IOWA STATE UNIVERSITY
Center for Industrial Research and Service

ciras

Iowa Manufacturing Needs Assessment

2021-2022

MEP National Network™
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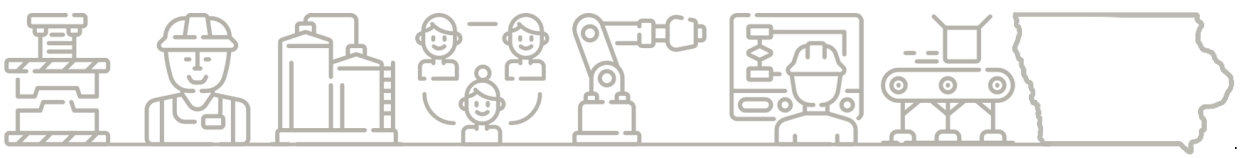

Contents

The Center for Industrial Research and Service (CIRAS) provides applied research, education, and technical assistance to Iowa industry through partnerships with Iowa's universities, community colleges, and government agencies. Assistance is supported in part by the DoC/NIST Hollings Manufacturing Extension Partnership, the DoD/DLA Procurement Technical Assistance Program, the DoC/EDA University Center Program, and the State of Iowa Economic Growth Committee appropriation for the CIRAS Technology Assistance Program.

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Executive Summary

CIRAS conducts a biennial assessment to better understand the needs of manufacturers in Iowa. This report highlights the results of a survey of leaders at 213 manufacturers across Iowa and follow-on discussions with manufacturing leaders and others supporting the manufacturing ecosystem.

Key findings include the following:

- Manufacturing profitability has remained generally flat through the pandemic, demonstrating the resiliency of manufacturing businesses.
- Raw material costs, availability of hourly workforce, and rising labor costs have surpassed rising healthcare costs as the top concerns limiting growth over the coming years.
- Development and introduction of new products was hampered by the pandemic. Delays were not aimed at conserving cash, but a lack of human capital and material availability.
- Manufacturers expect continued growth in the cost of supplies due to re-baselining of commodities and the flow-through of increased wages industry-wide.
- Safety, social media marketing, 3D CAD, and flexible scheduling are now joined by cybersecurity as the most implemented initiatives in Iowa manufacturing.
- 87% of survey respondents report implementing at least one Industry 4.0 technology or enabling technology, which demonstrates readiness for continued technology change.
- Training, identifying applications, and availability of technical talent are the largest concerns limiting Industry 4.0 implementation.

As a result of the analysis, CIRAS identified the below as the core needs of Iowa manufacturers to remain competitive over the next three to five years:

WORKFORCE	LEADERSHIP & GROWTH	TECHNOLOGY & PRODUCTIVITY
NEED 1: Transition to company-specific, actionable workforce solutions.	**NEED 1: Support to thrive in uncertainty.**	**NEED 1: Leverage technology to create productivity leaps.**
NEED 2: Continue to increase workforce collaboration.	**NEED 2: Build the leadership pipeline.**	**NEED 2: Build on early success with Industry 4.0.**
	NEED 3: Improve supply chain connections.	

The State of Manufacturing in Iowa

Manufacturing is a core driver of Iowa's economy. Nearly 3,500 manufacturers contribute in excess of $33 billion to Iowa's economy, making it the largest sector in Iowa's economy. With nearly 219,000 people making an average wage of $55,924, manufacturing is unmatched in its ability to provide high quality jobs for such a large portion of Iowa's population.[1]

To better understand the underlying issues, risks, and opportunities that will define the future of manufacturing, CIRAS conducts a biennial needs assessment of Iowa manufacturers. In 2021, 213 manufacturers of all varying sizes and types responded to an in-depth survey regarding their companies, limitations to growth, actions, and results.

Respondents to this survey represent 3% of very small manufacturers (19 or fewer employees), 9% of small manufacturers (20-99 employees), 13% of mid-sized manufacturers (100-499 employees) and 15% of large manufacturers (500 or more employees). This survey is not a strong representation of manufacturers that are classified as very small. However, we consider this survey to be a good representation of Iowa manufacturing as a whole since small, mid-sized, and large manufacturers make up 94$ of all manufacturing employment in Iowa.

In past reports, a variety of formal forums have been held to provide context to this report. In recognition of the current strain on manufacturing workforce and supply chains, formal forums were not held. In their place, input and supplemental information were obtained through a variety of existing formal and informal interactions with manufacturers and stakeholders throughout Iowa. These include Industry 4.0 roundtables hosted by Iowa's fifteen community colleges, the Iowa Innovation Council's Advanced Manufacturing Working Group, the CIRAS Advisory Board, CIRAS events, and others.

[1] Source: U.S. Census Bureau County Business Patterns, U.S. Bureau of Economic Analysis

This section of the report provides the key findings and conclusions on the wellbeing of Iowa manufacturers and subdivisions within manufacturing. The second section provides additional detail on Industry 4.0, and the final section identifies key focus items that are critical to the wellbeing of Iowa manufacturing in the next three to five years.

Profitability

The majority (53%) of respondents to the survey report a return on sales (ROS) of more than 10%, the first time that this survey has indicated a majority above 10% (Figure 1). Generally, profitability remained consistent through the pandemic. Manufacturers with less than 100 employees are more likely to report losing money or having a profitability below 5% (Figure 2).

