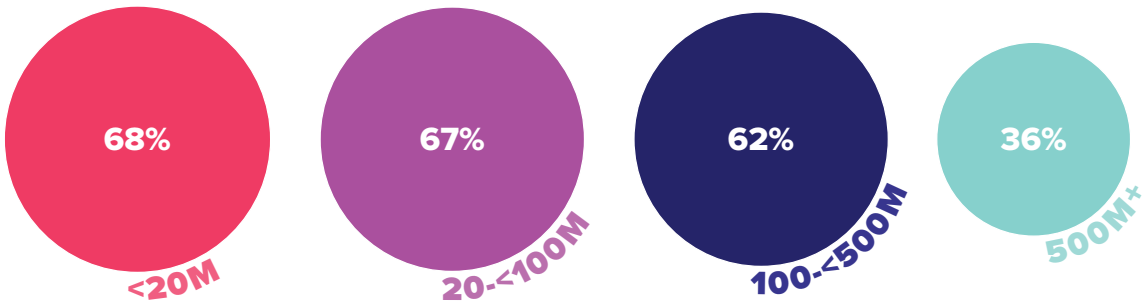
FIGURE 1.9 INITIAL COST FOR IMPROVEMENTS SELECTED AS TOP AUTOMATION AND INDUSTRY 4.0 BARRIER

Please rank your company's top barriers to implementing automation and Industry 4.0 technologies. [Rank top 3]



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Data is a subset of Figure 1.8.

REAL-WORLD EXAMPLE

Reducing the need for brand transfers

Large beer makers need every batch to taste the same, but sometimes they have a high-quality product that is off spec. They may do a brand transfer, selling it at a lower price.

Digital technologies help eliminate this waste. They improve all stages of a batch process like beer fermentation, including exact control of the amounts of ingredients added, the temperature and the time needed to make the perfect beer.

The result? Better quality control means fewer wasted batches. And improved management of the supply chain means less inventory because, when an order comes in, the manufacturer is confident they can fill it rather than having to pull from a backup buffer of lower quality beer.

SMART PARTNER SELECTION IMPROVES THE ODDS AS WELL

In general, it seems that food and beverage manufacturers take a varied approach to partner selection (Figure 1.10). Our analysis is that consultants would advise on a plan, which others would take to the next step to implement. System integrators and engineering firms may be able to both plan and implement, so it may be wise for companies strapped for resources and time to consider this option. Electrical contractors typically do not have the capabilities to implement digital technologies. Installing systems to transmit data and manufacturing controls is quite different from electrical wiring and infrastructure.

A complete solution involves finding a partner to help develop the overall philosophy, identify your needs and plan for automation and digitalization. They can work with appropriate technology vendors, then together deliver the ideal situation. While this can sound more expensive, overall, such a partner has more intimate knowledge throughout the project, including your end goals, which eliminates misunderstandings at handoffs or rehashing of information to add clarity to an incoming team.

FIGURE 1.10. PREFERRED PARTNERS FOR IMPLEMENTATION OF AUTOMATION AND INDUSTRY 4.0 (BY REVENUE)

Who would you prefer to develop and implement automation and Industry 4.0 technologies? [Multi-select]

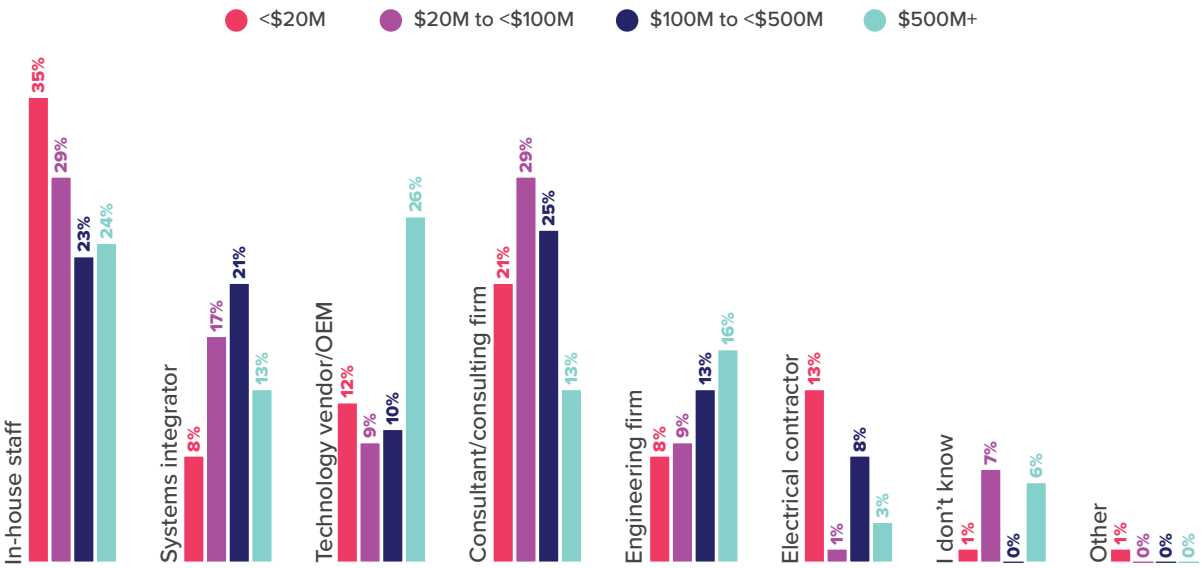

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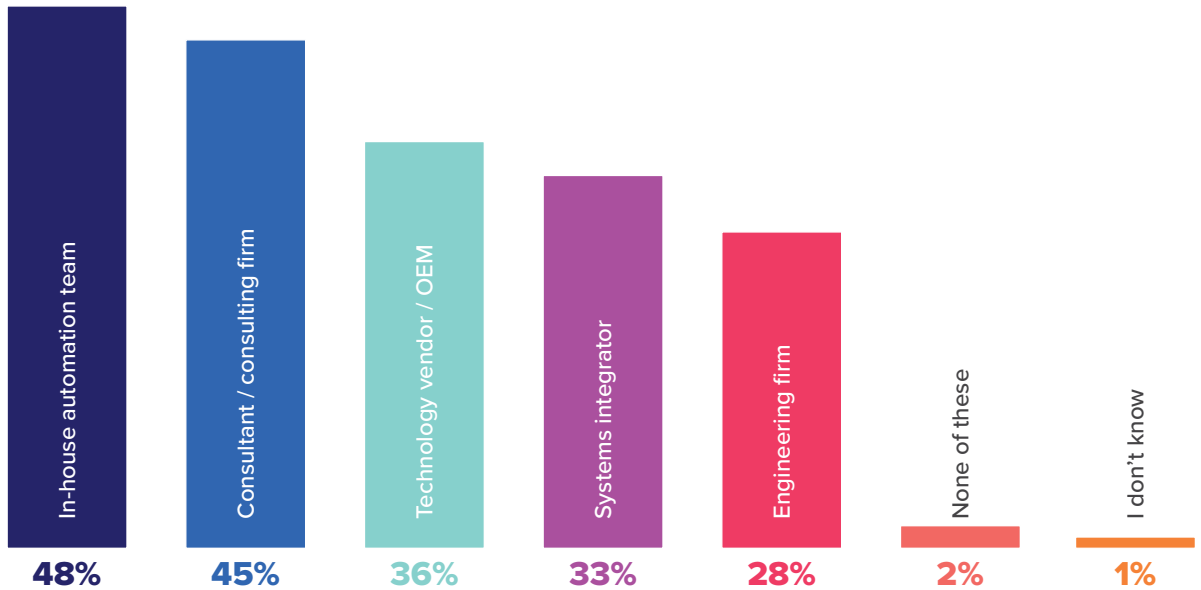
FIGURE 1.11. PREFERRED PARTNERS FOR IMPLEMENTATION OF AUTOMATION AND INDUSTRY 4.0

Who would you prefer to develop and implement automation and Industry 4.0 technologies? [Multi-select]



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The journey to the facility of the future

The future of food and beverage manufacturing is bright. Companies are aware of the ongoing digital transformation and are looking for innovative, cutting-edge technologies. But the transformation risks falling short unless the industry can see the full range of benefits and find the right partners for implementation. There are challenges to arriving at the destination—there always will be—but a future of automation and fully digitalized facilities is within reach.

Know before you grow:

How data-driven insights are helping manufacturers improve and expand operations

By Jerry Steenhoek, Pablo Coronel, PhD and Riju Saini, PhD



Section 2

The future of food and beverage manufacturing looks bright—but to step into that light, manufacturers must first navigate the push-and-pull of increased uncertainty and risk on one side, and the emergence of powerful new digital technologies on the other.

To understand how these dynamics are shaping the decisions made in today's food and beverage boardrooms as well as the day-to-day processes underway on the manufacturing floor, we asked our 300+ survey respondents to tell us about their operational challenges, the strategies they're pursuing to address those challenges and emerging opportunities which could make a meaningful difference to their bottom line.

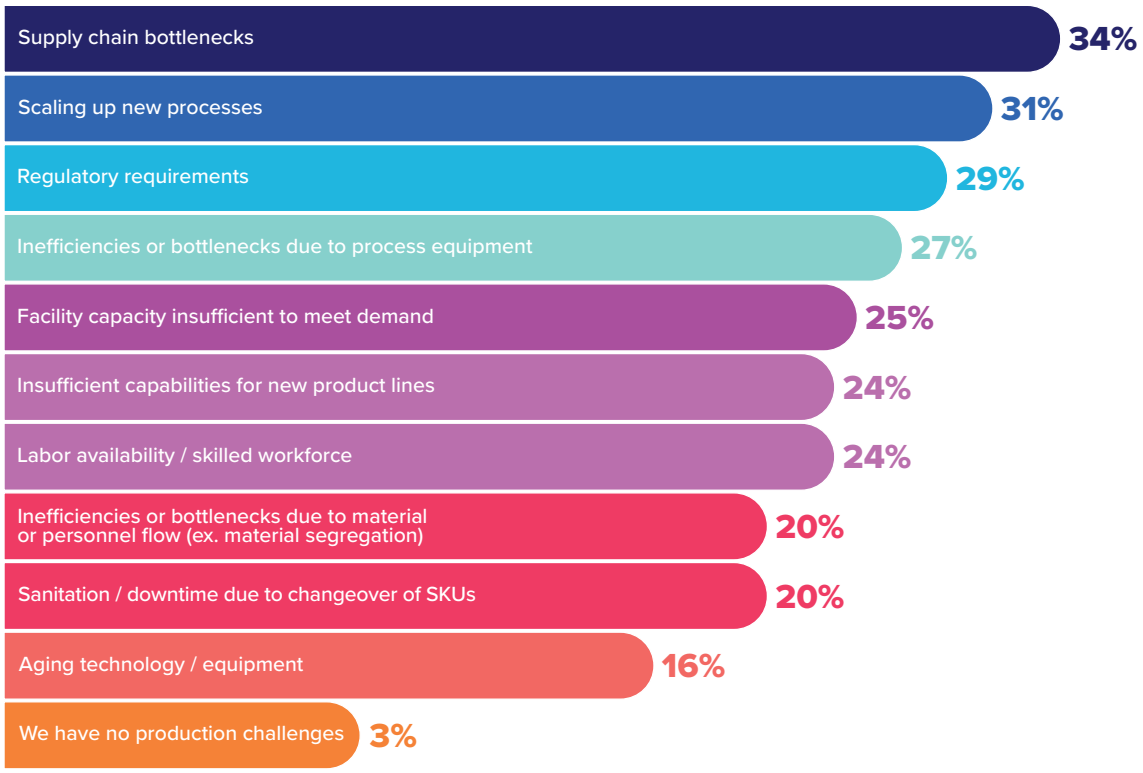
TOP CHALLENGES SUGGEST A LACK OF VISIBILITY INTO OPERATIONS

Manufacturers are struggling to resolve bottlenecks and align capacity with scale-up needs.

When survey respondents were invited to identify the production issues currently on their radar, the stand-out result was that nothing stood out—across the board, manufacturers appear to feel the weight of each challenge equally, give or take a few percentage points (Figure 2.1).

FIGURE 2.1. TOP PRODUCTION CHALLENGES

What are your company's top production challenges? [Multi-select]



Source: CRB

Curiously, supply chain bottlenecks rank as the number one challenge. The global supply of raw materials has, in many ways, stabilized following its turbulent pandemic years. It's possible that survey respondents are reacting to a transient problem, or perhaps they're thinking more broadly of supply issues: not necessarily access to raw materials, but the overall complexity of managing a growing list of SKUs and the variable inventory that comes with them.

A notable proportion of survey respondents (29%) also see regulatory requirements as a challenge. In our experience, this is a consistent theme across the industry as manufacturers devote significant time and resources to keeping pace with ever-changing regulations.

Many of the remaining challenges identified by a quarter of respondents or more share a common cause: a lack of visibility into the processes on which manufacturers rely. Bottlenecked equipment (27%), insufficient capabilities (24%), a misalignment between demand and capacity (25%)—these are issues that arise when manufacturers don't have the insights they need to right-size their processes and make appropriate spending and resourcing decisions at the appropriate time.

If the root problem is a lack of visibility, what's the solution? From what survey respondents told us about their future implementation plans, most believe that digital technologies are part of the answer, with instrumentation and automation near the forefront of their operational improvement plans.

REAL-WORLD EXAMPLE

How production data helped a commercial kitchen increase throughput by 30%—with no CapEx investment.

Using a wide range of robust historical production data, this specialty food manufacturer worked with our team to develop a better understanding of their current-state constraints and bottlenecks.

With this understanding as our basis, we ran dynamic simulations to test potential improvement opportunities, ultimately leading us to several recommendations:

- Engineering changes to decouple lines
- Adding hold tanks to minimize the blocking/starving phenomenon
- Adjusting the production schedule
- Reducing downtime duration for certain codes

This debottlenecking approach, which relied on greater visibility into operational data as the pathway to improved efficiency, generated meaningful results:

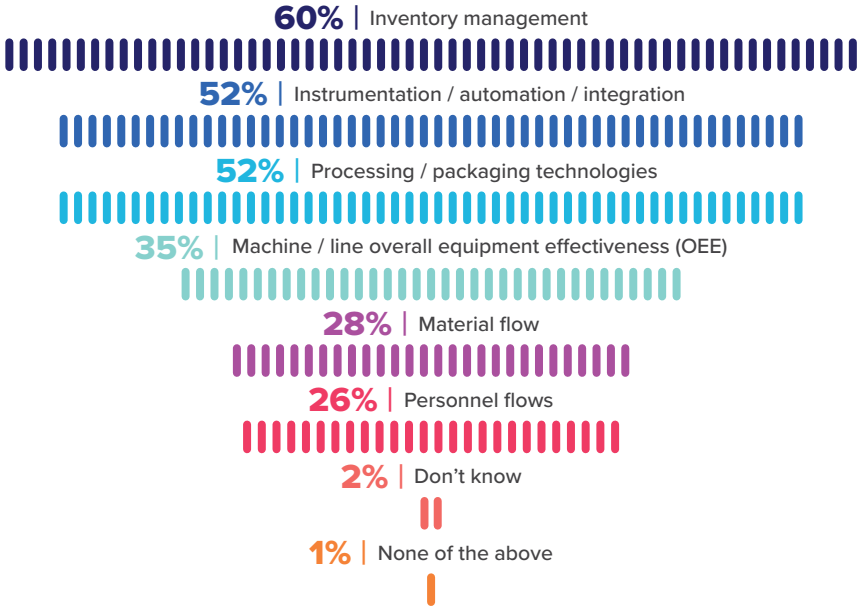
- **A 20% increase in kitchen utilization**
- **A 30% increase in weekly throughput**

More than half of manufacturers are turning to instrumentation and automation.

Access to good-quality production data and a pathway for turning that data into actional insights—that's the formula needed to address many of the challenges identified in Figure 2.1. Manufacturers agree, with more than half planning to invest in instrumentation, which enables accurate data collection, as well as automation and integration, putting that data to work on the plant floor with responsive, real-time process adjustments and other proactive capabilities (Figure 2.2).

FIGURE 2.2. OPERATIONS: IMPLEMENTING/IMPROVING

Which of the following areas of operation does your company plan to implement or improve in the next three years, if any? [Multi-select]



Source: CRB

It's notable that instrumentation and automation are equally as important as new processing and packaging technologies, according to survey respondents. Typically, these two capital initiatives are driven by different business cases. Automation, put simply, is often about reducing operational costs and managing complexity; packaging expansions, on the other hand, typically address business growth (as in the case, for example, of a potato chip manufacturer adding packaging equipment capable of handling 1 oz bags to access the convenience store market). The parity we see between them in these survey results is a sign that manufacturers are taking the digital age of food production seriously; they're giving digitalization projects the same weight and level of priority as more traditional capital projects.

Both instrumentation and packaging initiatives, popular as they are, fall short of the number one optimization strategy identified by survey respondents: inventory management. It surprised us to see that 60% of respondents are investing in this area. Perhaps inventory-related pain is a phenomenon felt across entire organizations, whose experience of the pandemic has urged them to invest in new systems and strategies that will mitigate against future supply chain risks in the event of another catastrophe. Better to modernize and expand current warehousing capacity today, for example, than risk another standstill if tomorrow's transportation networks fail or a supplier fails to deliver.

> ***Area of opportunity:***
>
> *When it comes to personnel and material flow, banish the words "we'll figure it out later."*

Manufacturers are about half as likely to invest in improving material or personnel flows as they are in instrumentation and automation projects, which may be a missed opportunity for many—especially those who identified capacity shortfalls and bottlenecked processes as their top challenges in Figure 2.1.

Every time materials move to a new process step or an operator travels from one area of the facility to another, there's the potential for maximized efficiency—or for lost time spent on non-value-added movement, which can add up to a significant loss of productivity. To put yourself in the former category, the first element you need is a deep understanding of your current (or prospective) flow strategies.

This understanding is not always readily available. When working to optimize a new or existing system, the larger, and most influential variables are often first to come into focus: How big is our utility system? How much equipment do we need? But failing to think through the granular details of a process could cost you significantly. How many totes, carboys and other containers are required per process step? How does your team move containers of raw ingredients from the warehouse floor to the mezzanine? What's the travel distance between your production line and the quality testing lab?

Companies with an existing site can improve these material handling and delivery (MH&D) dynamics throughout their facility by studying historical data and applying digital tools to optimize their scheduling strategy, their material pathways and other key variables. In our experience, it's not uncommon for these optimization exercises to result in millions of dollars saved through double-digit increases in productivity—more on that in the following section.

Companies planning a greenfield project have the potential to build these optimizations directly into their layout, ensuring that the cycle times associated with their material and personnel flows are optimal via well-planned staging areas, conveyor systems, functional adjacencies and more. The key is to think proactively about these strategies, and to rely on data—your own, or hypothetical data generated by expert consultants—to understand their impact before you begin.

KEY TAKEAWAY

Manufacturers are facing an array of equally important production challenges—challenges which are exacerbated by a lack of visibility into process data, which is preventing manufacturers from understanding the root causes of chronic bottlenecks and other production inefficiencies.

Instrumentation, automation and integration are important solutions. Instrumentation enables data collection, while automation uses that data as a vehicle for real-time process improvements. Today's manufacturers, recognizing these advantages, are giving automation projects as much weight as traditional revenue-generating initiatives.

REAL-WORLD EXAMPLE

Food manufacturer's cycle times drop by 50% after material handling optimization study.

Constrained by an uncertain labor market and under pressure to reduce their operating and MH&D costs, this manufacturer of liquid and powder nutritional products engaged our consulting team to identify improvement opportunities.

We started by defining their current system interactions and strategies. Using a dynamic simulation model, we tested the impact of specific operational improvements on their material handling capabilities and overall labor efficiency. Using data from these studies, we proposed an optimized conveyor system and an automated dumping operation designed to:

- Reduce their MH&D cycle time by more than 50%
- Reduce headcount by 40%
- Improve ergonomic and safety aspects of the MH&D process

As a result of these improvements, this client was able to save more than $3.8M annually in operating costs.

DIGITAL MANUFACTURING AS THE PATH FORWARD

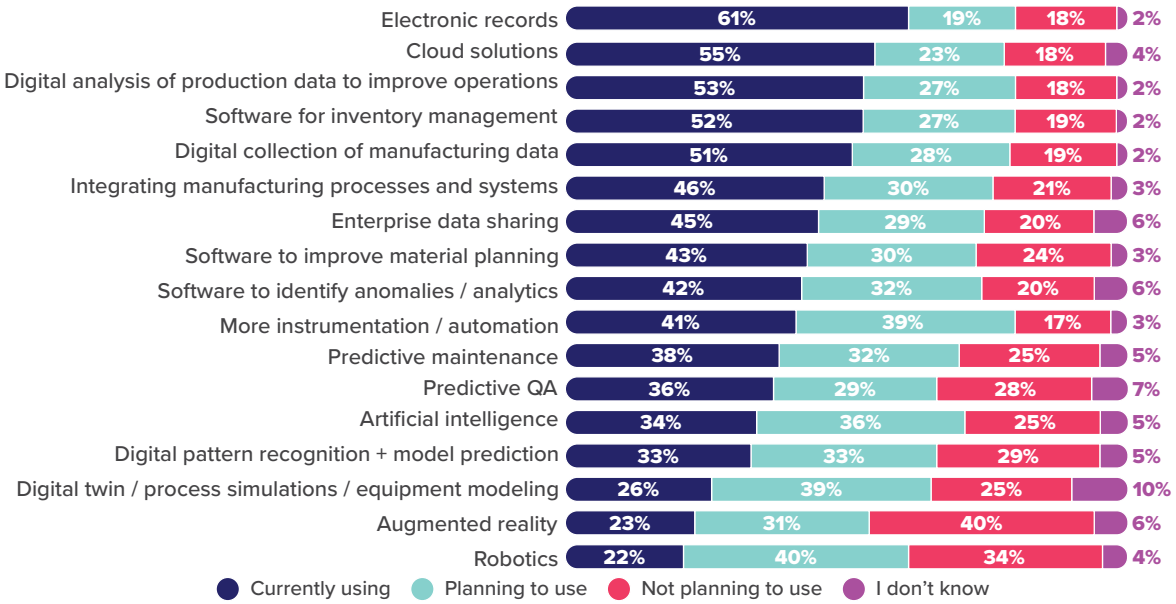
Manufacturers show keen interest in digital systems aimed at generating knowledge, solving production issues.

We've just examined the potential to increase productivity by identifying and eliminating non-value-added personnel and material movements. But how does that identification happen, and how can manufacturers determine if potential solutions will pay off? Process simulation and digital twins are the answer. Process simulation is the art and science of understanding your process more deeply by duplicating it in a computational environment called a digital twin, then running scenarios to test potential solutions without staking real-world resources on the outcome.

The potential for this technology to dramatically impact not only how efficiently your personnel and materials flow, but virtually any variable that's suitable for optimization—utility usage, staffing strategy, production scheduling—makes it an especially powerful tool in this digital age. Our survey respondents appear to agree. When we asked about digital manufacturing strategies, 65% reported using or planning to use digital twin technology, process simulations and equipment modeling (Figure 2.3). Though they're powerful, it's worth approaching these tools with a note of caution. They can deliver significant ROI, but only when applied to the right situations with the necessary skills in place—and given the discrepancy between those planning to implement digital twin technologies (65%) and those who say they're familiar with the concept (45%), there's room here for error. Manufacturers would be wise to consult with experts on how best to deploy these technologies so that maximum value can be extracted from them.

FIGURE 2.3. DIGITAL MANUFACTURING STRATEGIES

Which of the following digital manufacturing strategies is your company currently using or planning to use?



Source: CRB

REAL-WORLD EXAMPLE

A spotlight on how process simulations reveal pathways to greater production capacity.

Discrete event simulations (DES) account for variability within a process, giving our consulting team the opportunity to accurately model future operations based on current data. This is a useful tool for food manufacturers coping with supply chain turbulence, staffing issues or marketplace uncertainty.

Other manufacturing industries value it for the same reasons, and that's the case here: to help a vaccine manufacturer increase their throughput by revising their layout, we developed a model of their current operation, ran a DES exercise and identified high-impact solutions to help them meet their capacity needs.

Chief among these solutions is a new floor layout that supports the equipment necessary to meet future demand and reduces this client's total material movement by about 20%. The result is an increased production capacity of 65%—without the need for additional footprint.

Like process simulations, most of the digital manufacturing technologies in Figure 2.3 are about deepening manufacturers' understanding of their processes and the factors that impact productivity, quality and speed-to-market.

Look at the surge of popularity behind enterprise data sharing, for example: 45% of respondents are currently taking advantage of this strategy, and another 29% plan to implement it. The idea is that by integrating manufacturing execution systems (MES) with higher-order business planning (via enterprise resource planning, or ERP systems), managers can understand and analyze plant operations, clients and customers can check the execution status of their products and company leaders can align business decisions with current and future plant capacities.

For the nearly 20% of survey respondents who are not planning to take advantage of enterprise data sharing, consider a hypothetical scenario in a facility that operates its manufacturing and business units as siloed entities. In response to consumer demand, the business makes plans to launch a new high-protein cereal bar and establishes an ambitious delivery timeline. This puts sudden downward pressure on the company's manufacturing layer. The R&D team rapidly develops a recipe and begins scaling it to commercial volume. How long should they proof the product? How much water should they add? How long should the product bake, and at what

temperature? In a race to meet the schedule established in the boardroom, the team can't calculate optimal answers to these questions before delivering their product, leading to quality issues and a suboptimal yield.

Now consider the same scenario in a company with two-way visibility between its business and manufacturing layers, facilitated by integrated MES and ERP systems. Plans for a new product launch emerge from joint consultation and input across the organization, with timelines indexed to realistic production capacities and a digitally driven system in place to monitor and adjust production variables in real time, ensuring optimal yield and quality from batch one through batch one hundred.

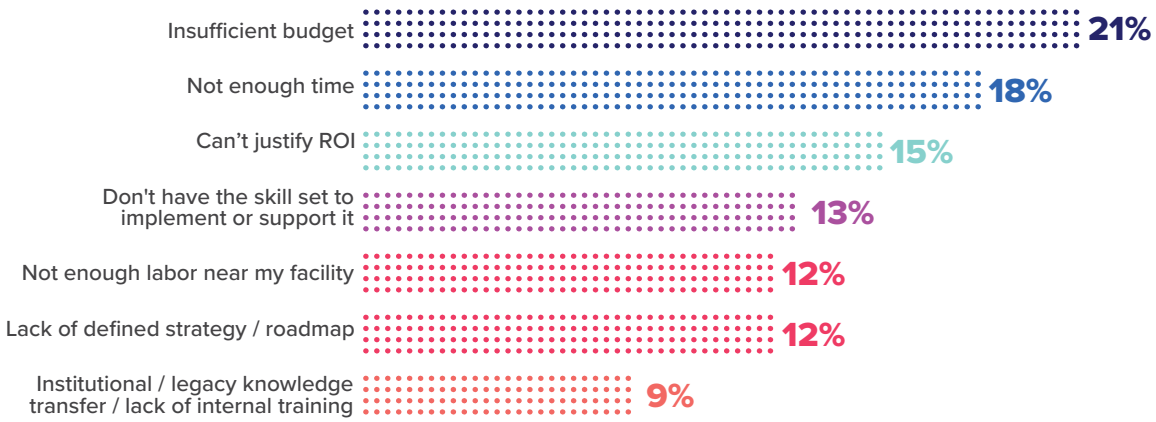
That's the difference that enterprise-level system integration can have—more visibility, which translates to a greater opportunity for optimization and data-driven success.

> ***Budget and time constraints stand in the way—but potential solutions are imminent.***

While it's clear from Figure 2.3 that manufacturers see digital transformation as the key to understanding and streamlining their manufacturing operation, getting to that point of transformation is proving difficult for some. Insufficient budgets stand in the way of addressing manufacturing challenges, with time and talent constraints contributing to the issue (Figure 2.4). Our survey respondents also point to ambivalence around ROI—how do you justify investing in solutions that don't have a clear pathway to payback?

FIGURE 2.4. CHALLENGES — WHAT'S PREVENTING A SOLUTION?

What is preventing your company from addressing [your manufacturing] challenges? [Top rank]



Source: CRB

The industry appears to be at a tipping point, still daunted by these barriers but quickly gathering momentum for a step-change in the way food and beverages are made. Advances in the digital technologies aimed at commercial food and beverage manufactures are helping to stoke that momentum and get manufacturers over these budgetary and skills-related speed bumps.

Consider that 40% of respondents plan to implement robotics in their plants (Figure 2.3). This technology has advanced dramatically over recent years, making it more accessible even for manufacturers without specialized skills. For example, operating a multi-axis robot once required complex engineering to coordinate all the axes and motion components (or instructions). Today, this technology has advanced to the point where manufacturers can simply tell a robot where it needs to go, and its embedded code will run the necessary calculations.

For the 13% of survey respondents who feel they don't have the in-house skillset to optimize their processes, this is good news. And there's more: along with these advances in usability, the cost for implementing robotic systems and other technologies has dropped, making them more accessible to manufacturers concerned about budget.

In addition to the falling costs and growing accessibility of digitally driven optimization tools and strategies, there's another factor working in favor of manufacturers as they tackle these barriers to improvement: the potential for third-party partnership.

KEY TAKEAWAY

Food and beverage companies are embracing digital manufacturing strategies in large numbers, likely with the idea of developing a deeper, more pragmatic understanding of their processes and the potential rewards of future improvement strategies. Process simulations are an area of keen interest, and so is enterprise-level data sharing—two strategies that unlock the potential for dramatic increases in productivity.

To get there, though, manufacturers need to overcome constraints on their budget, their time and the skills they have available in-house. Third-party partnership is part of the solution. The right experts can plug key knowledge gaps and help manufacturers calculate realistic ROI on their digital investments.

THE KEY TO PROGRESS? PARTNERSHIP.

Manufacturers build hybrid internal/external teams to solve manufacturing challenges.

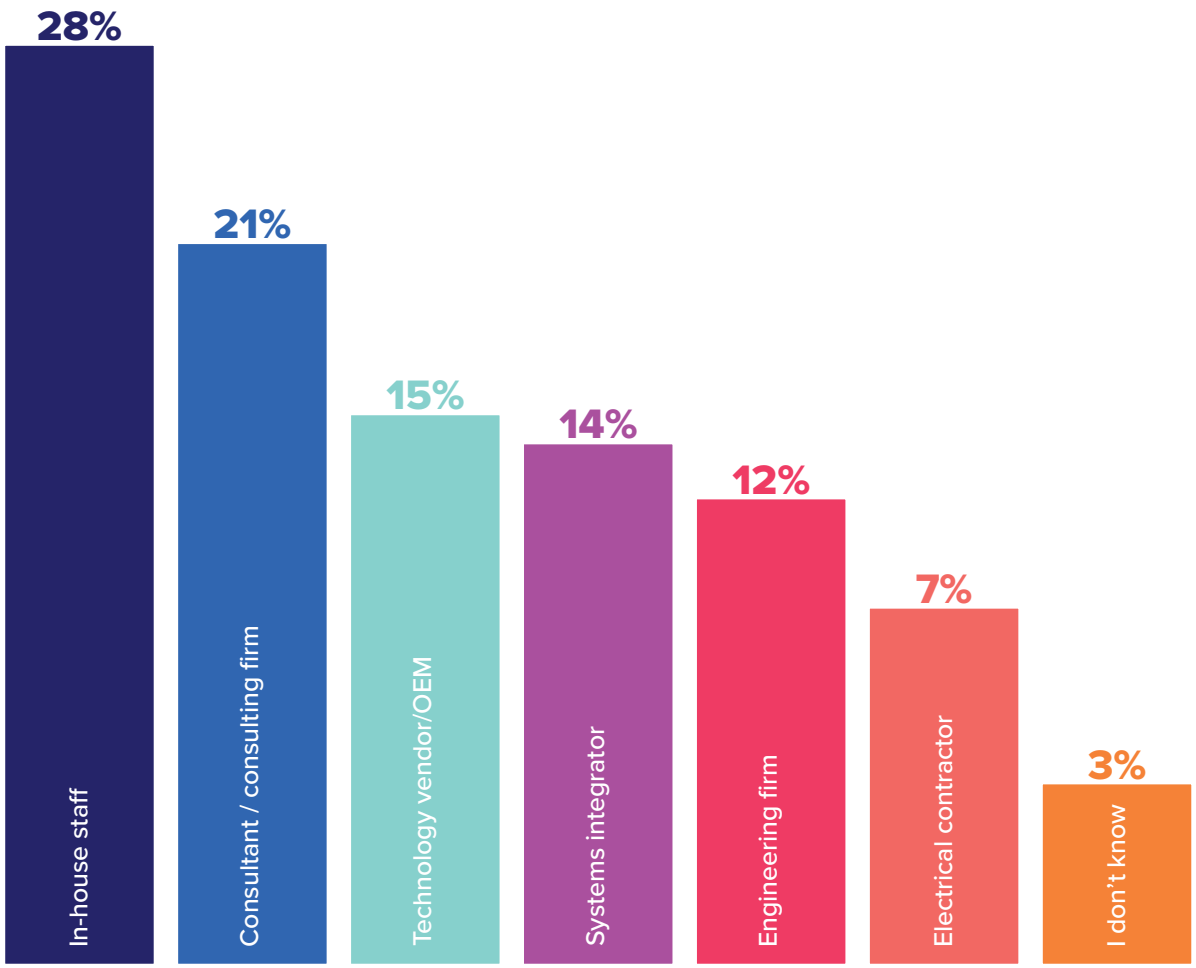
We acknowledge that as a consulting firm for the food and beverage industry, it serves us to advocate for partnership as a pathway to further optimization and

process efficiency. But there is also an empirical argument here in support of partnership: in Figure 2.1, a quarter of respondents point to lack of a skilled workforce as a factor behind their production challenges, highlighting a gap that could be serviced by a third party.

Conducting in-depth operational studies, developing solutions and implementing those solutions takes specialized skills—skills that reach beyond the science and safety of food and beverage manufacturing to encompass digitalization and its rapidly expanding possibilities. In our experience, underestimating the scope of these requirements is often a reason that optimization projects stall in their early phases. For that reason, we are concerned to see that more than a quarter of survey respondents plan to solve their manufacturing challenges using only internal staff (Figure 2.5). This ratio climbs to 35% for the smallest companies we surveyed (Figure 2.6).

FIGURE 2.5. PREFERRED PARTNERS (OVERALL)

Who is your company's preferred partner in helping solve your manufacturing challenges?



Source: CRB

FIGURE 2.6. PREFERRED PARTNERS (BY REVENUE)

Who is your company's preferred partner in helping solve your manufacturing challenges?

Source: CRB

Arguably, these smaller companies likely have the greatest need for expert guidance, given the probable lack of internal engineering and implementation teams. Some appear to know this—21% of small companies prefer to partner with a consulting firm, on par with the overall average. But an interesting schism appears in another category: while only 7% of overall survey respondents say they're seeking help from electrical contractors to solve their manufacturing challenges, that number nearly doubles for small companies.

It's a curious statistic. Partnership is a key part of improvement, but it must be the right partnership—and a partner who can study your overall operation, finding opportunities to increase yield by automating quality checks—or to eliminate downtime with a few strategic adjustments to a production schedule—could make all the difference.

KEY TAKEAWAY

Most manufacturers recognize partnership as the key to leveraging their manufacturing data, identifying problem areas and developing tailored solutions as part of their overall roadmap toward digitalization.

Data is knowledge. Knowledge is the door to operational improvement.

There's a lot of talk about digital transformation in the food and beverage industry, but too little talk about how, exactly, digital technologies impact the business, the process and the day-to-day experience of making food. With this survey, we've attempted to get behind the buzzwords and look at exactly what challenges manufacturers are facing today, and how digital technologies can help them address those challenges and measurably improve their operational efficiency.

The consensus: technologies which enable a better understanding of manufacturing processes and their relationship to business success—technologies like instrumentation and automation, process simulations, and ERP/MES integrations—are mission-critical. To implement those technologies, many manufacturers are looking to the experts, whether that means developing their in-house capabilities or bridging those gaps with the specialized knowledge of outside consultants.

These initiatives bring us to the verge of a significant leap forward for the food and beverage industry—a leap that will help companies grow and thrive in an uncertain and rapidly changing marketplace.

ESG implementation:

Where we are, where we're going and solutions to fuel the journey

By Aaron Kilstofte, Maya Dehart and Renee Benson



Section 3

When we refer to the food and beverage industry, our frame of reference is immense. A European chocolate manufacturer. A mycelium producer in South Carolina. A Wisconsin dairy operation. Each has their own challenges, history and business case. Increasingly, though, there's one thing that unites them all: a mission to reduce environmental harm and to protect the workers, partners and consumers who count on this industry to meet their needs and fill their pantry shelves.

This shared vision for a safe and responsible food manufacturing industry falls under the auspices of an Environmental, Social, and Governance (ESG) policy. Examining the industry's current "ESG mindset" gives us a strong indication of how food and beverage manufacturers will perform in the future, both in business terms and from an environmental and social stewardship perspective.

With that goal in mind, our 2024 global survey of more than 300 food and beverage manufacturers offers several reasons to feel optimistic:

- 83% have an ESG policy in place.
- Over 50% have grounded their ESG policies in concrete KPIs.
- 75% are leveraging tax credits to enable ESG implementation.
- Manufacturers are adopting a variety of sophisticated strategies to address Scope 3 emissions.
- More than half anticipate achieving carbon-neutral or net-zero manufacturing in fewer than five years.

Alongside these achievements, however, runs a current of untapped opportunity. By recognizing the work still to do and the technologies and strategies available to do it, today's food and beverage manufacturers can make an even greater impact tomorrow—not just in the marketplace, but in the global fight to slow climate change, improve lives and build resilience against a rapidly changing planet.