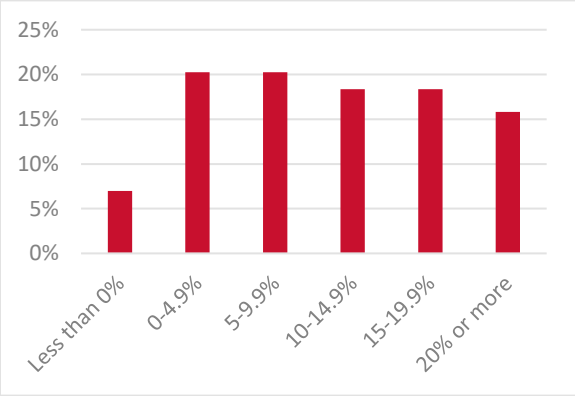


Figure 1: Return on sales for all respondents.

53% of respondents report a return on sales of more than 10%

More than 15% of respondents reported an ROS of 20% or higher. This demonstrates that there is a significant group of manufacturers that create and sell high-value products. There are no aggregate characteristics that effectively explain this group of high performers. Rather, this is a group of companies that have created a unique offering for their market

and are implementing the right solutions to maintain their competitive advantage.

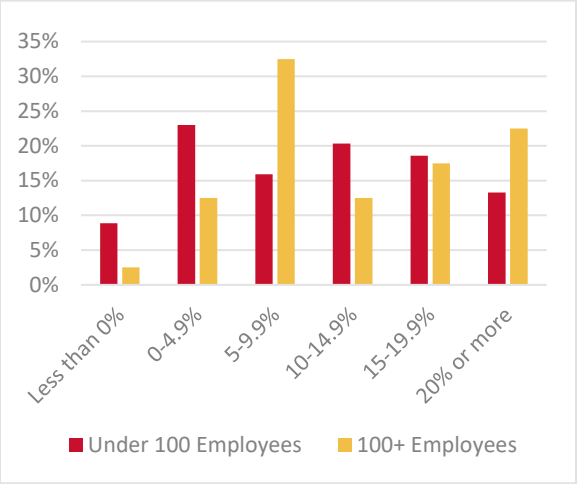


Figure 2: Return on Sales results, by number of employees.

A notable finding is the general lack of statistically significant variation in ROS by a number of factors. As we have found in past surveys, location, industry and other factors also did not show statistically significant impact on ROS.

In contrast to previous surveys, respondents with a stated strategy of innovation were more likely to report an ROS of 20% or more. This matches results found in a similar survey in Georgia[2]. One possible cause of this improvement is that manufacturers with a stated strategy for innovation are more flexible and better able to respond to the significant demand shifts seen in the pandemic. However, the limited sample size and history of not seeing this correlation indicate that caution should be taken in drawing any strong conclusions.

Business Strategy

The ability to deliver products with higher quality than the competition is the most common strategy among Iowa manufacturers (Figure 3), followed by superior customer service. There have been no significant changes in the strategy mix among respondents since the previous survey.

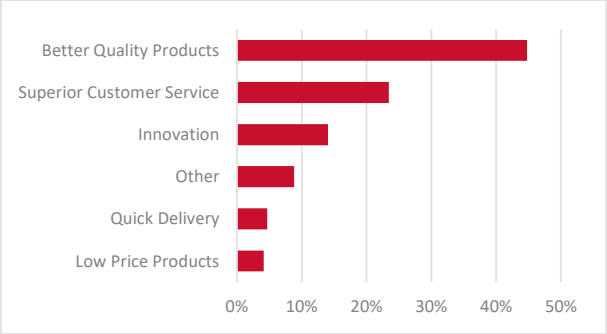


Figure 3: Primary business strategy of respondents.

Growth Strategies

The survey asked a variety of questions related to strategy, including identification of the top three planned actions to grow profits (Figure 4). The most frequently identified planned source of sales growth is to increase sales through increasing market penetration in current markets. Reducing production costs was the second most frequently stated goal and accessing new domestic markets was third.

The number of companies reporting that they intend to grow through new products dropped by 25% from the previous survey. This is partially influenced by shifting investments due to COVID-19 uncertainty and by a higher than typical response rate from fabricated metal products manufacturers. Manufacturers in this category are typically job shops and historically much less likely to develop and market products of their own.

Figure 5 shows the variation in strategy by company size. As expected, larger manufacturers are more likely to grow through new products and international markets, while smaller manufacturers tend to aim at higher market penetration and adjacent markets in an effort to achieve the market size of larger manufacturers.

Figure 6 shows the variation in growth strategies by industry. Respondents in the food manufacturing and plastics and rubber product manufacturing industries are more focused on new products than other industrial groupings. Their levels of new product introduction have remained similar from past surveys, while other industries have dropped.