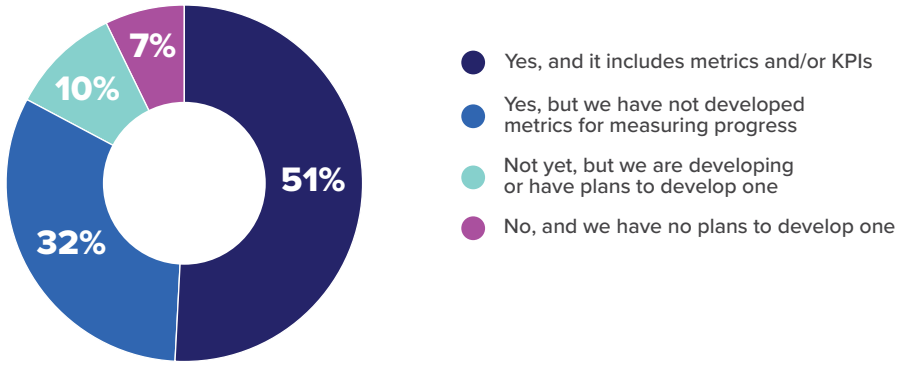
OPPORTUNITIES TO DO MORE, STRENGTHEN BUSINESS CASE STILL ON THE TABLE

Not everyone is on board with ESG policy—yet.

With so many concrete plans in place, why do nearly 10% of respondents have no plans to implement an ESG policy (Figure 3.1), while a similar proportion have no action plan in place to address their Scope 3 emissions—that is, indirect emissions generated upstream or downstream of the manufacturing plant's own operations (Figure 3.2)?

FIGURE 3.1. FORMALIZED ESG POLICY

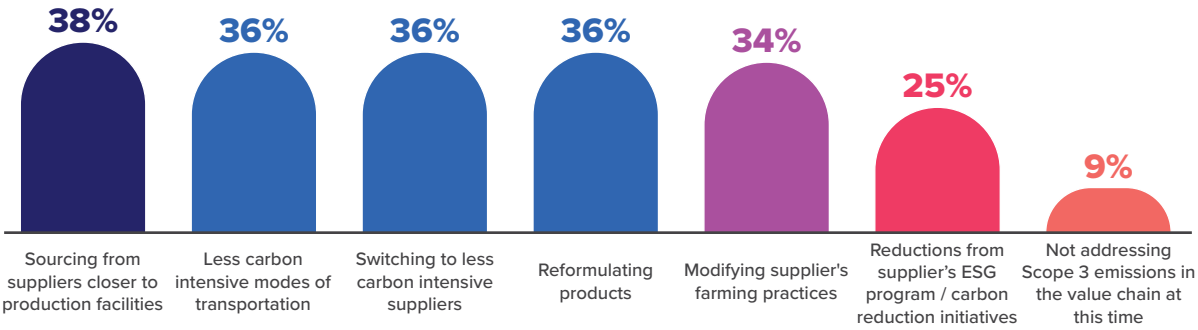
Does your company have a formalized ESG policy?



Source: CRB

FIGURE 3.2. SCOPE 3 EMISSIONS

Which of the following strategies, if any, is your company using to address Scope 3 emissions in your value chain? [Multi-select]



Source: CRB

What will it take for this small but significant minority of manufacturers to join the movement toward a more sustainable, equitable and well-governed food and beverage industry? The data reveals a simple answer to this question: time and revenue.

Of all survey respondents who say they have no plans to develop an ESG policy, nearly 80% have products that are pre-commercial or have only just entered the commercial market, with limited distribution (Figure 3.3). As we move along that curve toward commercial maturity, the likelihood of finding a formal ESG policy grows. This suggests that the shift from ambivalence to adoption is tied to a company's balance sheet. In other words, it takes cashflow to fund ESG initiatives, which in turn requires robust commercial sales.

FIGURE 3.3. COMMERCIAL PHASE VS. ESG POLICY

Does your company have a formalized ESG policy?

In which phase(s) of development does your company currently have product(s)?

	Does your company have a formalized Environmental, Social, and Governance (ESG) policy?				
In which phase(s) of development does your company currently have product(s)? Please enter the percentage (%) of your products that are in each phase. It is okay to estimate if you are not sure.	All	Yes, and it includes metrics and or KPIs	Yes, but we have not developed metrics for measuring progress	Not yet, but we are developing or have plans to develop one	No, and we have no plans to develop one
No commercial sales. Concept/consumer testing/pilot/scale-up:	**23**	**18**	**28**	**18**	**33**
Commercial sales. Regional distribution/test markets:	**31**	**27**	**31**	**35**	**45**
Commercial sales. National distribution:	**36**	**41**	**33**	**37**	**20**
Commercial sales. Global distribution:	**10**	**14**	**8**	**10**	**2**

Source: CRB

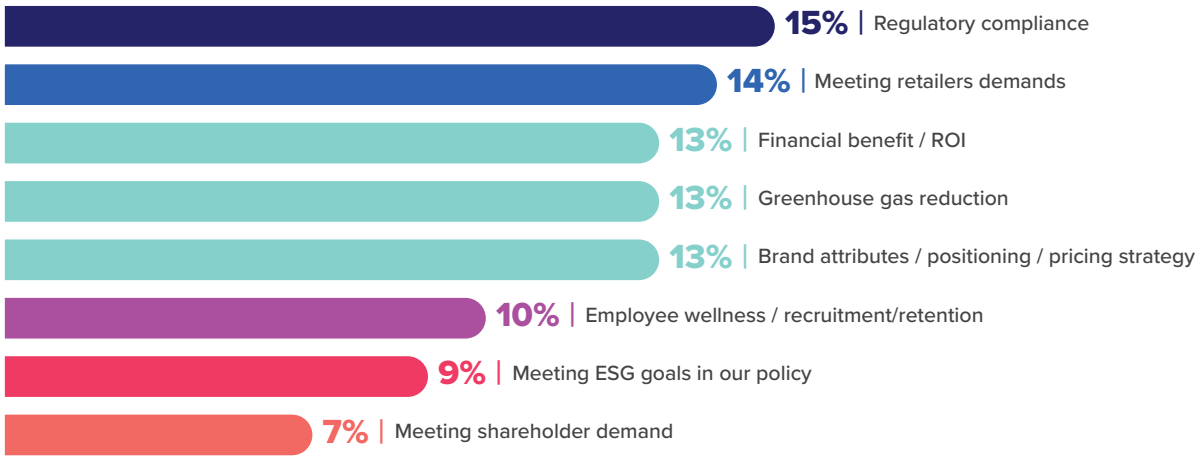
Urgency around ESG implementation comes from external sources.

Even while facing concerns about upfront capital costs, early-phase companies can develop a high-level ESG policy and roadmap to make future spending more efficient and targeted. As Figure 3.3 shows, however, many early-phase companies have not yet developed such a policy.

To understand what might be holding them back, we looked more closely at the priorities driving established ESG policies (Figure 3.4). A trend became clear: regulators, retailers and competitors are a strong tailwind, pushing manufacturers toward ESG adoption. Internal drivers, such as shareholder pressure or boardroom policy, offer comparatively little forward momentum.

FIGURE 3.4. ESG PRIORITIES

Rank your company's ESG priorities [Top rank - Select up to 5]:



Source: CRB

For early-phase manufacturers, this could translate to a perceived lack of urgency around ESG-related issues. They're focused on developing their product, scaling their process and delivering the value promised to investors—and if those investors aren't pressuring them for ESG action, why devote limited resources to it?

In fact, there are many good reasons to proactively develop an ESG strategy, even when financial resources are scarce. As young companies move deeper into the commercial space, they'll begin feeling the full force of those external pressures from regulators and retailers. Failing to plan for that eventuality could cost more in the long run as these manufacturers scramble to catch up with expectations via factory retrofits, formulation changes, new labor initiatives and other costly modifications. If planned from the start, these ESG-related strategies can deliver more value sooner, with fewer interruptions along the way.

Tax incentives: Don't leave money on the table!

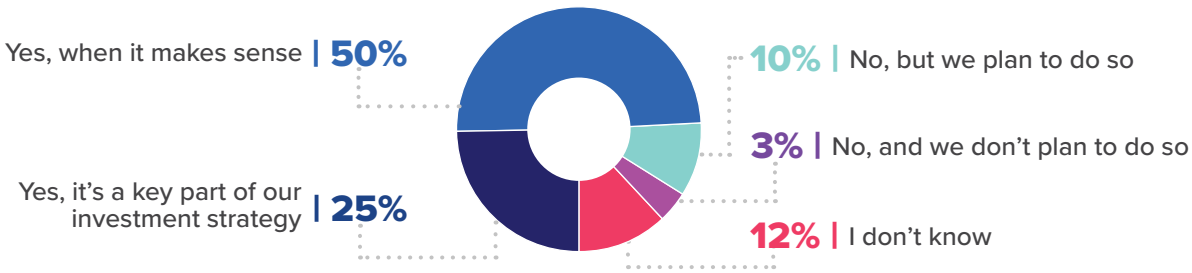
Even for manufacturers with national or global reach, the cost of implementing ESG initiatives can be daunting—which is perhaps why one-third of our survey respondents see their ESG budget as insufficient, given the scope of their goals.

Fortunately, the financial burden of ESG implementation doesn't fall on manufacturers alone, particularly when it comes to addressing climate change. The federal government has allocated billions of dollars to help offset the hard costs of decarbonization, most recently through the 2022 Inflation Reduction Act (IRA). In the

short time since its introduction, the IRA's popularity as a financial vehicle has soared; among our survey respondents, for example, 75% are taking advantage of it and another 10% plan to join that majority (Figure 3.5). These numbers suggest that most food and beverage manufacturers are comfortable leveraging tools like the IRA to help them move toward their ESG objectives.

FIGURE 3.5. TAX CREDITS/REBATES

Is your company taking advantage of tax credits / rebates via Inflation Reduction Act (IRA), investment tax credits?



Source: CRB

Still, 15% of survey respondents are either choosing not to take advantage of the IRA and other tax-related levers or are unaware of these strategies. If you belong in this minority, consider the money you're potentially leaving on the table—money which could help you increase your efficiency, recover wasted resources and position your company to succeed in an economy that increasingly prioritizes responsible, sustainability-driven manufacturing.

A realistic roadmap is the solution to corporate rubber-stamping.

With ESG policies in place and funding coming in from internal and external sources, how close are manufacturers to achieving their carbon-neutral or net-zero goals?

As a benchmark, we looked back at our survey of alternative protein manufacturers, conducted one year ago. At the time, this innovation-driven segment of the food and beverage industry showed ambition: 48% of alternative protein manufacturers aimed to meet their goals in fewer than five years, while an impressive 20% were even more optimistic, giving themselves two years or less to get there. Another 20% anticipated needing more than five years to reach carbon neutrality or net-zero.

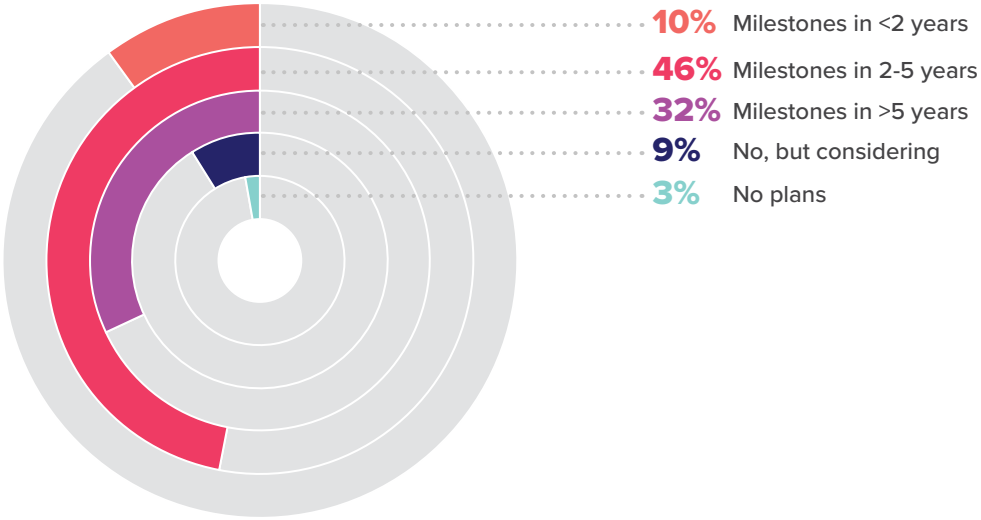
A year later, we broadened our scope to include the whole food and beverage industry (manufacturers with alternative proteins in their pipeline make up about a quarter of respondents in this report). We hoped to see further support for an aggressive offensive against carbon emissions. Instead, we noted movement in the

opposite direction (Figure 3.6). The same proportion of manufacturers are aiming for the 2- to 5-year timeline, and support for the 2-years-or-less timeline has dropped. Manufacturers pursuing the “5+ years” timeline have grown by about the same proportion.

FIGURE 3.6. CARBON-NEUTRAL OR NET-ZERO GOALS TIMEFRAME

2024: THE BROADER FOOD AND BEVERAGE INDUSTRY

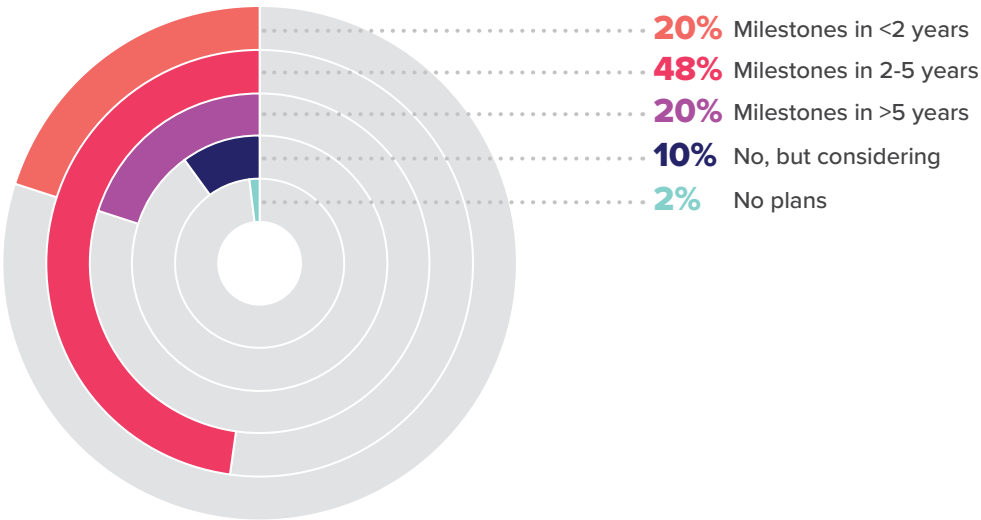
Does your company’s ESG program include carbon-neutral or net-zero goals within the following timeframes?



Source: CRB

2023: SPOTLIGHT ON ALTERNATIVE PROTEIN MANUFACTURERS

Does your company’s sustainability plan include carbon-neutral or net-zero goals within the following timeframes?



Source: CRB

There are several positive reasons that could explain this shift. For example, many manufacturers may have already achieved their near-term objectives and are now focused on longer time horizons.

It's also important to note that the alternative protein manufacturers who answered our survey in 2023 represent a segment of the industry characterized by rapid innovation and unencumbered by aging factories and a legacy of traditional operations. It makes sense for this segment to judge themselves closer to carbon neutrality or net-zero manufacturing than the food and beverage industry overall.

Even when taking this difference between demographics into account, however, these results suggest that the enthusiasm and urgency which drove initial net-zero timeframes may be yielding to a more sober understanding of the steps required to get there. Those who initially rubber-stamped an ambitious timeline may now be realizing that they lack the checks and balances needed to make it a reality.

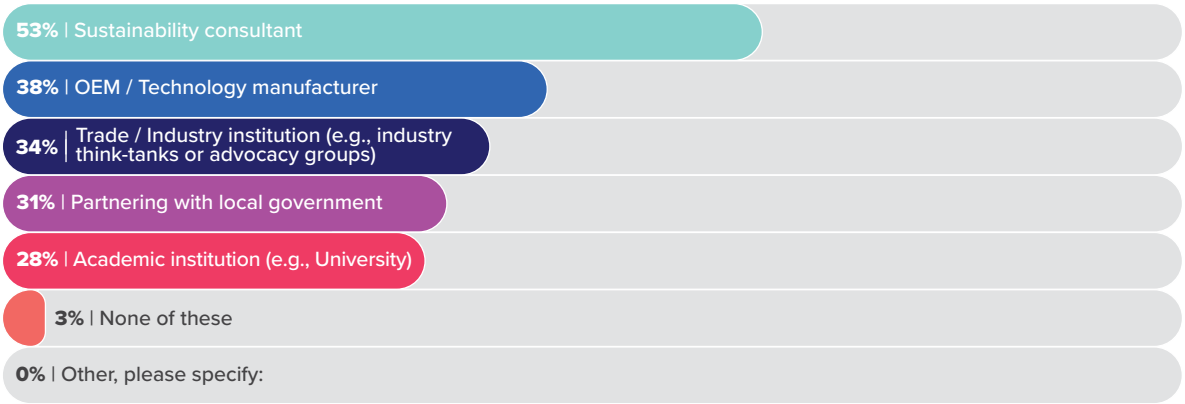
The good news: companies are partnering with experts to reach their goals

So far, the 2024 survey has laid bare several opportunities available to help food and beverage manufacturers navigate their ESG journey: early preparation to meet the pressure of retailers and regulators, a canny approach to partially funding their ESG initiatives via tax incentives and the push for concrete strategies to anchor corporate timelines.

Manufacturers face an enormous task as they endeavor to consolidate these strategies into a workable ESG action plan, but there's good news: they aren't doing it alone. Nearly all survey respondents—97%—have turned to third-party experts for help navigating the ESG pathway (Figure 3.7).

FIGURE 3.7. THIRD-PARTY ESG PARTNERS

Which of the following third-party partners has your company worked with to address ESG-focused challenges within the last 3 years? [Multi-select]



Source: CRB

Most are partnering with sustainability consultants, who offer a deep and experienced perspective on the ESG landscape and the tools and technologies needed to succeed there. Manufacturers are also seeking out the advice of technology vendors and trade groups, showing a sophisticated understanding of the diverse and complex elements that must converge to drive meaningful ESG implementation.

KEY TAKEAWAY

Most food and beverage manufacturers have ESG policies in place, backed by realistic budgets and designed to meet the expectations of regulators, retailers and the consumer marketplace. However, there's still room for improvement—particularly for smaller manufacturers who have yet to establish formal ESG objectives.

The good news: there's help available. Tax-related vehicles like the Inflation Reduction Act (IRA) offer financial incentives, and third-party consultants offer expert guidance to help every company, large or small, map their unique journey toward ESG implementation.

PEOPLE AND PACKAGING DRIVE ESG POLICYMAKING

Companies are implementing pragmatic solutions that are low on both complexity and cost.

From Figure 3.4, we know that manufacturers see regulators, retailers and consumer perception (in terms of brand positioning and pricing) as their top ESG priorities. What strategies are they implementing to meet these priorities?

To find out, we presented survey respondents with sixteen ESG elements ranging in sophistication and area of impact, from simple in-house efficiency initiatives to programs and policies aimed at employee recruitment and network optimization. Survey respondents told us which elements make up their ESG plan—and which are not yet on their radar (Figure 3.8).

FIGURE 3.8. ESG ELEMENTS

Does your company plan to address any of the additional ESG elements?

Source: CRB

The results show a trend toward ESG elements that promises two advantages: ease of implementation and a strong business case. The two most popular ESG elements achieve these advantages via packaging changes and waste reduction—relatively low-hanging opportunities that not only align with responsible stewardship for the planet, but that positively impact the bottom line as well, making them easy to justify in the boardroom.

Also notable is a focus on the people who make food production happen. Here, too, we can intuit how business drivers shape a company's ESG approach. Manufacturers appear to agree that a worker who is treated fairly is an asset and we can see the result in our survey data: more than 40% of respondents spend $26/hour or more for a plant floor operator (including wages, benefits, etc.). The current US living wage is estimated at $25.02/hour for a family of four.[1]

It's encouraging to see these fair labor practices among the most popular ESG elements, with diversity initiatives and equitable hiring policies not far behind. Sustainability initiatives often attract the lion's share of investment and media airtime, but manufacturers are clearly giving serious consideration to the social dimension of ESG initiatives, as well.

Underrepresented vendor programs: an underrated opportunity?

If the easiest and most business-friendly initiatives claim the top spots in this ranking of ESG elements, what sits at the bottom?

1. *Living Wage Calculator. New Data Posted: 2023 Living Wage Calculator. Available at: Living Wage Calculator (https://livingwage.mit.edu/). Accessed March 15, 2024.*

Our survey results are decisive: underrepresented vendor programs trail all other ESG elements by a notable margin (Figure 3.8). Real or perceived barriers can make these initiatives difficult to implement, which may also make them more expensive—in the beginning, at least. But by overlooking the opportunity to invest in underrepresented vendor programs, manufacturers may be forfeiting a business advantage without realizing it, not to mention an opportunity to level-up their ESG performance.

Consider, for example, a manufacturer seeking a soybean supplier. This manufacturer has a program in place to prioritize diverse vendors, which leads them to the door of a local vendor. But there's a problem: the manufacturer requires a specific lab certification that the local vendor lacks, so in the end the manufacturer takes their business to a large producer three states over.

What could have gone differently here? The manufacturer could have helped the local vendor acquire the necessary certifications, or they could have worked with regulators to adapt their requirements and accommodate the vendor's existing certifications. This would have required an investment of time and money, making it a more difficult journey than following the well-trodden road to the large producer, but consider the long-term benefits of investing in partnerships with local vendors:

- **A win against Scope 3 emissions:** In Figure 3.2, we learned that sourcing from suppliers closer to production facilities is the #1 strategy for manufacturers seeking to reduce their Scope 3 emissions. By applying extra effort to the project of working with local, underrepresented vendors, manufacturers can move this needle to a meaningful degree.
- **A strong ESG play:** A more efficient transportation and shipping network is among the most popular ESG elements identified by survey respondents in Figure 3.8. Supporting local and diverse vendors also contributes to stronger community ties, a pillar of the ESG agenda.
- **A more cost-effective and robust supply chain:** Sourcing ingredients that are closer to their manufacturing site reduces the cost, complexity and potential turbulence of a manufacturer's supply chain network. Adding suppliers also makes their overall supply chain more resilient against potential disruptions.

KEY TAKEAWAY

When it comes to ESG implementation, manufacturers show a strong preference for relatively low-cost initiatives which protect business margins by cutting down waste.

For manufacturers looking to extend their impact while continuing to strengthen their business case, consider overlooked initiatives with the potential for high rewards, such as underrepresented vendor programs. Investment in this area could lead to lower emissions, greater supply chain resilience, and stronger local communities.

TO SUPPORT ESG EFFORTS, COMPANIES TURN TO NEW TECHNOLOGIES AND IMPROVED DATA COLLECTION

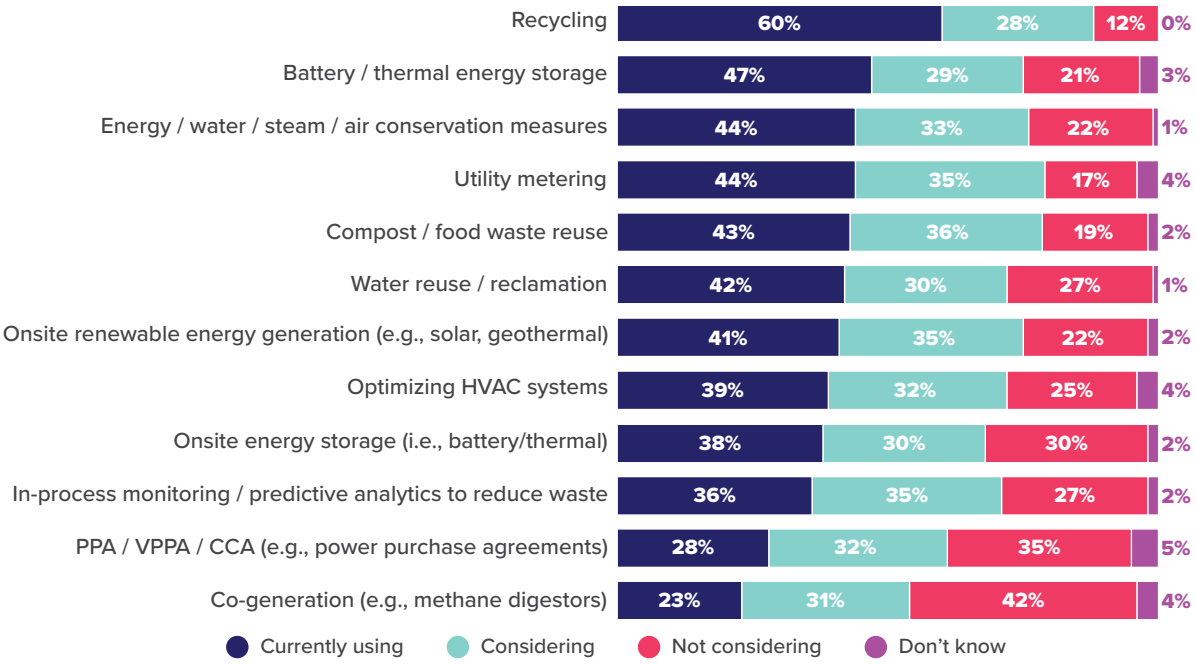
Manufacturers show a notable interest in battery and thermal energy storage technologies.

We've established that today's food and beverage manufacturers are taking ESG initiatives seriously, with funding to support them and clarity around which ESG elements they plan to implement for the benefit of their business, their employees and the planet. But *how* will they implement those elements? Which practical solutions are manufacturers choosing to bridge the gap between boardroom policy and on-the-ground results?

With a focus on reducing energy costs and improving environmental outcomes, we asked survey respondents to help us answer this question by identifying the technologies they've adopted—or plan to adopt—on the road to deeper ESG implementation (Figure 3.9).

FIGURE 3.9. ESG TECHNOLOGIES/INITIATIVES

What technologies/initiatives is your company using or considering using as a means of reducing energy costs and improving environmental impacts?



Source: CRB

This survey question includes an unintended redundancy: respondents could choose both "Battery / Thermal Energy Storage" and "Onsite energy storage (i.e., battery/thermal)." This redundancy notwithstanding, we see a strong indication of support for energy-storing technologies in the survey data, and this indication is the basis of our recommendations in this section.

Consistent with the preference we've seen toward easy-to-implement and relatively low-cost solutions, recycling initiatives top this list. But close behind comes an unexpected technology: battery energy storage (BES) and thermal energy storage (TES) systems.

Demand for solutions that contribute to more efficient buildings and fewer service interruptions may explain why a technology that's relatively new to food and beverage manufacturing is receiving so much attention. From our relationships with original equipment manufacturers (OEMs), we've witnessed a surge in R&D around safe and sustainable energy-storing technologies in response to this demand. Flow batteries, for example, have steadily evolved as a sustainable alternative to conventional batteries, offering manufacturers a pathway to energy storage that uses sustainable materials and abundant, non-toxic metals. As OEMs continue along this development pathway, it's unsurprising that manufacturers are taking note—after all, Figure 3.7 confirms that nearly 40% rely on OEMs to help them address their ESG challenges.

REAL-WORLD EXAMPLE

At a small-scale distillery, TES solves for low square footage, high costs

Manufacturers have long turned to cooling towers as a means of generating chilled water. But for this small-scale distillery, located in a dense industrial park in a Southern region of the US, cooling towers are not practical—there's too little room, and too much heat and humidity for them to perform reliably.

The owner saw an opportunity to implement an industrial ice tank as an alternative. This TES system allows the distillery to produce ice at night, then deploy it as a 'heat sink' to support their production lines during the day. As a result of this sequencing approach, they're able to concentrate their electrical consumption during off-peak hours, when rates drop, while continuously meeting their production targets—no cooling towers needed.

With development underway among OEMs, and with manufacturers turning to those OEMs for guidance, it appears that BES and TES systems are having a moment—a moment which may soon be normal practice, particularly if we look at the life sciences for guidance. In that industry, manufacturers leverage stored-energy technology as the key to several advantages:

- **Lower costs:** Using TES and BES systems, manufacturers can take advantage of off-peak price periods for electricity consumption.
- **Less downtime:** Manufacturers can take advantage of TES and BES systems to reduce the frequency, duration and cost of outages by wasting less energy. If outages occur, stored energy accelerates recovery, bringing critical systems (such as HVAC or the generation of hot and chilled water) back online faster.

- **Greater resilience:** With TES or BES systems providing critical support, manufacturers have better resilience against grid outages.

REAL-WORLD EXAMPLE

From the life science industry, a TES system in action

To help a recent biotech client reduce their fossil fuel consumption, our engineering team proposed using a TES system as an intermediary thermal loop between their chiller plant equipment and their heat pump system.

The TES system takes advantage of time-independent energy recovery to maximize daily simultaneous heat rejection and heat collection load profiles. The result is a highly efficient, self-contained chilled water/heat pump system—an alternative to depending solely on energy-intensive cooling towers and boilers.

With these modifications and innovations, our client had the opportunity to dramatically slash their carbon emissions and lower their operational costs with a less wasteful, more efficient system.

Takeaway for food and beverage manufacturers: Transferring these benefits from the life science industry into the food manufacturing plant is highly achievable, especially given the relatively small footprint and operational simplicity of TES systems.

With an eye to future growth, companies appear to prioritize data automation.

In addition to marking the popularity of energy-storing technologies, the results in Figure 3.9 point to another promising trend: manufacturers are equally invested in technologies designed to conserve resources (energy, water, steam and air) and track utilities.

These priorities suggest that the adage “what gets measured gets managed” still prevails. Manufacturers have bought into it—often literally, by investing in technologies that will take them beyond manual data collection and into the realm of accurate, up-to-date measurements delivered in real time, in a standardized format that’s optimized for in-depth operational and business analysis.

That’s only possible with a digitalization strategy in place, which prioritizes automation and integration as enablers of smarter decision-making and, by extension, better outcomes from both a business and an ESG point of view:

- **Less waste:** When it comes to justifying an investment in automation, the manufacturing industry often focuses on reducing waste and conserving

physical resources. But what about the personnel hours that are wasted on manual operations? When workers are tied to rote tasks which provide little value, their time becomes a silent drain on ROI. Focusing instead on transitioning a workforce to a digitally mature operational model through upskilling initiatives may require more investment, but it stands to pay dividends in the long run. Formal mentorship programs, which feature in the ESG plans for a quarter of survey respondents (Figure 3.8), are a good place to start.

- **More value from third-party partnerships:** Virtually all survey respondents are investing in partnerships with outside experts to help them meet their ESG goals (Figure 3.7). The value they'll get from these partnerships corresponds directly to the quality of data they put into them. With better data comes more accurate predictions, more fit-for-purpose advice, and a greater speed of implementation.
- **The potential for lightning-fast business growth:** Most of our survey respondents (75%) depend on manual data collection for at least half of their data collection protocol. On average, manufacturers in this category targeted a 16% growth rate over the last three years. The other 25% of manufacturers—those whose data collection is mostly or entirely automatic—targeted, on average, a 30% growth rate over the last three years. That's twice the growth over the same period, with digital maturity as a key difference-maker.

KEY TAKEAWAY

The prospect of safer, more resilient and highly efficient food and beverage production has many manufacturers embracing new and emerging technologies.

For inspiration, look to the life science industry, where technologies such as battery energy storage (BES) and thermal energy storage (TES) systems are transforming plant operations and inviting a future of sustainable, cost-effective manufacturing into the present.

A marathon, not a sprint

When it comes to moving from traditional food and beverage manufacturing to a future of environmental stewardship, social responsibility and good governance, our industry is only just crossing the starting line—but all signs point to a strong performance.

Companies are establishing formal ESG policies and fueling them with appropriate budgets, and they're embracing a variety of technologies and initiatives to power them through every mile. To keep this momentum going, the industry needs to draw support from all corners—corporate willpower from the C-suite, financial resources from government initiatives and guidance from experts who specialize in sustainable, future-facing food and beverage manufacturing strategies.

Where these elements converge, success is possible—not just for businesses, but for the people who work in this industry, the products they manufacture and the planet on which we all rely.

Addressing labor force needs

Strategies for attracting and retaining talent to complement digital solutions fuel the journey

By Jim Vortherms and Katie Ireland

Section 4

There is a labor shortage...*right?*

We hear it from our food and beverage manufacturing clients, who work with us to help them build resilience against gaps in their workforce. We read about it every week in reports like this 2023 F&B manufacturing survey by Bristol Associates, which found 89% of hiring managers are struggling to find the workers their companies need.

Yet, 76% of the more than 300 food and beverage manufacturers we surveyed said they don't foresee a staffing problem in the next three years (Figure 4.1). This data surprised us since it implies that, while we know there's a current labor shortage, three-quarters of people expect it will be resolved soon.

FIGURE 4.1. STAFFING SHORTAGES

Do you believe it will be more difficult to staff your company's facilities in the next 3 years?

Source: CRB

WHY THIS DISCREPANCY?

What could be driving this level of confidence, and could manufacturers have blind spots in their labor strategies that might impact future operations? Our survey revealed possible answers.

- **Digital maturity correlates with optimism about a turbulent labor market**

  As we'll see, the number of respondents who believed they won't have difficulty staffing in three years jumped to at least 85% if their company had implemented such digital manufacturing capabilities as AI or IoT (Figure 4.6). It appears that, the deeper manufacturers are in their journey to digital transformation, the more confident they are about avoiding labor disruptions.

- **A reliance on contract manufacturers could be shielding owners from labor shortages—for now**

  Three-quarters of manufacturers are outsourcing all or part of their production to contract manufacturers (Figure 4.2). And 96% of those who use contract manufacturers exclusively don't believe there's an impending staffing problem. This leads us to believe these companies are more focused on marketing and other business needs, as opposed to the nuts-and-bolts of manufacturing. In other words, they may be unaware of labor shortages—current and future—because they've kicked the can down the road and, at least for now, someone else is dealing with the problem.

FIGURE 4.2. USE OF CO-MANUFACTURERS

To what extent does your company use, or plan to use, co-manufacturing strategies?

Do you believe it will be more difficult to staff your company's facilities in the next 3 years?

	Do you believe it will be more difficult to staff your company's facilities in the next 3 years?		
To what extent does your company use, or plan to use, co-manufacturing strategies?	ALL	YES	NO
We are a contract manufacturer.	2%	5%	0%
We use contract manufacturers exclusively for production.	25%	9%	32%
We use both co-manufacturers and have internal manufacturing capacity.	49%	55%	47%
We have used co-manufacturers in the past but have no plans to use them again.	10%	15%	8%
We have not used co-manufacturers in the past, but plan to begin using them.	5%	5%	4%
We have never used co-manufacturers and do not intend to.	9%	11%	9%

Source: CRB

WHAT'S CAUSING CURRENT LABOR SHORTAGES?

In part, today's constrained labor market is due to a wave of Baby Boomer retirements, which is significantly impacting institutional knowledge and reducing the available workforce. Not far behind are Gen Xers, leaving Millennials to fill management and knowledge positions. Another dynamic—by no means insignificant—are the workers who have not returned to the traditional workforce. While food and beverage manufacturing employees have been more likely to return to work after those in service and retail businesses, it's still a problem. There's also been increased pressure on wages as employers have rushed to keep up with inflation and have started competing for talent with retailers and the warehousing sector.

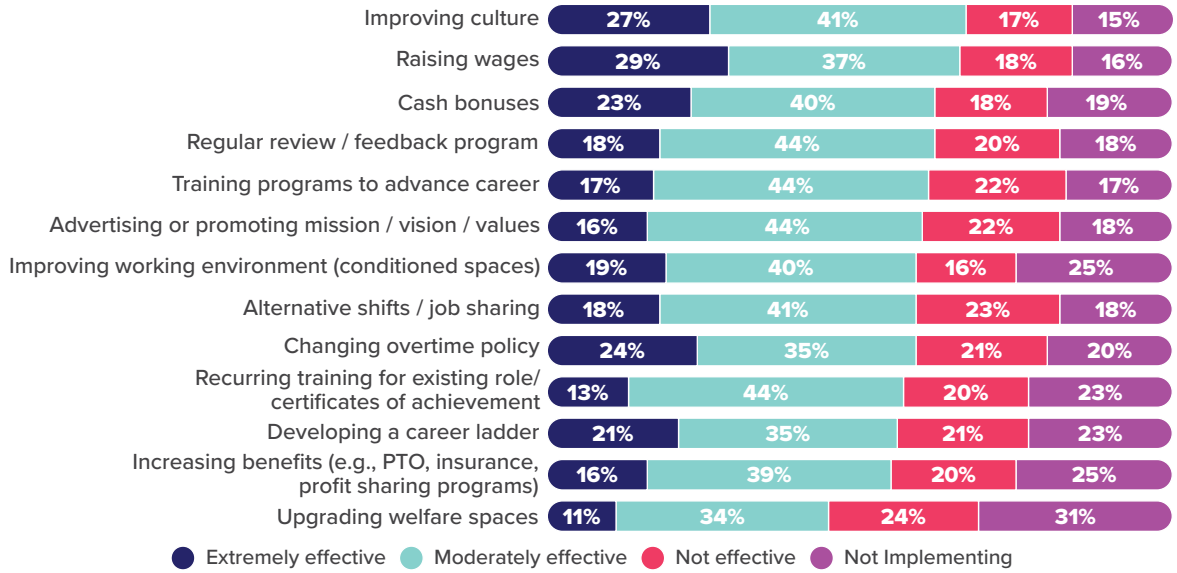
Fortunately, automation and digital manufacturing technologies—tools like IoT, AI, AR, cybersecurity and smart factories—can help manufacturers overcome the challenges of a turbulent labor market. Conventionally, digital transformations and automation have been viewed as solving labor shortages by replacing workers. But there's a lot more to the story than that. It can make companies much more attractive places to work for the generations that grew up in the digital world and are now entering the workforce. Let's look at what our survey said about digital manufacturing as a way to inoculate against labor shortages.

APPROACH 1: DIGITAL MANUFACTURING DRIVES TALENT RETENTION

For manufacturers who already have a talented mix of skilled and trainable workers, the challenge lies in persuading those workers to stay. Our survey respondents appear undaunted by this challenge—more than half of them are finding almost all the methods they're using to encourage staff retention are effective (Figure 4.3).