[2] http://gms-ei2.org/

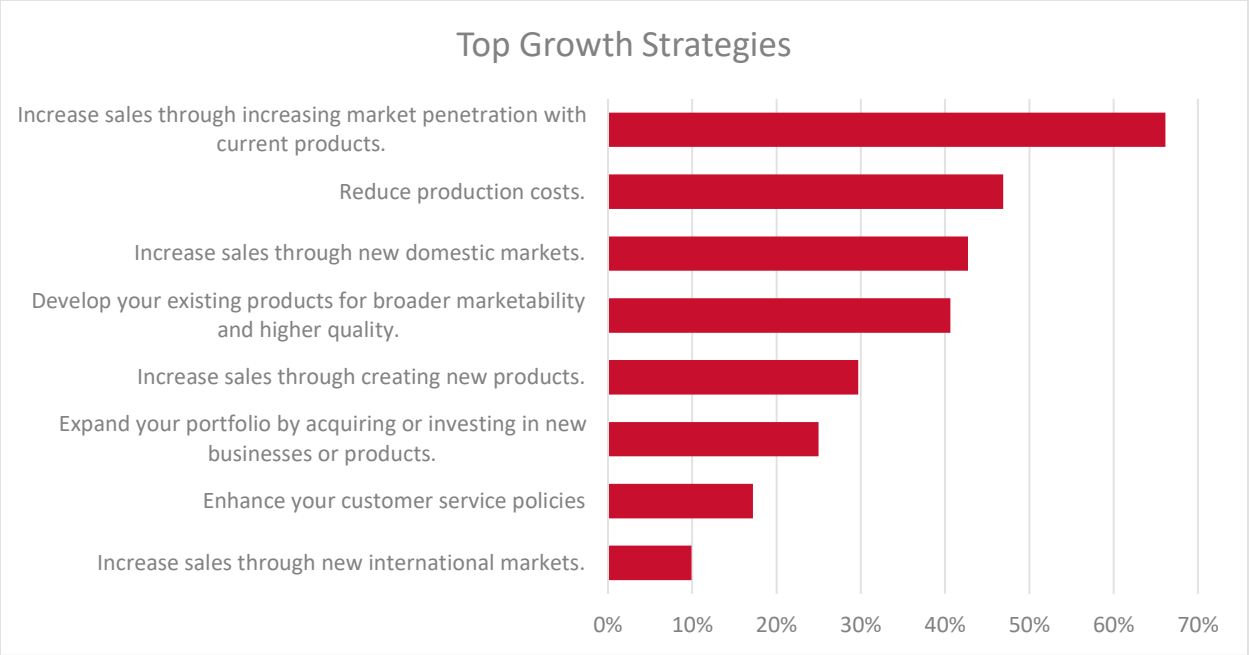


Figure 4: Percent of respondents identifying a given strategy among their top three approaches to growth.

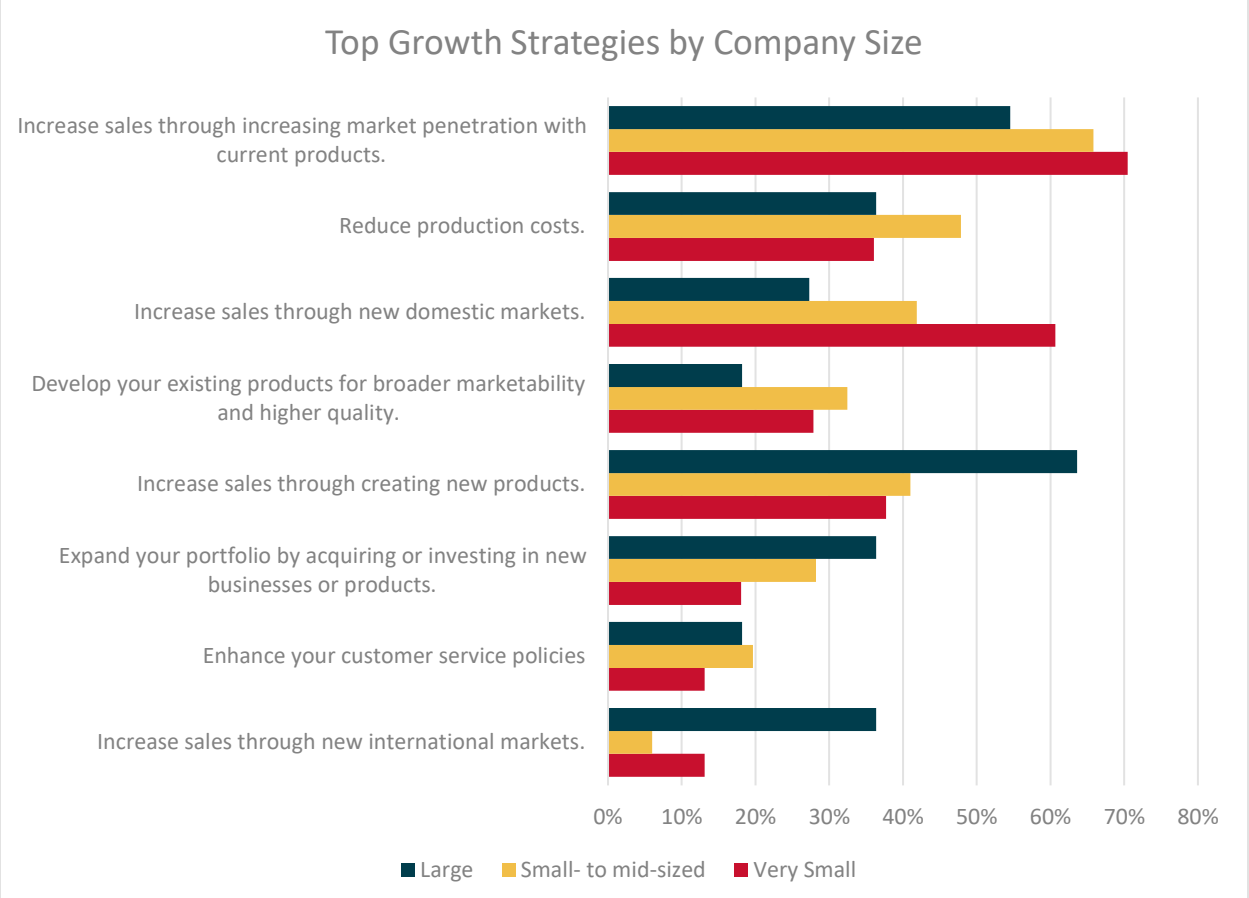


Figure 5: Growth strategies by company size.