FIGURE 4.3. RETAINING TOP TALENT

Which of the following is your company implementing to retain talent and how effective is the solution?



Source: CRB

Improving culture

Two-thirds found a culture change to be effective. Depending upon feedback from employee surveys and exit interviews, a change in culture at an organization may be necessary to retain talent. An employee who experiences a positive work environment—nice working conditions, opportunities for growth and advancement, challenging projects and independence to make decisions—is more likely to stay long term. Digitalization and automation provide opportunities for upskilling workers and can replace those in undesirable assignments, like picking materials from freezers, where robots can work. Changing the culture to one of continual improvement, employee empowerment and a growth mindset will improve a sense of belonging and retention. This change needs to start at all levels of the organization, especially with the rapid change of this industrial revolution.

As Millennials move up to higher levels of management, we may see some changes. This cohort, to generalize, is often more willing to switch companies if they don't have an attractive value proposition at their current place of work, so it's important to provide a strong culture. They also tend to be faster to adapt to new technology, having grown up with it, so it may make this digital culture easier to implement.

KEY TAKEAWAY

The assembly line model is dead.

Workers aren't happy with the same job day in, day out. Moving into a new era of digital maturity isn't just about implementing technology. It's also about leading transformational change from within a company's culture—an initiative which is difficult, but that pays dividends when it keeps employees engaged.

Raising wages

Increasing pay scales is a top factor in retaining talent, effective for 65% of companies. But it's extremely difficult for manufacturers to do without employing productivity gains. Fortunately, implementing digital technologies is one way to achieve both.

- **Cost of labor:** The average cost of labor for most plant floor operators is less than $35/hour (84%) with 56% falling below $25/hour (Figure 4.4). Automation and advancing technologies will allow the reallocation of existing resources to more digital roles with training, and may justify pay increases for the change in skillsets.
- **Are companies realistic about staffing costs in an automated future?** With oncoming automation, companies will be paying toward the higher end of the hourly wage range for workers to operate and maintain these systems. Thus, one solution generates a new problem. Given this, are companies realistic about what it's going to take to staff automated and digital plants?

- **The benefits of increased wages:** There are benefits to a business beyond enhanced worker satisfaction when individual employee wages go up. Fewer employees needed means a reduced overall wage burden, as well as expanded capacity and increased return on investment.

FIGURE 4.4. COST OF LABOR

What is the average entire cost of labor (wages, benefits, etc.) for a plant floor operator at your company?

Source: CRB

Training programs to advance careers and upskill workers

Another effective way to retain talent is providing training programs, according to 61% of respondents. As discussed in the section above, this can go a long way towards improving culture. But beyond culture, it can be a key means of implementing digital solutions in the facility. We've seen a lot of resistance in the industry to adopt digital manufacturing tools due to a lack of skilled workers to operate and maintain these systems that are leading to innovative changes. Production employees have varying abilities—and desire—to learn about new technology and equipment that's capable of monitoring itself and relaying to the company's network how the entire production system is performing.

Regardless, there's a real need for additional training as we move into this next manufacturing revolution. Upgrading and changing production lines requires ensuring resources have the training they need. No doubt, some manufacturing staff—those interested in more fulfilling work and who want to cover these positions—should be willing and able to learn the skills. And, if they already know the equipment and production processes, they have an advantage to learning the new technical aspects. These skills are not typically learned on the plant floor and require additional education to add the experience, such as a two-year college program or industry-specific certification training.

Learning opportunities can be a mix of instruction from the OEMs supplying automated and digital technologies, trade school programs and internal learning specialists. We have found that bringing learning specialists in during the factory acceptance testing (FAT) has been helpful. They were able to take pictures and ask questions of the operators and mechanics during FAT, which they used to build the instruction programs at the facility.

Upgrading welfare spaces

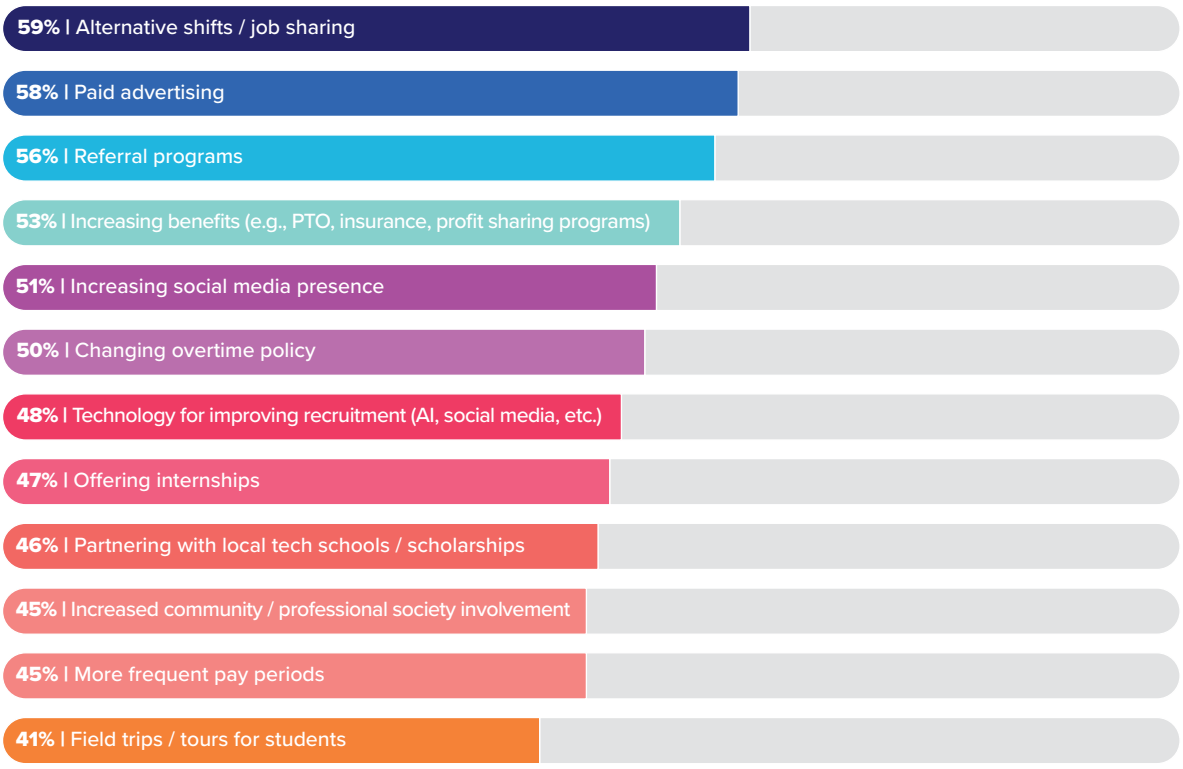
Only 45% of respondents found this to be effective, suggesting that amenities like gyms or meditation rooms aren't as important to people as once imagined. Although manufacturing remains largely an in-person endeavor, we suspect this may reflect both a desire to do more personal activities at home as well as the society-wide shift to remote work for some jobs.

APPROACH 2: DIGITAL MANUFACTURING DRIVES TALENT ACQUISITION

Many companies hire people who are willing to show up on time and then train them on the job. But as facilities become more digitalized, they will need workers to arrive with specific skillsets so they can hit the floor running. Respondents found many ways to attract skilled workers to be effective (Figure 4.5).

FIGURE 4.5. ATTRACTING TALENT

Which of the solutions your company is implementing to attract talent are effective? [Top 2]



Source: CRB

TODD GILLIAM
FOOD & BEVERAGE INDUSTRY LEADER
ROCKWELL AUTOMATION

"In response to the severity of today's global labor shortage, leading Food and Beverage processors are leveraging the use of smart manufacturing technology to not only help empower and amplify their workers' efforts and decision-making, but also to upskill and elevate their roles to address more value-add responsibilities. As a result, these manufacturers are becoming more attractive workforce destinations."

Alternative shifts/job sharing

Creating an environment that allows for alternative shifts or job sharing gives employees the opportunity for the kind of work-life balance many workers desire. This is likely to attract employees who typically would not look at a traditional manufacturing job. Digital facilities enable this transformation. The more production and data collection are automated, the easier it is to flex workers' schedules around work outcomes, not when lines are running.

Changing overtime policy

We have seen a shift in which changes to overtime policy are more favorable for the worker, less for the company. It has come to the point where, perhaps, employer-mandated overtime is optional—if you don't want to work on a Saturday, you can choose not to. Half of respondents said these changes are effective at attracting talent, while 59% said they're effective at retaining talent (Figure 4.3). Staffing overtime becomes less urgent, as your lines become more automated and integrated. Your workers are more likely to be planning the work and programming systems, rather than performing it on a weekend.

BOTTOM LINE: DIGITAL MANUFACTURING IS A WHOLE INDUSTRY SOLUTION

Remember we said that 96% of those relying on contract manufacturers exclusively don't believe there will be a staffing problem? As demand for contract manufacturing rises and available labor falls, we'll all feel the pinch of this potential blind spot. The solution: embrace the principles of digital manufacturing, and the ways they can be used as levers to retain and attract staff.

Automation and other digital technologies are influencing labor challenges. Those who have implemented the fundamental aspects of a connected facility—artificial intelligence (AI), Internet of Things (IoT) capabilities, a manufacturing execution system (MES) and the integration of information technology and operation technology (IT/OT)—were significantly more confident about staffing over the next three years (Figure 4.6).

FIGURE 4.6

Do you believe it will be more difficult to staff your company's facilities in the next 3 years?

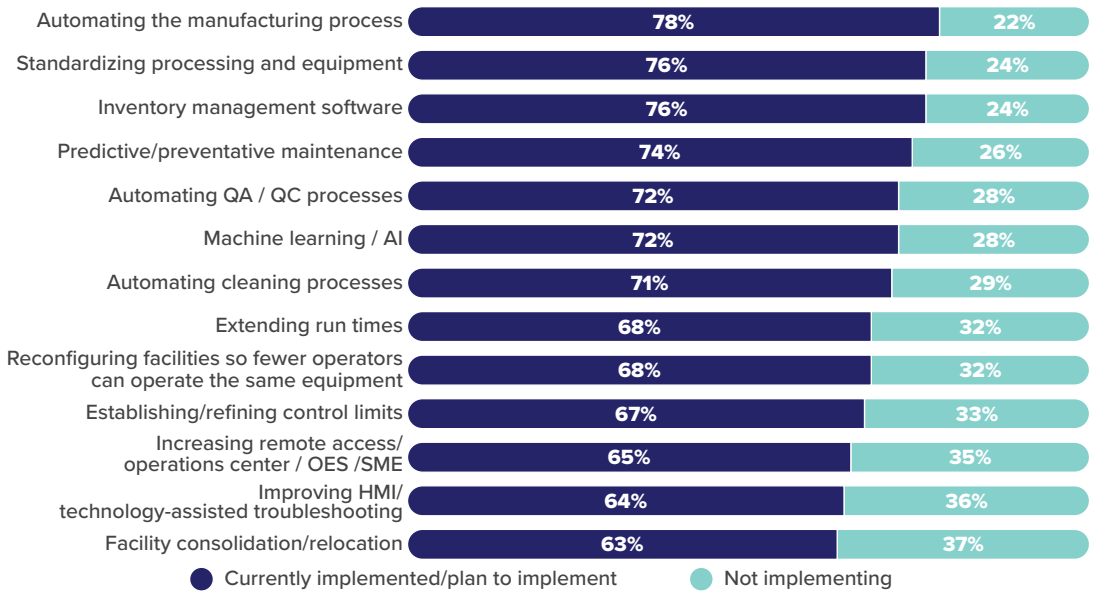
Has your company implemented, or is it planning to implement, these concepts in manufacturing facilities?

Has your company implemented, or is it planning to implement, these concepts in manufacturing facilities?	Do you believe it will be more difficult to staff your company's facilities in the next 3 years? YES	NO
All	24%	76%
Artificial Intelligence (AI)	14%	86%
Internet of Things (IoT)	15%	85%
Information Technology / Operation Technology Integration (IT/OT)	18%	82%
Lights-out Manufacturing / Dark Manufacturing	11%	89%
Connected Supply Chain / Digital Supply Chain	17%	83%
Connected Factory / Smart Factory	15%	85%
Manufacturing Execution System (MES)	16%	84%

Source: CRB

FIGURE 4.7. SOLUTIONS TO LABOR SHORTAGES

Is your company planning to implement, or have you implemented, these solutions to labor shortages?



Source: CRB

What we consider the most logical first steps into the digital age of food manufacturing were found to be effective means of solving labor shortages by over 70% of respondents (Figure 4.7). This includes automating the manufacturing process (78%) and standardizing processing and equipment (77%), a sign that companies are going digital.

Given that 31% of respondents come from companies with annual capital budgets of less than $20M, it's promising that more than 70% of respondents have either implemented, or plan to implement, major automation and Industry 4.0 assets. Some smaller companies may not yet know what they want to automate, but if they're expecting double-digit growth in the next three years, they need to anticipate how that growth will affect their current equipment and human asset base. Adding automated equipment that is prepped for digital transformation and planning for the personnel skill sets to run these new lines may be part of their change to keep up with the demand.

Inventory management

This response surprised us since inventory management software can't directly solve labor issues. Perhaps a company will need less labor if its system ensures staff has the raw ingredients and inventory in stock, making them more efficient. Most companies are already using an enterprise resource planning (ERP) software, like SAP, to manage inventory, warehouse and supply chain logistics.

The labor market is evolving. Your digital strategy should, too.

There's no doubt the labor market is undergoing rapid change, from reported shortages, to pending retirements of one of the largest generations in US history. However, our survey indicates that not all manufacturers agree about how this will impact their business. Those who rely heavily on outsourcing tend not to foresee labor shortages coming, possibly because they're less visible to them now—but not to their contract manufacturers. For those that self-manufacture, the key distinction seems to be how advanced they are on their digital journey. We believe that's not a coincidence. Digital technologies foster productivity gains, reduce pressure on staffing and create facilities with improved cultures and growth opportunities. It's a virtuous cycle, one that every company should consider.

Less cash, more value:

Automation and the push to maximize capital spending

By Monte Vander Velde and Dennis Collins

Section 5

Today's food and beverage manufacturers have several reasons to feel optimistic. After years of pandemic-related turbulence, they've proven themselves resilient and adaptable. They have access to a growing market of digital technologies designed for safer and more efficient operations. Automated systems are helping them move away from manual data collection and toward more transparency and visibility, making it possible to stay ahead of supply-related issues and operational bottlenecks.

With these advantages propelling them forward, what's holding food and beverage manufacturers back? Two simple words: capital budgets.

Inflation and rising interest rates are widening the gap between manufacturers' business goals and the capital available to meet them. For the 300+ manufacturers who shared their perspectives with us through our industry survey, this gap has introduced difficult questions:

Where will our capital budget come from?
For our survey respondents, "access to capital" is a top business driver.

How can we do more with less?
Half of respondents have reduced their annual capital investments.

How can we accelerate ROI?
More than 40% expect payback on capital upgrades in under 2.5 years.

These questions indicate that food and beverage manufacturers are facing extraordinary pressure to protect their margins and shrink their capital spending.

At the same time, they're thinking years ahead, with the understanding that today's investments will determine tomorrow's business outcomes.

Cost-cutting on one side, pressure to grow and improve operations on the other: caught in the middle, are manufacturers feeling more uncertainty than optimism? To find out, we turned to the survey data, looking for insights into today's top manufacturing challenges and opportunities.

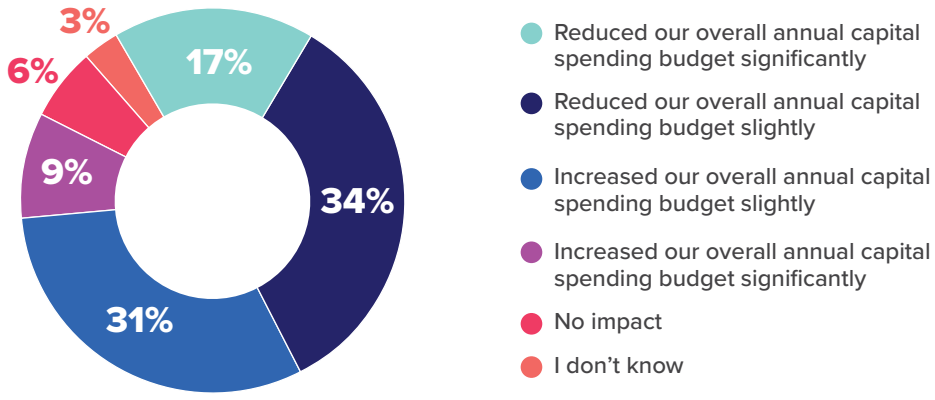
HOW HAS INFLATION IMPACTED CAPITAL SPENDING?

Despite inflation pressures, capital spending drivers stay consistent.

Though most survey respondents are tightening their capital budgets in response to inflation, that's not always the case (Figure 5.1).

FIGURE 5.1. INTEREST, INFLATION, ECONOMIC SENTIMENT IMPACT

How have increased interest rates, inflation and your company's overall economic sentiment affected your company's annual spending?



Source: CRB

- **40% of respondents have *increased* their capital spending.**

  For any manufacturer, capital spending is unavoidable. At a minimum, it's part of maintaining operations. For many, though, pressure to spend goes much further than necessary maintenance. Some may have projects underway that require completion, despite inflation; others may be responding to shifting expectations from retailers, regulators or consumers. For manufacturers in this situation, a budget increase is likely necessary to cover the rising cost of materials, labor, equipment and other project delivery resources.

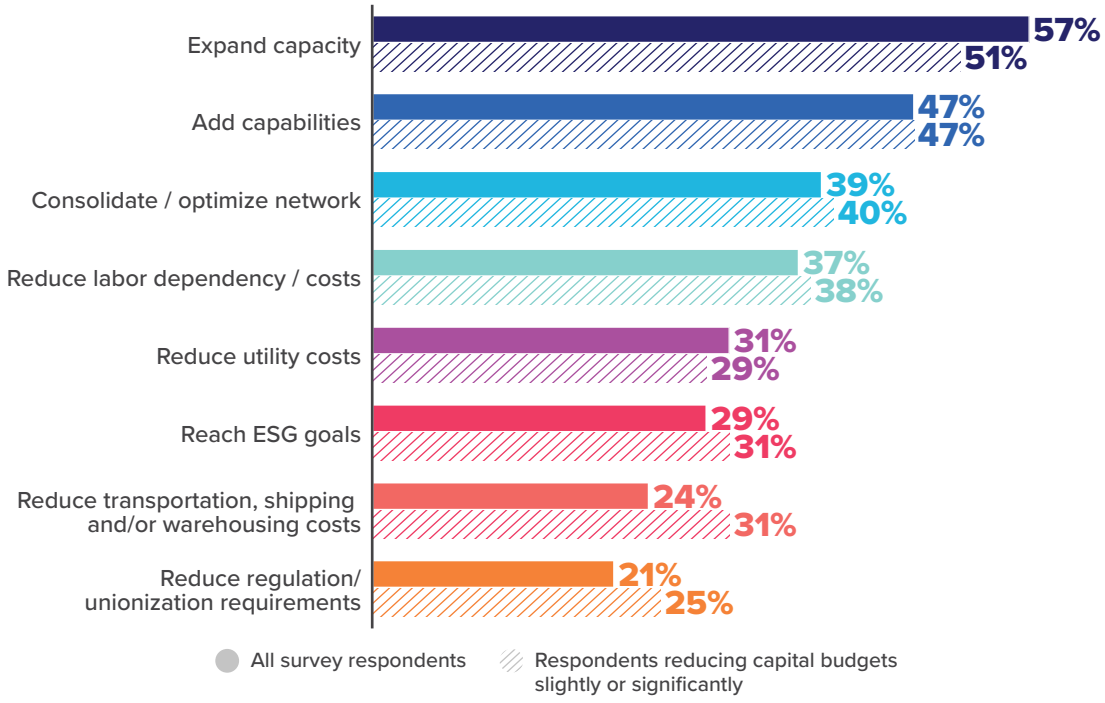
- **51% of respondents have *decreased* their capital spending.**

  Have manufacturers in this group changed their capital priorities to reflect this reduction in spending? The answer appears to be no, with two notable

exceptions: of those who have decreased their spending, we see a 6% drop in capacity expansion projects and a corresponding rise of 7% in projects aimed at reducing transportation, shipping and warehousing costs (Figure 5.2). This indicates a shift away from revenue-generating projects and toward projects that restore or grow margins by reducing COGS (Cost Of Goods Sold). Manufacturers appear to be feeling the pinch of inflation and trying to mitigate its consequences.

FIGURE 5.2. CAPEX DRIVERS

What are the drivers for your company's capital expenditure projects? [Top Three]



Source: CRB

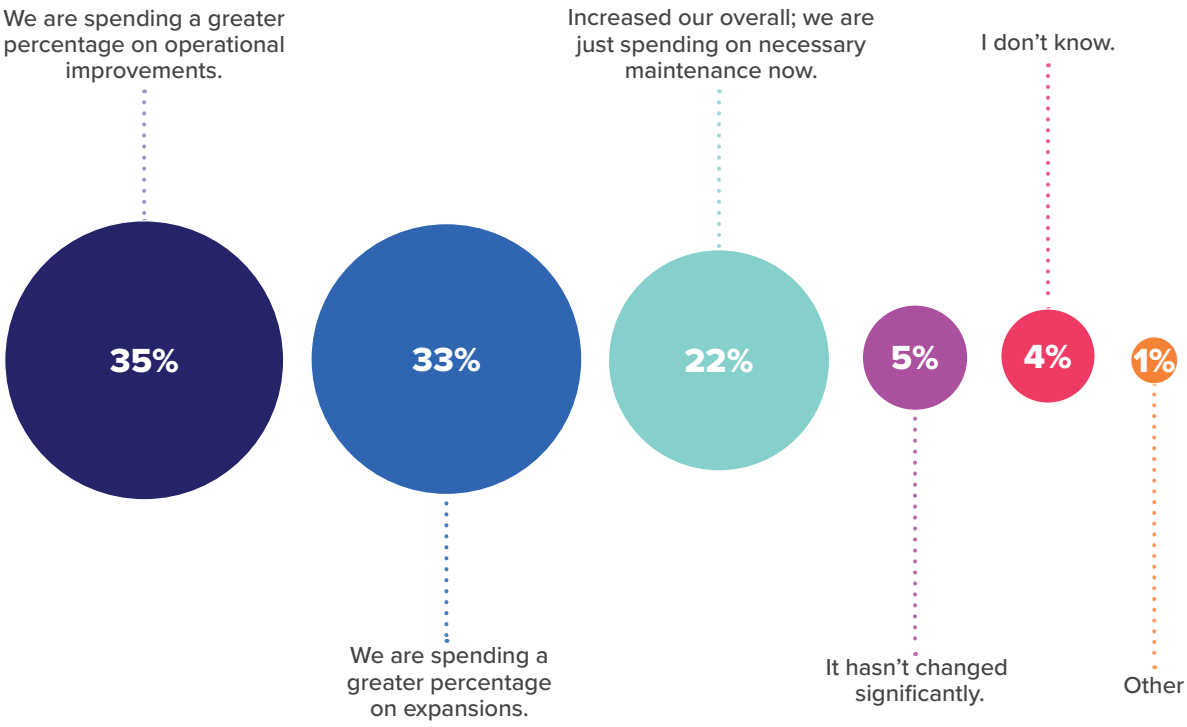
Both operational improvements and expansion projects are on the table.

The data above illustrates the push-and-pull facing today's manufacturers, as some are forced to expand their capital budgets and others are seeking to cut it back as much as possible.

There's another push-and-pull underway when it comes to *how* these budgets are allocated (Figure 5.3). About a third of survey respondents have increased their spending on operational improvements over the last two years, perhaps with an eye to squeezing more performance from existing assets. Meanwhile, nearly the same proportion is spending more on expansions, likely to keep up with consolidation activity, increased demand, rising transportation costs and other pressures.

FIGURE 5.3. CAPITAL SPENDING (CHANGE IN LAST 2 YEARS)

How has your company's capital spending changed in the last 2 years?



Source: CRB

KEY TAKEAWAY

Under pressure to meet improvement and expansion goals despite inflation, most manufacturers appear to have a "do more with less" mindset and an eye on protecting margins—though pressure to continue expanding and improving operations remains high.

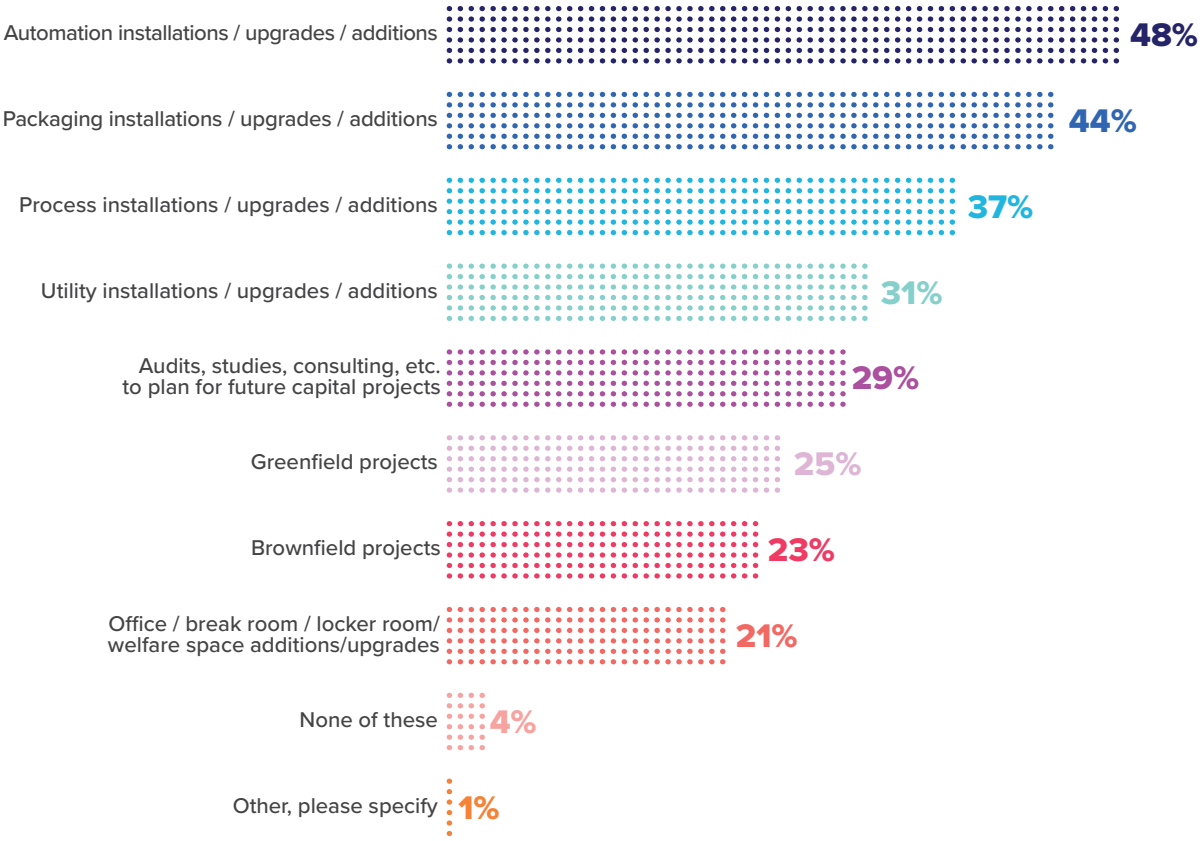
AUTOMATION PROJECTS DRIVE HALF OF ALL CAPITAL SPENDING

Automation is under the spotlight as a pathway to expanded capacity, new capabilities and achievements in Environmental, Social, and Governance (ESG) initiatives.

With expansions and operational improvements drawing equal support, how exactly are manufacturers deploying their limited capital budget to meet these twin goals? For about one in every two survey respondents, the answer is automation (Figure 5.4).

FIGURE 5.4. CAPEX DRIVERS (TYPES OF PROJECTS)

Which of the following types of projects are part of your company's capital expenditure plan for the next three years? [Multi-select]



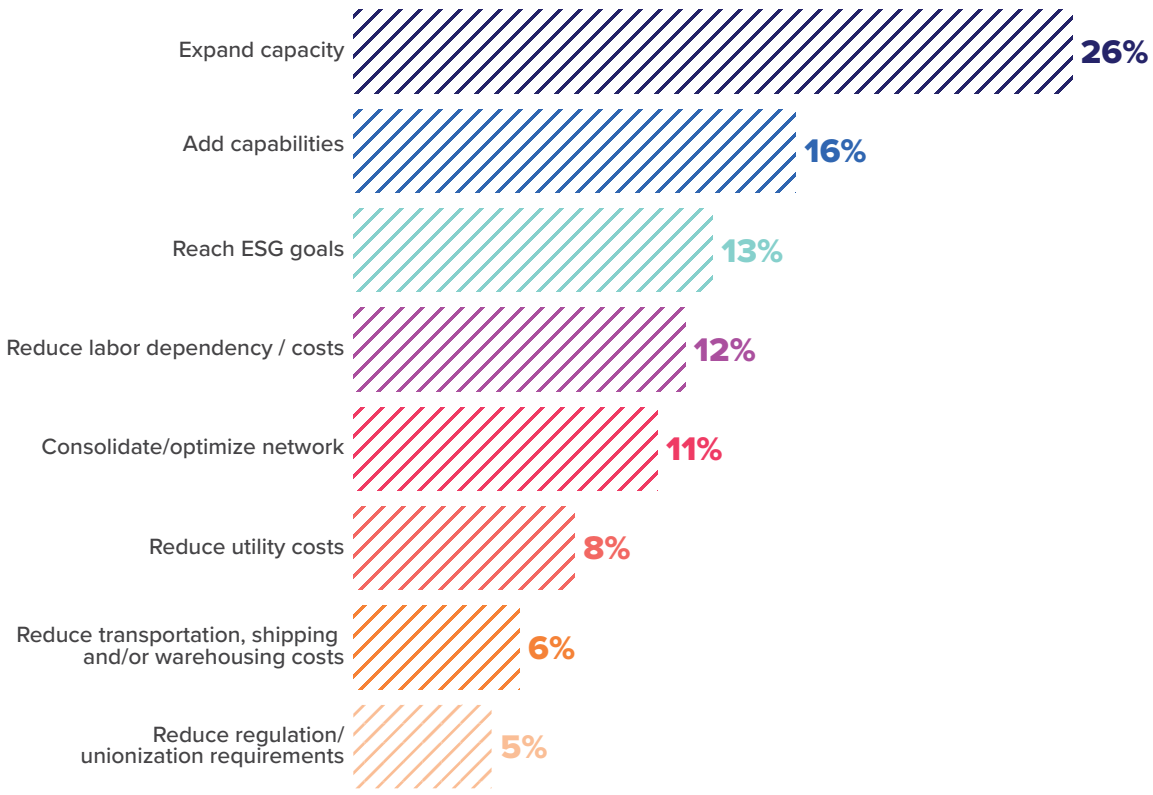
Source: CRB

To better understand this trend, we asked survey respondents to indicate how much of their capital spending they've set aside for automation and control system upgrades. Most companies earning less than $500M annually plan to spend between $500K and $1M; larger companies are more likely to earmark between $1M and $10M for automation-related spending. These numbers indicate that even in an era of cautious spending, manufacturers are taking automation seriously (relative to their size) and are counting on it as a mission-critical enabler of commercial success.

But what, exactly, is the relationship between automation and commercial success? To answer that question, consider the factors pushing manufacturers to spend. Figure 5.2 shows survey respondents' top three business drivers; when we zoom in to look specifically at the drivers that respondents chose as their #1 priority, additional capacity remains in the top spot, with new capabilities and ESG drivers next in the ranking (Figure 5.5).

FIGURE 5.5. CAPEX DRIVERS

What are the drivers for your company's capital expenditure projects? [Top rank]



Source: CRB

Digitalization, which encompasses automation but also includes robotics for precise and consistent tasks, smart sensors for proactive performance monitoring, AI-driven quality control and other advanced technologies across the manufacturing value chain, plays a key role in meeting each of these objectives.

Digitalization as a pathway to expanding capacity

Manufacturers can expand capacity by adding new production lines to a facility, but that strategy is a blunt instrument available only to those with appropriate space and capital.

A more surgical approach is available—one which leverages data to extract more run time from the same equipment, thereby increasing capacity *without* adding new capital assets. Digitalization makes this possible; like a high-definition x-ray machine, the right digital technologies let manufacturers look closely at the factors impacting their overall equipment effectiveness (OEE), allowing them to make precise, discrete changes that add up to significant increases in capacity and throughput. For example:

- **More efficient batching:** Adding ingredients individually can extend the time required to prepare each batch. With the right instrumentation and automation in place, manufacturers can program their equipment to add all ingredients at once, where appropriate. Batch over batch, this change can lead to a significant gain in efficiency.
- **Fewer shutdowns for clean-in-place (CIP) cycles:** With access to the right data at the right time, manufacturers may find it possible to justify fewer interruptions for cleaning, or they may uncover opportunities to reduce the time required for each cleaning cycle. At a commercial scale, even a few seconds shaved from this process can greatly impact overall equipment uptime.
- **Issues solved at the source:** By integrating real-time monitoring capabilities into the production line, manufacturers can catch and fix quality deficiencies exactly when and where they happen—*before* those deficiencies make their way downstream. That could involve anything from real-time moisture monitoring to precision magnets capable of detecting exactly where a rogue metal appears, potentially avoiding the need for a full-line shutdown and/or a lost batch.

- **Digitalization as a pathway to new capabilities**
  In traditional manufacturing terms, "capabilities" refers to functions that play a direct role in process execution, such as mixing, blending and packaging. In the digital era of food manufacturing, though, a new type of capability is emerging—one that's focused on managing supply chain risk and proactively resolving operational chokepoints.

  Interactive human-machine interfaces (HMIs) that feed real-time performance data to plant engineers are one example of this emerging type of capability. An automated Manufacturing Execution System (MES) that gives manufacturing clients visibility into real-time status updates is another. These capabilities are evolving all the time; soon, for example, manufacturers may be able to leverage artificial intelligence as a means of predicting and solving future supply chain problems *before* they impact plant operations.

- **Digitalization as a pathway to ESG implementation**
  More than 90% of our survey respondents have a formal ESG policy (or are planning to develop one), and half have backed their ESG policy with sufficient budget—an important indicator of priorities in this period of austerity. By earmarking at least some of that budget for digitalization projects that enable better measurement and analysis of the environmentally impactful systems that make manufacturing possible—such as utility and HVAC systems, water distribution systems and transportation networks—manufacturers can plan, implement and track their resource reduction sustainability strategies with greater accuracy.

From a social perspective, digitalization may play a key role in attracting employees. More than 40% of our survey respondents are under the age of 40, a segment that's sure to grow as boomers and the Gen X population approach retirement. The younger workers who will fill these vacancies belong to a digitally native generation, which may influence their choice of employer. By digitalizing the work environment, employers can set themselves apart from competitors and strengthen their approach to attracting and retaining employees.

There's also a safety component to the push for digitalization: by using automated systems to perform dangerous or ergonomically taxing tasks, manufacturers can move employees into roles that protect them from harm while engaging them in higher-value activities.

Digitalization also plays a key role in good governance by enabling robust, up-to-date quality management and track-and-trace activities, giving audit teams the visibility they need and ensuring ongoing regulatory compliance.

WHAT'S THE ROI FOR DIGITALIZATION PROJECTS?

It's difficult to calculate with precision the direct return that manufacturers can expect from their investment in digital transformation projects, in part because that return encompasses both quantifiable and non-quantifiable benefits (such as the impact of automation on improved operator safety).

However, it's increasingly clear that without digitalizing, manufacturers risk slipping behind competitors who leverage new technologies to operate faster, more efficiently and more reliably in an increasingly turbulent manufacturing landscape.

For that reason, digitalization is becoming an imperative—and it appears to be paying off for those who invest in it. **In a 2023 study[2], KPMG International found that 56% of US enterprise technology leaders from diverse industries say "the returns from digital transformation investments had exceeded their expectations."**[1]

KEY TAKEAWAY

Manufacturers with access to high-quality operational and business data have an advantage: they know which levers to pull as they endeavor to extract more value from new capital investments, optimize their current assets and proactively maintain equipment to ensure long-term performance.