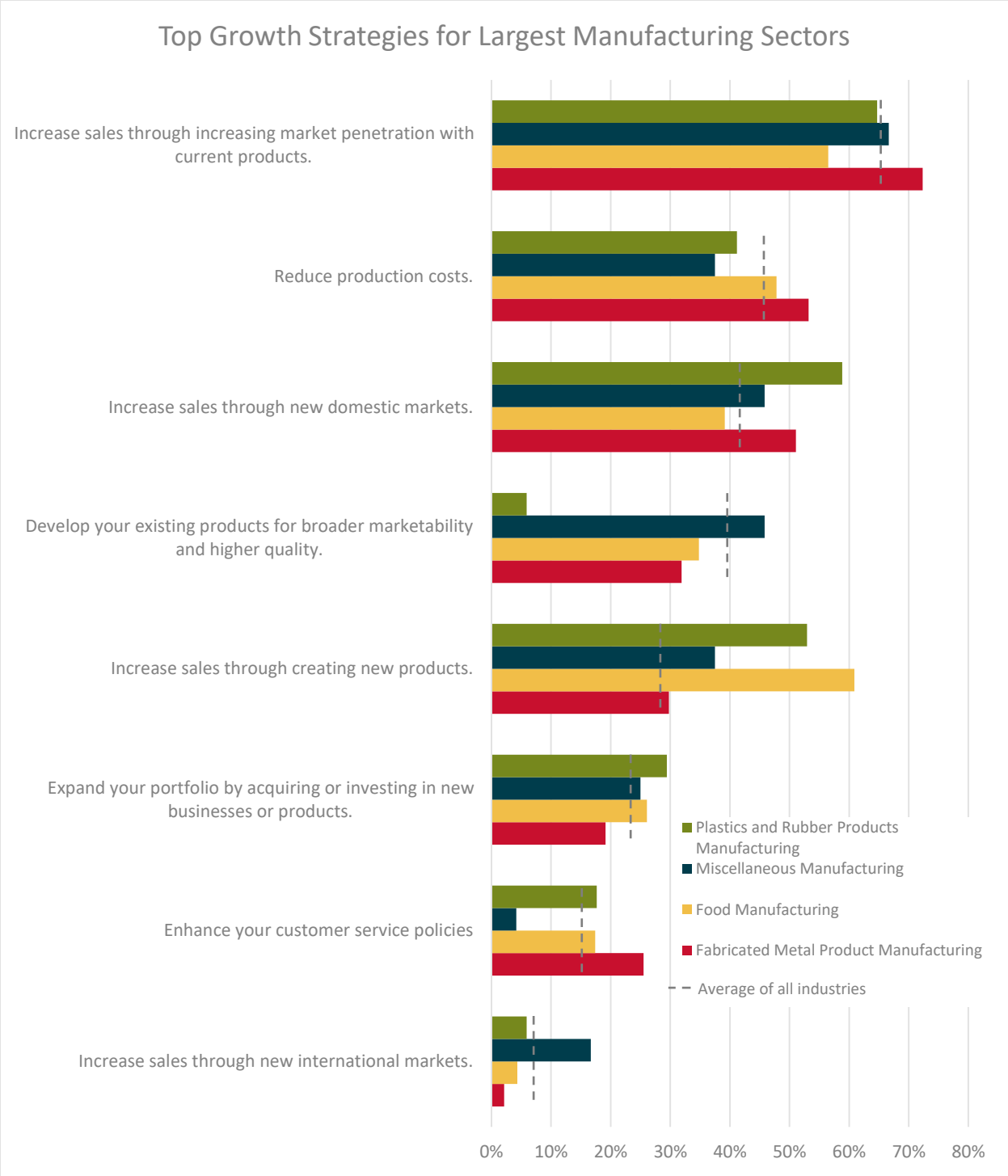


Figure 6: Growth strategies by industry.

Developing New Products

One key factor in the long-term success of a manufacturing business is the ability to develop new products and services on a regular basis. This survey (Figure 7) continues to demonstrate that the portion of Iowa manufacturers releasing products new to the market is relatively small. In this survey, the portion of manufacturers that have not released any new products has grown substantially. See sidebar "New Products Gap" for additional information.

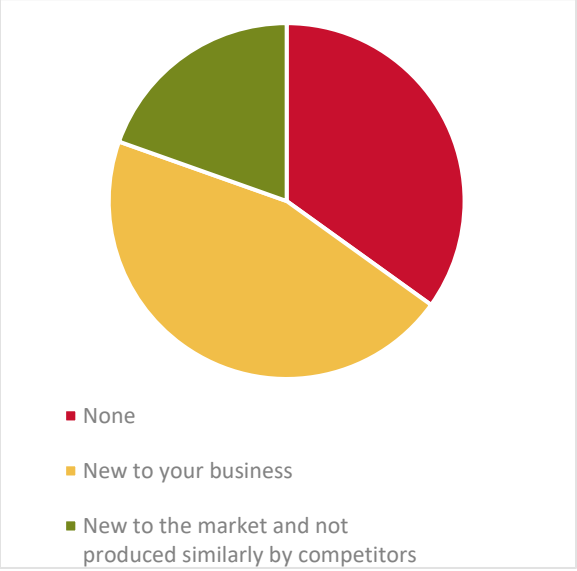


Figure 7: Portion of companies releasing new products and services in the past year.

We also continue to identify a significant gap in product development among companies with less than 100 employees. Only 58% of manufacturers with less than 100 employees released new products, while 82% of their larger counterparts released new products. Long term success of smaller companies, especially in times of wage growth, will be influenced by the ability of these companies to innovate their products and processes to capture additional value.

New Products Disruption

Manufacturers have released fewer new products in the past year and have generally reduced their plans to rely on new products for growth. However, manufacturers are clearly continuing to invest in capital and labor, so why the sudden change in strategy? Follow-up conversations with manufacturers identified three key interrelated reasons.

1. **Companies prioritized emerging issues over product development.** COVID-19 and supply chain complexities forced leaders to make difficult decisions with their limited labor pools. In many cases, staff were diverted from product development to alternate supplier identification, production floor controls, and similar concerns.
2. **Existing backlogs for some manufacturers are measured in years, not weeks.** When the backlog for products extends beyond the typical product development cycle, developing and releasing new products delays their return on investment until factory capacity is available.
3. **Suppliers are unwilling to quote new products** due to their current backlog and risks associated with price, transportation, and material availability.

When an individual company is required to delay or halt new product development, it frequently puts them at a long-term disadvantage. However, the number of companies in this position reduces the risks. Manufacturers that are fastest to clear backlogs, develop, and tool new products will be able to create new advantages as we emerge from the impacts of the pandemic.

Inhibitors of Growth

To best determine the needs of Iowa manufacturers, it is important to understand what items business leaders perceive as the major impediments to growth. As the world recovers from the COVID-19 pandemic, leaders' perspectives on these risks will be a key driver in investments over the coming years.

Figures 8 and 9 provide summaries of responses to the question "*I believe ___ will impact my ability to grow over the next five years*." Raw material costs, workforce availability, labor costs, and healthcare costs stand out from the balance of issues. Infrastructure (power, water/wastewater, internet etc.) was rated the lowest among respondents.

As expected, these results have changed significantly compared to previous surveys. Figure 10 shows how perceptions of healthcare costs, availability of hourly workforce, labor costs, raw materials costs, and U.S. government regulations and their impact on growth have changed over time.

Raw material costs were identified as the top issue impacting growth over the next five years. While many expect some pricing relief in late 2022 on key commodities, leaders have expressed that they expect significant challenges to input cost prices. These concerns fall into three categories: Price re-baselining, supply chain restructuring, and cost flow-up.

Long-lasting price pressures in commodity industries have eroded margins. The price shocks have created an opportunity for these industries to reset pricing to restore margins and continue long term investments. Many businesses expect a new baseline for commodity inputs to remain.

Manufacturers have recognized the extent of supply chain risks associated with their current model. Research[3] has identified twenty-eight key supply chain risk drivers across nine categories. Historically, most manufacturers would manage several risks using basic operational tools (e.g., forecasting) and limited high-impact risks strategically (e.g., natural disasters) over long periods of time. Over the past two years, most have directly experienced dozens of the risks simultaneously. Now, manufacturers are aggressively restructuring supply chains, including distributed manufacturing, increased inventory, and new transportation routes. While these changes will reduce long-term risks, they come with short term costs.

In addition to the structural costs of supply chains increasing, the direct costs of labor are increasing at each stage of the supply chain. As a result, those costs are also flowing up the chain. Manufacturers with more tiers in the supply chain will see this in a more pronounced way.

Inadequate availability of hourly and salaried workforce coupled with **rising labor costs** have dramatically increased through the pandemic. Manufacturers have continued to implement traditional solutions including wage increases while also implementing innovative approaches to workforce including flexible scheduling, unique benefits, and others. However, manufacturers of all types continue to experience workforce gaps and increased costs.

Historically, manufacturers expressed confidence in their ability to tackle all challenges. However, in this survey, only 34% of respondents expressed confidence they have the resources to solve their workforce issues.

CIRAS research (see sidebar, page 11) indicates that the workforce constraints were accelerated by COVID-19, but the primary causes are structural population gaps and long-term trends. As a result, we expect the current struggles for workforce to continue for a long duration, which is clearly echoed by manufacturing leaders through this survey.

[3] Chopra, S. and Sodhi, M., "Managing Risk to Avoid Supply-Chain Breakdown", MIT Sloan Management Review. October 2004.

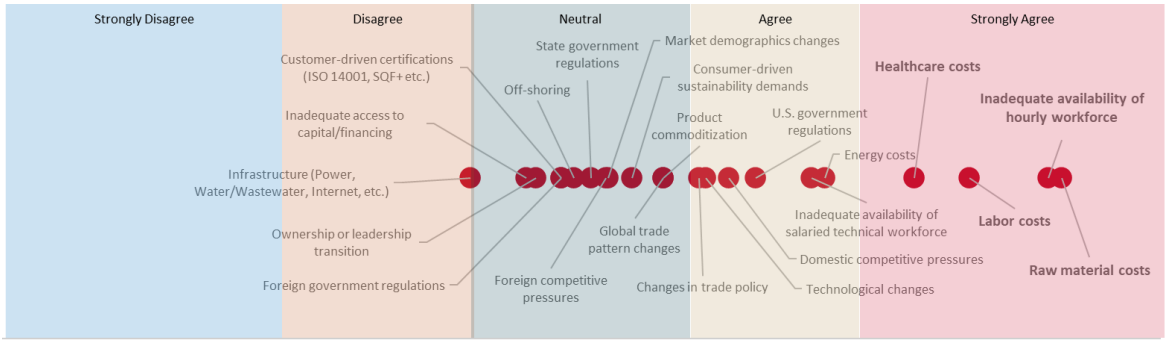


Figure 8: Average rating for company-reported inhibitors of growth.