2. *KPMG. 2023 KPMG US Technology Survey Report page. Available at: https://kpmg.com/us/en/articles/2023/us-tech-survey-2023.html. Accessed March 15, 2024.*

THREE OPPORTUNITIES TO POTENTIALLY INCREASE AND ACCELERATE ROI

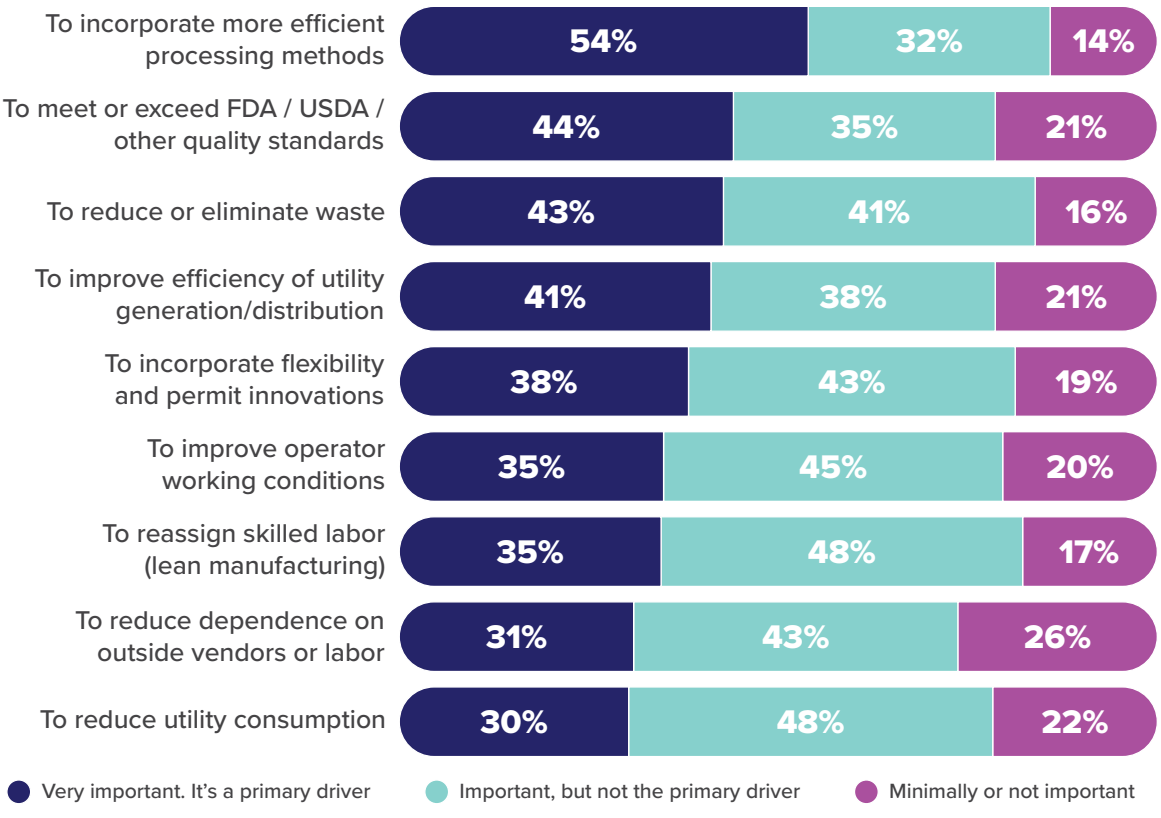
1. UTILITIES: IGNORE OR UPGRADE?

While maneuvering in the fast lane of recipe development and process scale-up, the hard work of planning and maintaining a highly efficient utilities system is often a lower-ranking priority. That's understandable: utilities are a comparatively small contributor to COGS, yet their upkeep requires considerable investment. Many manufacturers choose to steer that investment toward projects that will directly impact capacity and help them meet their speed-to-market targets.

The survey data bears this out. When asked about the goals driving their CapEx projects, respondents told us they're twice as likely to add capabilities as they are to reduce utility costs (Figure 5.5). And while projects focused on *generating* utilities are among respondents' primary capital objectives over the next three years, projects focused on *consuming* utilities more efficiently appear less popular (Figure 5.6).

FIGURE 5.6

How significant are the following drivers in executing your company's capital projects over the next 3 years?



Source: CRB

Over time, though, failing to invest in projects aimed at reducing utility consumption will leave manufacturers with a utility system that's gradually draining the plant's ROI through small but cumulative inefficiencies.

The good news? This means that directing even a small amount of capital toward regularly improving and upgrading utilities can have an equally cumulative effect on your balance sheet, making this area the source of a relatively "easy win" for cash-strapped manufacturers focused on lowering their operating costs by using what they already have—but using it *better*.

In addition to the business case behind efficient utilities, there's a case here for ESG implementation. By reducing emissions and conserving energy across the plant, manufacturers may see their capital investment working double-time: a bolster for their ROI *and* for the environment.

STEAM CONSERVATION: A SMALL INVESTMENT FOR A BIG WIN

Making simple changes to capture wasted condensate and repurpose it for future use can have a big impact on your bottom line, as well as a positive influence on your environmental footprint.

Step one is identifying problem areas. Often, a walk-through is all that's necessary to locate leaking gaskets, traps or drain points left open, piping issues or other physical abnormalities. Sometimes, a more in-depth assessment of how your operation generates and distributes steam is also necessary.

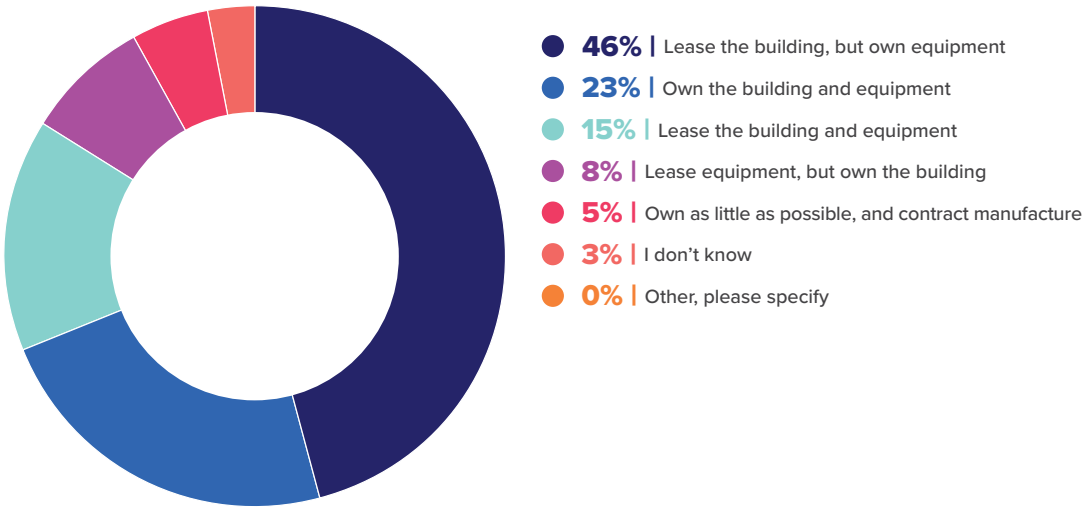
Step two is about finding and implementing appropriate solutions. A simple maintenance protocol could lead to a meaningful change in your energy and water usage, or perhaps you find an opportunity to right-size the volume of steam delivered to equipment by implementing a remote monitoring and control system. These changes, though relatively simple, can lead to meaningful margin gains.

2. BUILDINGS: LEASE OR OWN?

In a manufacturing landscape strained by escalating capital costs, there's one sure way to tip the balance sheet in the right direction: lease your building. That's the trend favored by survey respondents, nearly two-thirds of whom prefer not to own their plant (Figure 5.7). This avoids the cost of constructing the building; instead, manufacturers can categorize building-related expenses under their operating budget, thus preserving coveted capital dollars.

FIGURE 5.7. OWNING PHYSICAL ASSETS

What is your company's preference for owning physical assets? [Choose 1]



Source: CRB

With this model prevailing, what should manufacturers keep in mind as they look for leasing opportunities?

The first thing to know is that the perceived benefits driving many manufacturers toward leasing don't always materialize—at least, not without good planning. To manage your risks, consider the pros and cons of two common pathways:

Lease a spec building.

A speculative building is a pre-existing shell and core structure, built without a specific tenant in mind. Nearly 60% of survey respondents either operate in a spec building or would consider it for a future project.

Benefits of a spec building:

- The potential to move fast: Because the shell already exists, manufacturers can leapfrog the initial permitting and building phases that add considerable time to a greenfield project.
- The potential for a deal: Depending on demand, developers may be motivated to negotiate terms rather than carry the expense of an empty spec building.

Potential pitfalls of a spec building:

- Slow-downs caused by extensive improvements: Many spec buildings are designed for open warehousing, often with a shallow foundation that isn't suitable for the process sewers required to support a food and

beverage manufacturing plant. Without expert guidance, manufacturers may underestimate the time required to prepare such a building for GMP food production.

» Reduced ROI because of expensive TIs: The tenant improvements (TIs) required could be extensive, from removing floor slabs to modify the building's drainage to reinforcing the roof in order to accommodate specialized ventilation systems or support conveyors, piping systems and other hanging equipment. It's important to fully understand the scope of necessary TIs to arrive at a realistic ROI.

Partner with a developer.

With advanced planning, this strategy can unlock the best of both ownership and leasing—a building that's fit-for-purpose from day one but carried on someone else's balance sheet.

Benefits of a developer partnership:

» Custom development: Through careful coordination with a development team who understands food and beverage manufacturing, companies can advocate for necessary design elements before construction begins, avoiding the considerable costs of retroactive TIs.

Potential pitfalls:

» Scheduling: This partnership only works if it begins before shovels are in the ground, and unlike a preconstructed shell building, it comes with a considerable delivery timeline.

» Potential for compromise: Unlike a manufacturer-owned greenfield project, working in partnership with a developer/owner may require compromises to accommodate the owner's long-term business plan.

REAL-WORLD EXAMPLE

The best of both worlds.

We recently worked with a food manufacturer to help them maximize their partnership with a building developer.

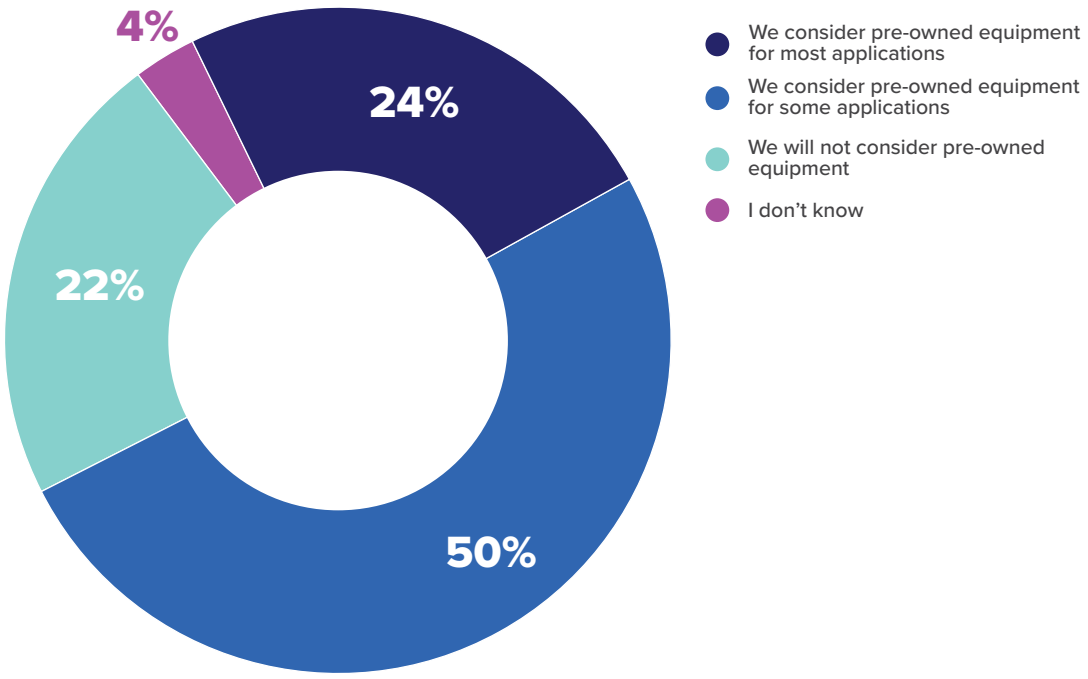
This manufacturer's unique process required specific features in their future site, but they didn't have the capital to build it themselves. In this arrangement, they were able to get the building they needed, without taking on enormous debt. For the developer, this meant gaining a loyal tenant on a long-term lease, and a differentiated building with unique capabilities—if they need to find a new tenant in the future, these features could set them apart.

3. EQUIPMENT: NEW OR PRE-OWNED?

Most manufacturers may prefer to lease their building, but that paradigm flips when it comes to what goes *inside* of that building. As Figure 5.7 illustrates, nearly 70% of survey respondents prefer to own their equipment rather than lease it. That equipment doesn't necessarily need to be new, either—three-quarters of respondents say they're open to the pre-owned marketplace (Figure 5.8).

FIGURE 5.8. PRE-OWNED EQUIPMENT

What is your company's policy on using pre-owned equipment to reduce capital costs or improve lead times?



Source: CRB

This trend toward pre-owned equipment indicates the lure of several benefits while concealing a few potential pitfalls.

- **Benefits of pre-owned equipment:**
  - ***Speed:*** Manufacturers stand to shave a year or more from their capital delivery timeline by skipping the long lead times typically required for new equipment.
  - ***Savings:*** It may be possible to acquire pre-owned equipment for pennies on the dollar, which is likely driving many manufacturers with shrinking capital to explore this avenue.

- **Potential pitfalls of pre-owned equipment:**
  - » ***Rising costs:*** As the promise of rapid deployment drives up demand in the pre-owned marketplace, the price for this type of equipment is climbing—in some cases, pre-owned may even cost manufacturers more than purchasing new.
  - » ***Abnormalities or undisclosed performance issues:*** In an environment such as an equipment auction, pressure to make a snap decision is high—which can lead manufacturers to acquire a pre-owned system, only to learn during a later audit that it's unfit for their purposes.
  - » ***Inappropriate sizing:*** Purchasing pre-owned equipment with twice the capacity you need may seem like good forward planning, but this decision can trigger a full capital reassessment of your production capabilities and generate unexpected capital expenses (if, for example, removing a floor slab or raising the roof is necessary to accommodate the new purchase).

REAL-WORLD EXAMPLE

A sweet deal gone sour.

When a manufacturer needed a new sterilizer to support their expanding operation, they sourced one from the pre-owned marketplace for about half of what they could expect to pay for a new sterilizer and a month of startup and installation costs.

The purchase proved a mistake. To function as needed, the used equipment required two engineers to tune it around the clock. A year after installation, this manufacturer has spent well above the cost of buying new—with no end in sight.

To avoid a similar situation, we recommend bringing an expert on-site to inspect any pre-owned equipment before you commit to a purchase. For the cost of a plane ticket and a day's work, you could spare yourself from expensive surprises down the line.

For each of these decisions (choosing a more efficient utility system, an appropriate building or the right pre-owned equipment), two ingredients are necessary to ensure a positive outcome: good-quality data enabled by reliable automation, and experts who can turn that data into a deep understanding of your current situation, your future objectives and the best pathway to get you there.

Approaching these decisions with both good data and qualified expertise in place will ensure that your spending is aligned with both your capital budget and your business case, giving you a meaningful advantage in a manufacturing world facing enormous complexity and financial pressure.

KEY TAKEAWAY

For manufacturers needing to generate more value from shrinking budgets, improving their utility systems could generate significant payback for relatively little upfront investment. Meanwhile, the lease-or-own debate appears all but resolved when it comes to buildings (lease) and equipment (own), though manufacturers need to stay vigilant to avoid potential pitfalls.

To make the most of these decisions, look to the data—and validate your choice with experts who can help you avoid surprises and capitalize on overlooked opportunities.

Digitalization is capital rocket fuel

Today's food and beverage manufacturers need to make every dollar work harder, go further and deliver greater value.

Doing that in a predominantly manual world is like merging on a highway in first gear: it's possible, but you'll soon find yourself far behind everyone else.

Digitalization is the answer. By directing a limited capital budget toward forward-thinking digital strategies such as automated data collection and production systems, manufacturers can set themselves up for a future of rapid, well-planned growth and innovation, especially in times of high inflation. It comes down to implementing systems that make it easier to access mission-critical operational and business data, which in turn fuels better decision-making—whether that means getting more from an existing production line or choosing the right piece of equipment from the right vendor.

At a moment when many manufacturers are cutting unnecessary projects from their capital spending plans, these automated systems continue to attract strategic investment and deliver long-lasting value. And that, from our point of view, is a good reason for optimism.

ABOUT CRB

About CRB

CRB is a leading provider of sustainable engineering, architecture, construction and consulting solutions to the life sciences and food and beverage industries. Our more than 1,300 employees provide world-class solutions that drive success and positive change for our clients, our people and our communities. CRB is a privately held company with a rich history of serving clients throughout the world, consistently striving for the highest standard of technical knowledge, creativity and execution. For more information about CRB and its services, please visit www.crbgroup.com.

CRB is honored to hold the esteemed position of being one of Rockwell Automation's preferred EPC partners. We would like to express our gratitude to Todd Gilliam, the Food & Beverage Industry Leader at Rockwell Automation, for his collaboration. His insights have enriched our report, providing further depth and credibility to the data presented.

To talk about your food and beverage project, contact us.

AUTHORS

Renee Benson is a seasoned packaging engineer with more than 30 years of packaging design and development experience in the food and beverage, manufactured products, chemical, pharmaceutical and medical device industries. She is responsible for many phases of project execution from concept development to installation and start-up, including project management of packaging centered projects and multi-discipline engineering capital projects.

Dennis Collins, AIA, brings 40 years of experience in architectural design to his role as Architectural Regional Discipline Leader. Dennis works closely with food and beverage clients to understand their business drivers and leverage creative solutions to deliver safe, lean and well-organized facilities.

Pablo Coronel, PhD, is a Senior Fellow of Food Processing and Food Safety and an FDA-recognized Process Authority. He leverages 20 years of experience as a process engineer and food scientist, especially in the development of novel technologies processing and hygienic manufacturing field, to lead clients in product and process design, food safety and regulatory compliance development. He is a co-editor of the third edition of the Handbook of Aseptic Processing and Packaging.

Maya DeHart, EIT, LEED GA, is an Energy and Sustainability Specialist with over 8 years in the AEC industry. Experienced in managing process design, she brings a holistic approach to sustainability to our client's projects. Maya believes that sustainability should be a thread that runs through every aspect of every project and has helped integrate clients' goals of LEED building certification into the design and construction processes.

Katie Ireland is a distinguished packaging professional, boasting over three decades of expertise in the field. Her career spans across renowned global brands, where she has consistently demonstrated a keen focus on comprehensive packaging strategies, equipment optimization and cutting-edge line design services. Ireland has played a pivotal role in spearheading a myriad of global packaging solutions and innovation initiatives, contributing significantly to the seamless optimization of packaging lines.

Aaron Kilstofte is a Mechanical Engineer with more than 10 years of experience in engineering design, systems analysis, performance testing, business development and engineering services management. His design experience includes conceptual design, detailed engineering, equipment procurement and construction oversight of mechanical systems (steam, compressed air, plumbing, fire protection and hydronics) throughout industrial-scale food production facilities.

AUTHORS

Jason Robertson is Vice President of Food + Beverage at CRB with more than 25 years of experience in design and construction. He has dedicated his career to bringing innovative solutions to food and beverage clients by leveraging industry expertise and collaborative relationships.

Riju Saini, PhD, a Fellow of Simulation, Modeling and CFD Modeling, has extensive experience helping clients globally in the chemical, petrochemical, pharmaceutical, semi-conductor and allied industries. Saini is an expert in thermodynamics, conceptual process design, steady state and dynamic process simulation, economic analysis, process safety, consequence and risk analysis, mathematical and numerical analysis and software development.

Jerry Steenhoek, Senior Director, Control Systems Technology, has nearly 30 years of experience in automation and process systems design, operational technology (OT) networks and cybersecurity. Steenhoek's role as Senior Director of Control Systems enhances CRB's project delivery by leveraging his automation expertise from early process design through start-up. Steenhoek has spearheaded development and systems integration teams throughout his career across all project phases, including high-level design, detail design, development, commissioning and start-up.