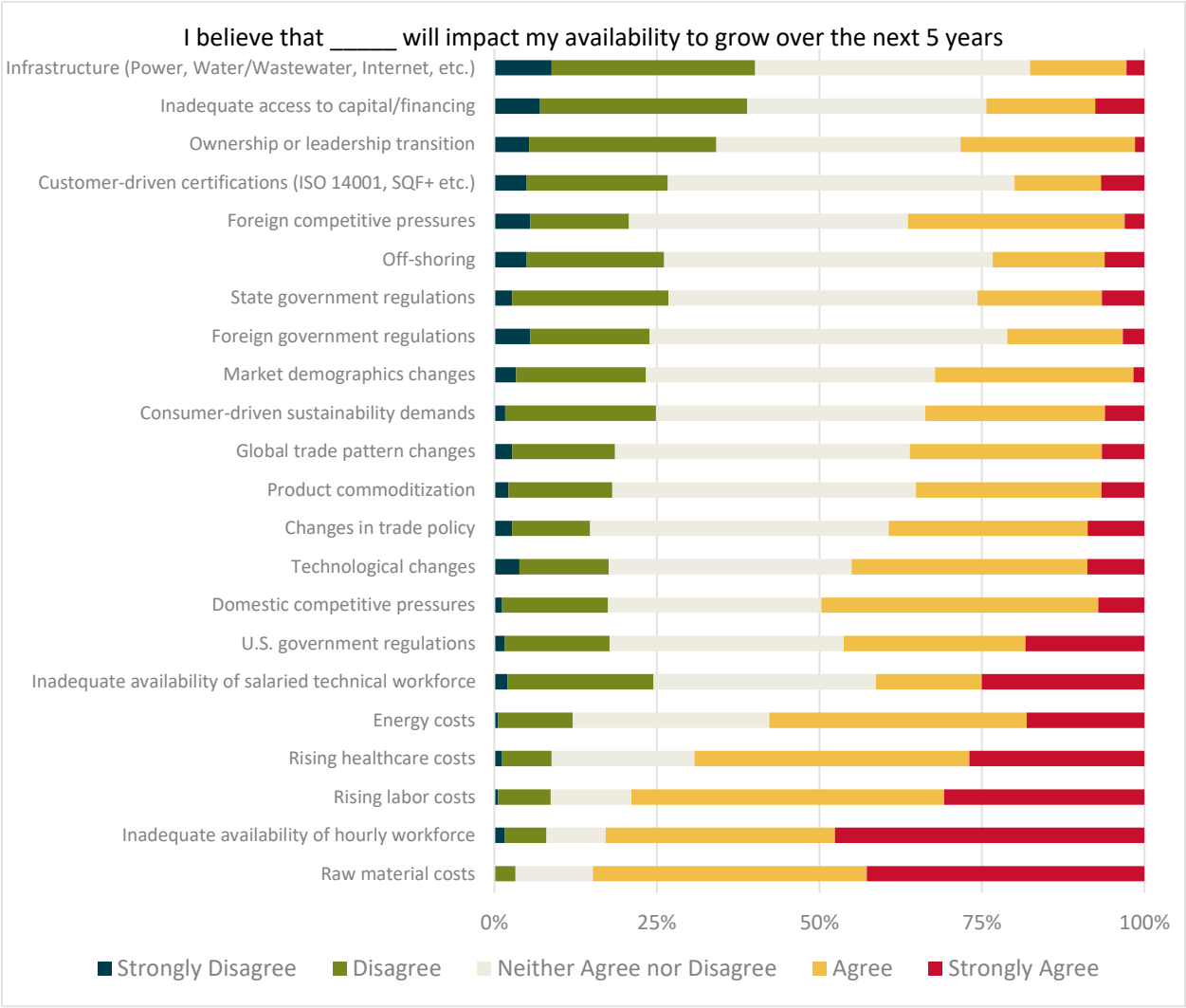


Figure 9: Detailed breakdown of company-reported inhibitors of growth.

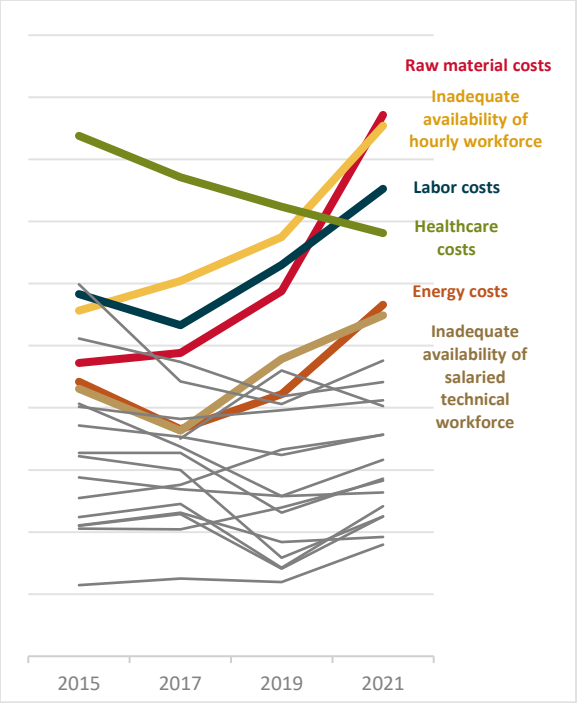


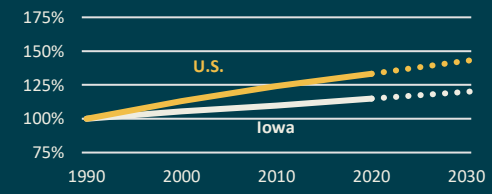
Figure 10: Key changes in growth inhibitors over the past four surveys.

Healthcare costs continue to decline in rank as a growth inhibitor. Manufacturers continue to report progress in managing healthcare costs as part of their overall cost structure. However, some of this cost control is through increases in employee shares of health care costs, which may put longer term pressures on labor costs.

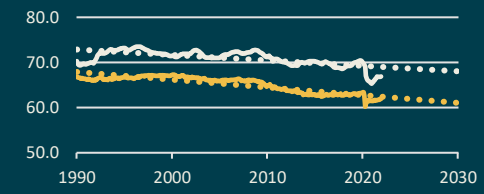
In addition, the impact of the pandemic on health care costs and long-term health is not fully understood. The Centers for Medicare and Medicaid Services (CMS) has reported that healthcare spending in the United States increased by 9.7% in 2020 alone[4]. However, a large share of that burden was taken on by the federal government, while private insurance spending decreased 1.2% during the same year. The impact of the cost of health care will continue to be a concern over the coming years.

Workforce Trends [5]

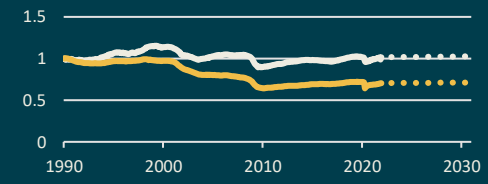
Since 1990, Iowa's population has grown at half the rate of the U.S. population:



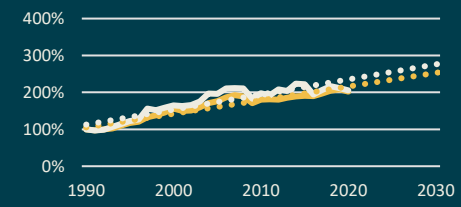
Iowa's workforce participation rate remains far above the national average:



The number of Iowa manufacturing employees has significantly outperformed the U.S. overall:



Real GDP has grown at a steady pace for U.S. and Iowa. Iowa's productivity (GDP/person) has not kept pace with national manufacturing:



For manufacturers to thrive over the coming decade, they may need to continue to grow with similar or reduced levels of total workforce and significant productivity gains.

[4] https://www.cms.gov/newsroom/press-releases/national-health-spending-2020-increases-due-impact-covid-19-pandemic. Accessed 2/10/2022

[5] Source: U.S. Census Bureau, U.S. Bureau of Labor Statistics. Population projections based on U.S. Census Bureau. Manufacturing Employment projections based on BLS Projections. Workforce participation and GDP trendlines displayed for perspective and are not a projection.

Energy cost concerns have grown substantially over the past four years. According to data from the U.S. Energy Information Administration, Iowa has the seventh lowest industrial electricity costs[6] and twenty-sixth lowest industrial natural gas costs[7]. Average industrial electricity prices have remained consistent for nearly a decade. However, summer month price increases have become more volatile. Historical prices would increase about 25% during the hottest months. For the past 5 years, those increases have been as high as 50%.

Natural gas prices were stable from 2015 through 2019, when they declined 40% from history followed by a significant increase to 60% above baseline prices from early 2020 through today.

Inhibitors by Industry, Strategy, and Size

As we have seen in the past, the specific growth inhibitors varied across manufacturing subsectors. Figure 11 breaks down top issues by a variety of factors.

		Top 3 Issues	Bottom 3 Issues
Industry	Fabricated Metal Product Manufacturing	Inadequate availability of hourly workforce **Raw material costs** Rising labor costs	**Infrastructure (power, water, internet, etc.)** **Inadequate Access to Capital/Financing** **Ownership or leadership transition**
	Food Manufacturing	**Raw material costs** Inadequate availability of hourly workforce Rising labor costs	Foreign competitive pressures Off-shoring **Foreign government regulations/Ownership or leadership transition (tie)**
	Miscellaneous Manufacturing	Raw material costs Inadequate availability of hourly workforce **Rising labor costs**	**Infrastructure (power, water, internet, etc.)** Inadequate access to capital/financing Ownership or leadership transition
	Plastics and Rubber Products Manufacturing	**Raw material costs** Inadequate availability of hourly workforce Rising labor costs	**Foreign government regulations** **Infrastructure (power, water, internet, etc.)** **State government regulations**
Strategy	Better Quality Products	**Raw material costs** Inadequate availability of hourly workforce Rising labor costs	**Infrastructure (power, water, internet, etc.)** **Inadequate access to capital/financing** **Ownership or leadership transition**
	Innovation	**Raw material costs** **Inadequate availability of hourly workforce** Rising health care costs	**Infrastructure (power, water, internet, etc.)** Market demographics changes Customer-driven certifications
	Superior Customer Service	**Raw material costs** Inadequate availability of hourly workforce Rising labor costs	**Ownership or leadership transition** **Market demographics changes** **Off-shoring**
# of Employees	1-19	Raw material costs Rising labor costs **Inadequate availability of hourly workforce**	Ownership or leadership transition **Infrastructure (power, water, internet, etc.)** **Foreign Government Regulation**
	20-99	**Raw material costs** Rising labor costs Inadequate availability of hourly workforce	**Infrastructure (power, water, internet, etc.)** **State government regulations** **Foreign government regulations**
	100-499	Inadequate availability of hourly workforce **Raw material costs** Rising labor costs	Inadequate access to capital/financing **Infrastructure (power, water, internet, etc.)** **Ownership or leadership transition**
	500+	Inadequate availability of hourly workforce Raw material costs **Rising labor costs**	Inadequate access to capital/financing Ownership or leadership transition **Off-shoring**

Figure 11: Top and bottom three inhibitors of growth by industry, strategy, and company size.
*Items in **bold** indicate new items from the 2019-2020 list. This is the first year infrastructure has been an option.*

[6] https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a.