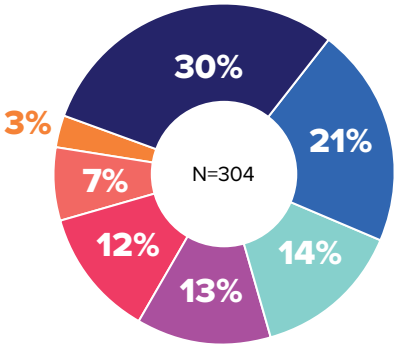
Ryan Thompson, Senior Specialist, Industry 4.0, brings more than 17 years of experience successfully leading companies and projects through their digital transformation. Ryan's experience spans the food and beverage, pharmaceutical and consumer packaged goods industries. He specializes in process and batch automation, data modeling and infrastructure, MES platforms, ERP integrations, FDA regulations such as 21 CFR Part 11 and a vast net of automation platforms and smart manufacturing tools and technologies. He is also a Smart Industry Readiness Index Certified Assessor by the International Center for Industrial Transformation.

Monte Vander Velde is a project manager with a diverse career trajectory encompassing engineering, control systems, and strategic management. With an impressive 26-year tenure, he has consistently honed his leadership skills by steering organizational teams, championing many internal process solutions, and assuming integral roles in the seamless execution of capital projects.

Jim Vortherms, Senior Director, Control Systems Integration, brings nearly 30 years of control systems programming knowledge, including leading teams and the development of control systems. Vortherms helps clients use and manage data to make smarter manufacturing and equipment decisions. Frequently involved in a project from start to finish, he plays a major role in the scope of work development, scheduling, resource allocation, budget management and business development support.

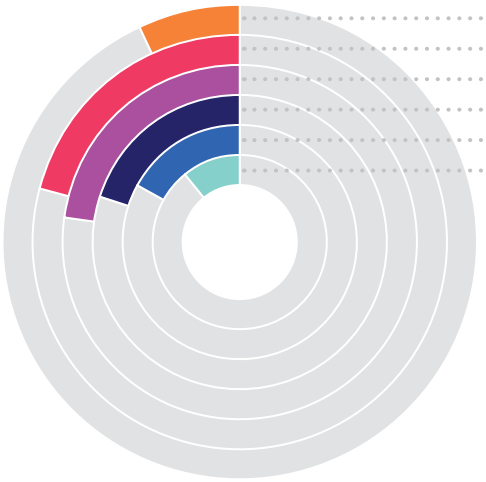
FIRMOGRAPHICS

Primary Respondent Job Function



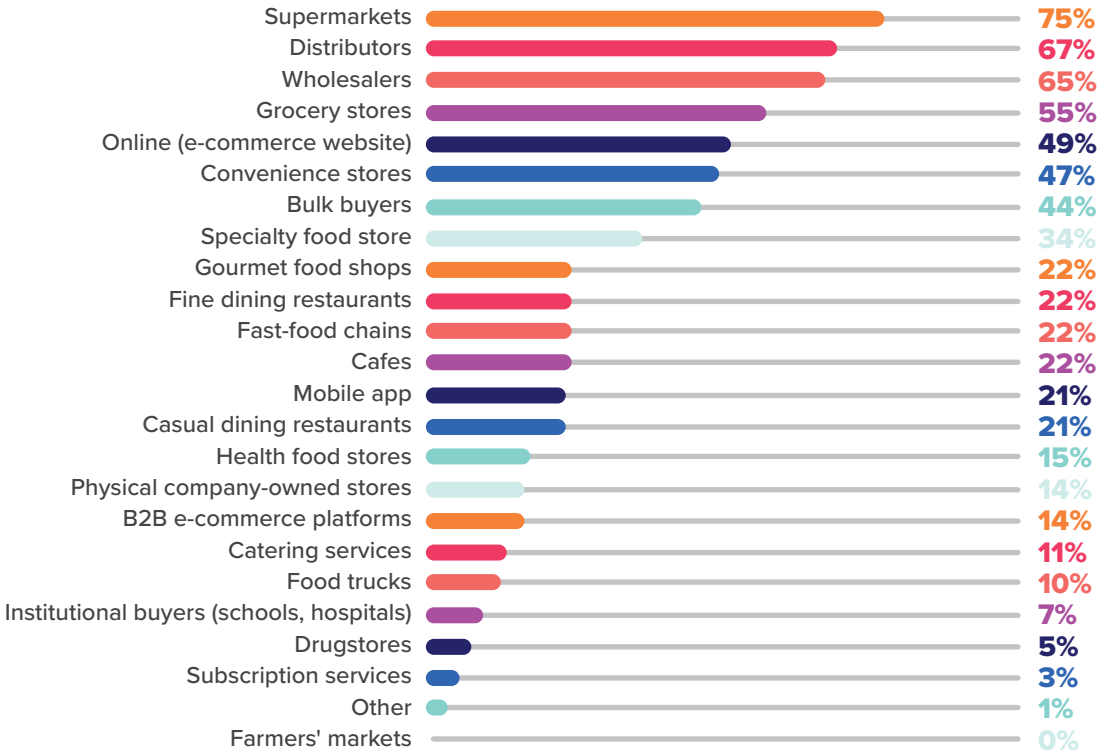
- Operations, plant engineering / maintenance
- Corporate management and/or business development
- Purchasing / procurement
- Logistics / supply chain
- Product, process, and/or package development
- Corporate / capital engineering
- Regulatory affairs, and/or QA/QC

Estimated Annual Revenue



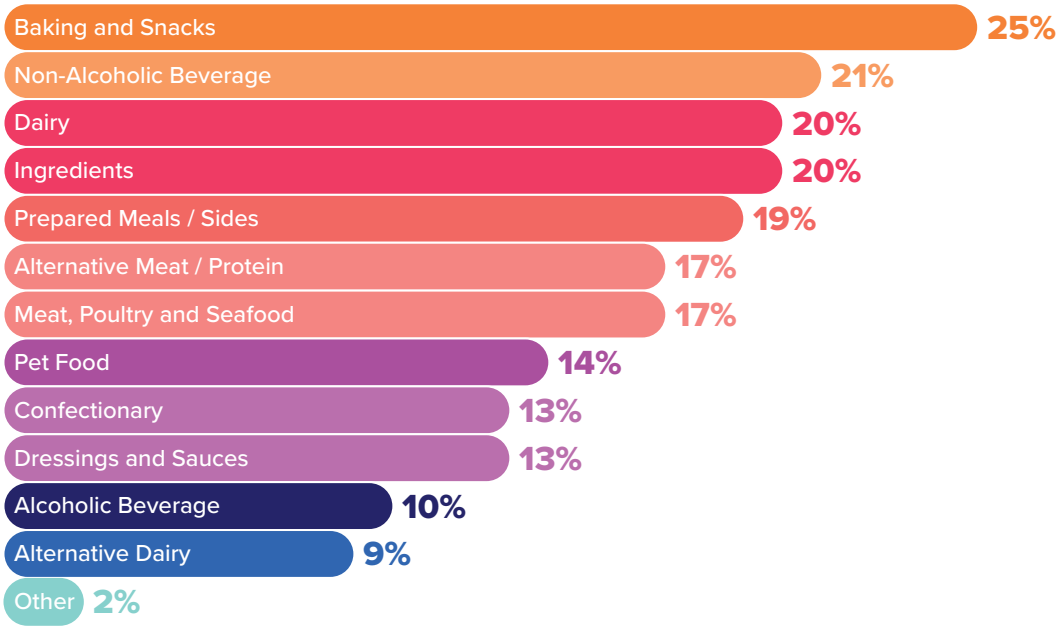
7%	< $2,000,000
21%	$2,000,000 to $19,999,999
23%	$20,000,000 to $99,999,999
20%	$100,000,000 to $499,999,999
18%	$500,000,000 to $999,999,999
11%	>$1,000,000,000

Across what channels does your company sell (or plans to sell) the products it produces?

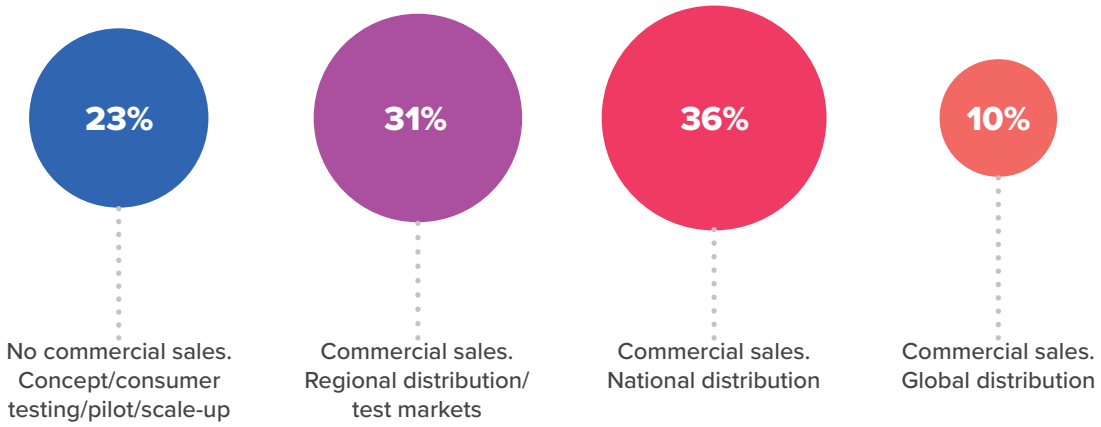


Supermarkets	75%
Distributors	67%
Wholesalers	65%
Grocery stores	55%
Online (e-commerce website)	49%
Convenience stores	47%
Bulk buyers	44%
Specialty food store	34%
Gourmet food shops	22%
Fine dining restaurants	22%
Fast-food chains	22%
Cafes	22%
Mobile app	21%
Casual dining restaurants	21%
Health food stores	15%
Physical company-owned stores	14%
B2B e-commerce platforms	14%
Catering services	11%
Food trucks	10%
Institutional buyers (schools, hospitals)	7%
Drugstores	5%
Subscription services	3%
Other	1%
Farmers' markets	0%

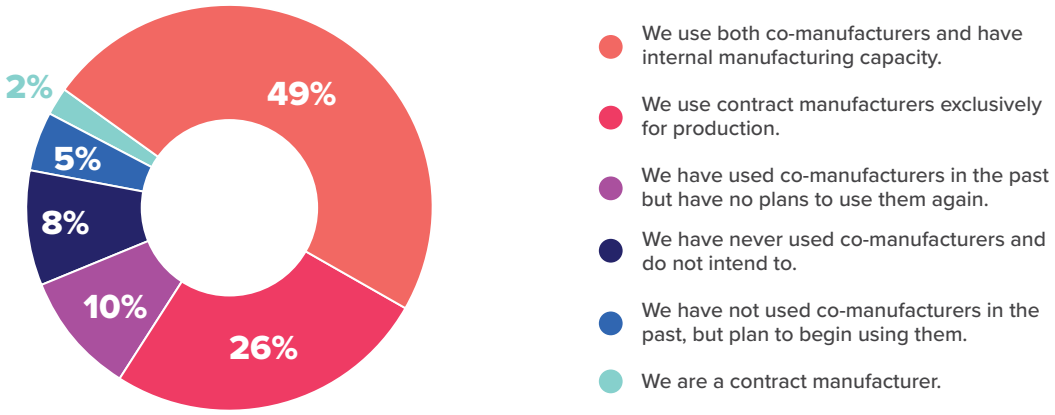
Company product types currently being developed or manufactured



Product developmental phases

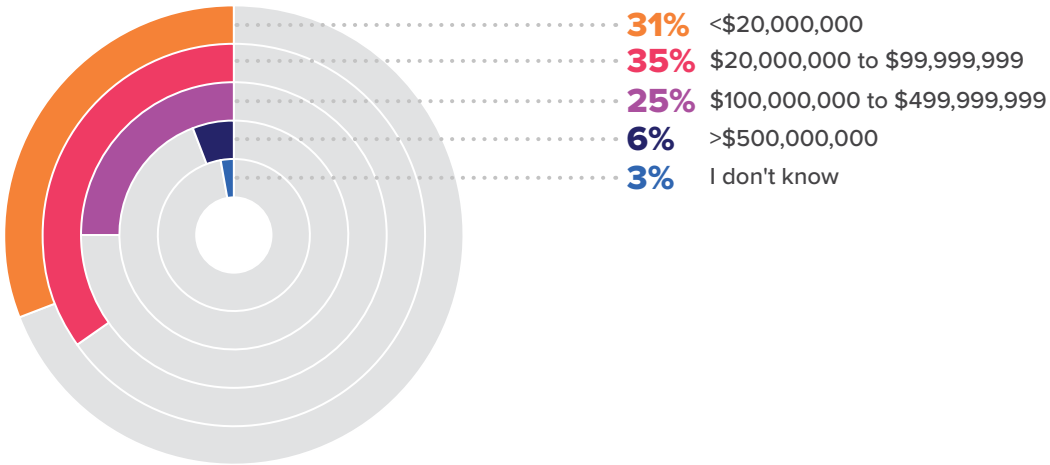


Co-manufacturing strategies

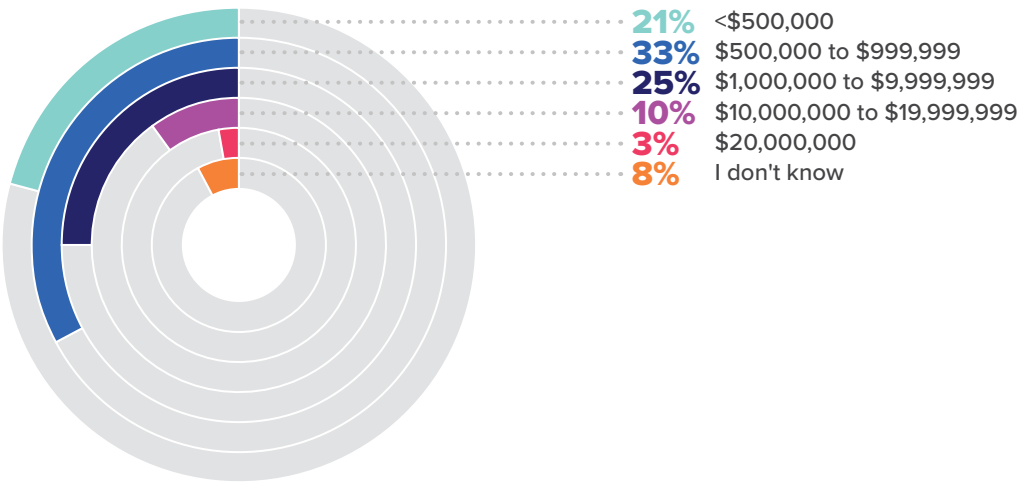


Business Drivers (Top Rank)

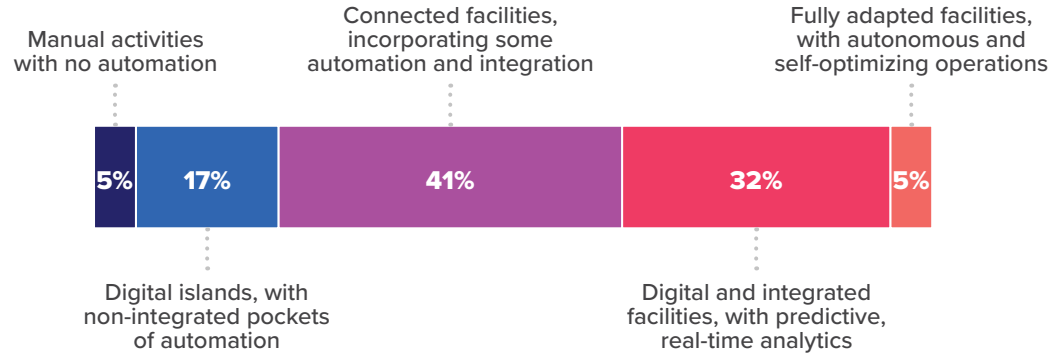
Capital Budget



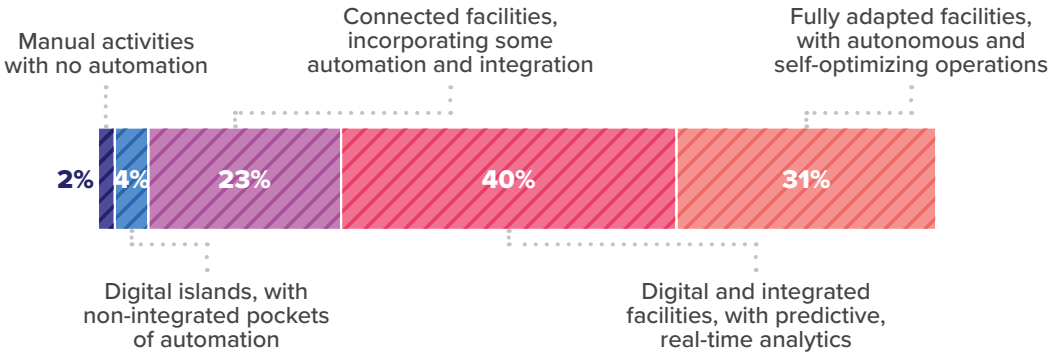
Automation and Control System Spending



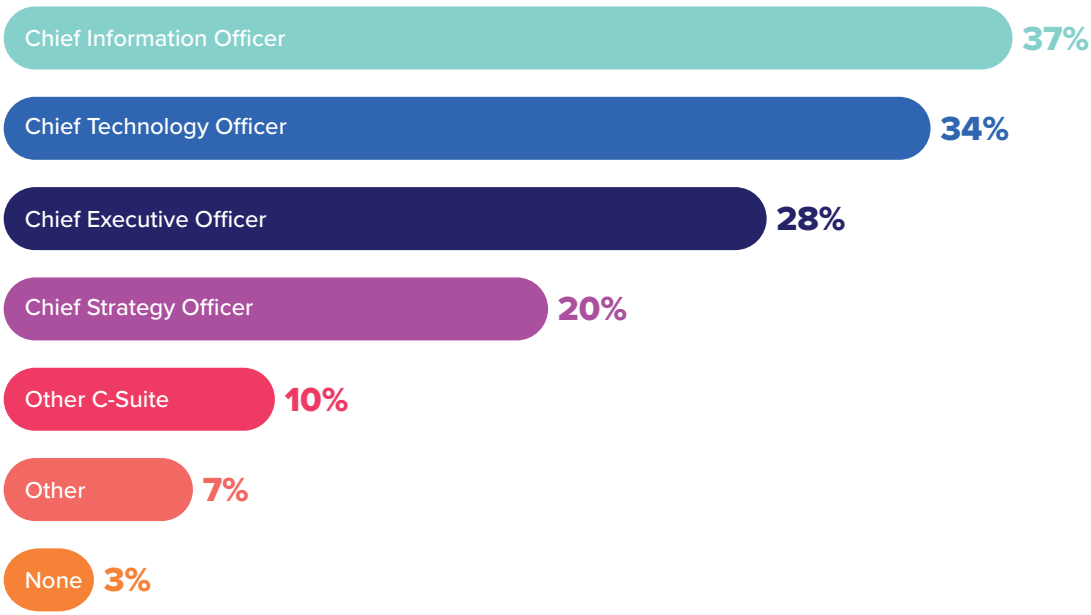
Level of Automation (Current)



Level of Automation (Target)



Data and AI Leadership



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