[7] https://www.eia.gov/dnav/ng/ng_pri_sum_a_epg0_pin_dmcf_m.htm

Actions and Results

Our survey asks two questions regarding strategic initiative actions and results. First, for a list of 23 initiatives, the survey asked the extent to which the company has implemented each item (5 = Implemented and being sustained, 4 = Implementation in Progress, 3 = Plan complete and starting implementation, 2 = Implementation planning started, 1 = Have not implemented). Note the scale has been changed from previous surveys and historical scores have been adjusted to the new scale in this analysis.

For the same list of initiatives, the survey asked the perceived benefits for the initiatives companies have implemented (5 = Significantly Above Expectations, 4 = Above Expectations, 3 = Met Expectations, 2 = Did Not Meet Expectations, 1 = Significantly Below Expectations).

Pairing these two questions provides insight into implementation levels among Iowa manufacturers and potential benefits compared to expectations.

Figure 12 shows the results from both questions. Of note is the continued generally low level of implementation of initiatives despite positive results for those that have implemented similar programs.

Keeping with the long-term trend, safety programs are the most widely implemented initiatives among Iowa manufacturers, and they have continued to demonstrate results above expectations for companies that have implemented them. In this survey, cybersecurity joined social media marketing, flexible scheduling for employees, 3D CAD (computer-aided design) and advanced engineering tools, as the only other initiatives scoring above a 3.0, which is the level at which an initiative is considered to have moderate penetration among Iowa manufacturers.

As the COVID-19 pandemic, geopolitical issues, and new technologies have impacted manufacturers, there have been significant changes in implementation rates in some key initiatives, as shown in Figure 13.

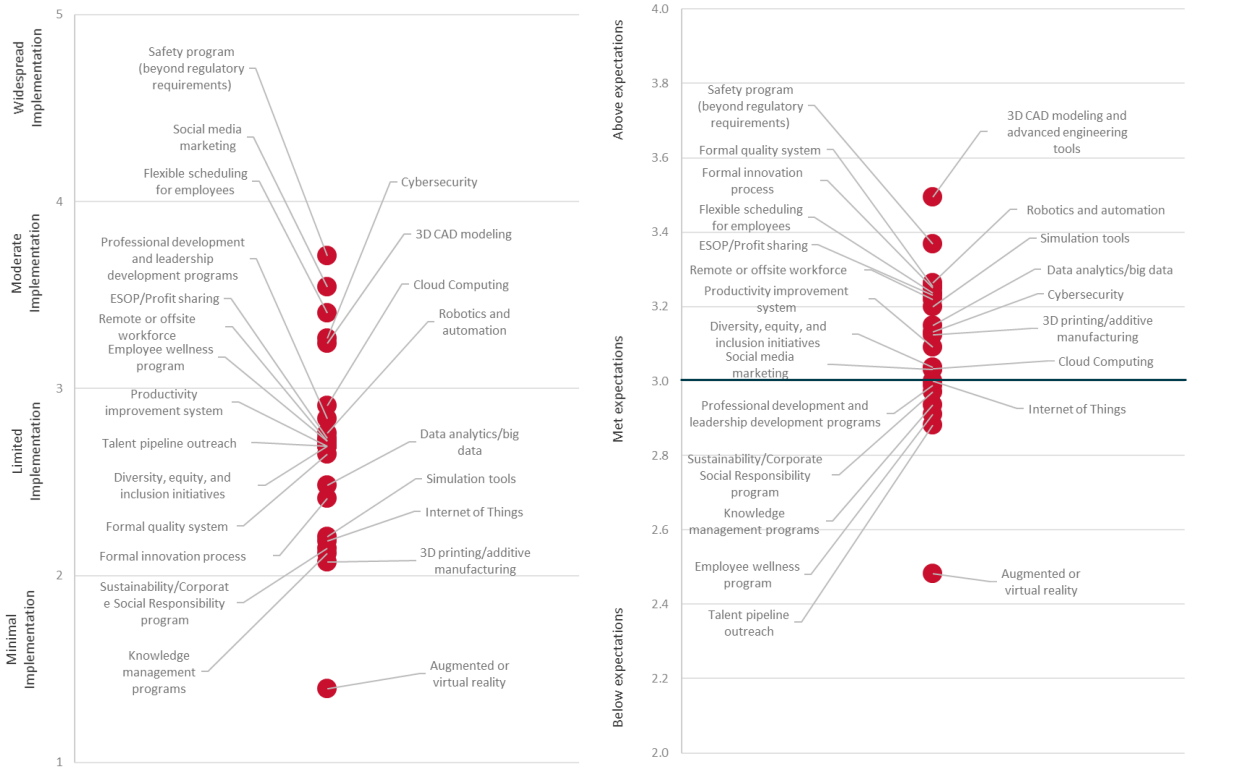


Figure 12: (a) Extent of initiative implementation among respondents; and (b) Perceived results of initiatives among those who implemented.

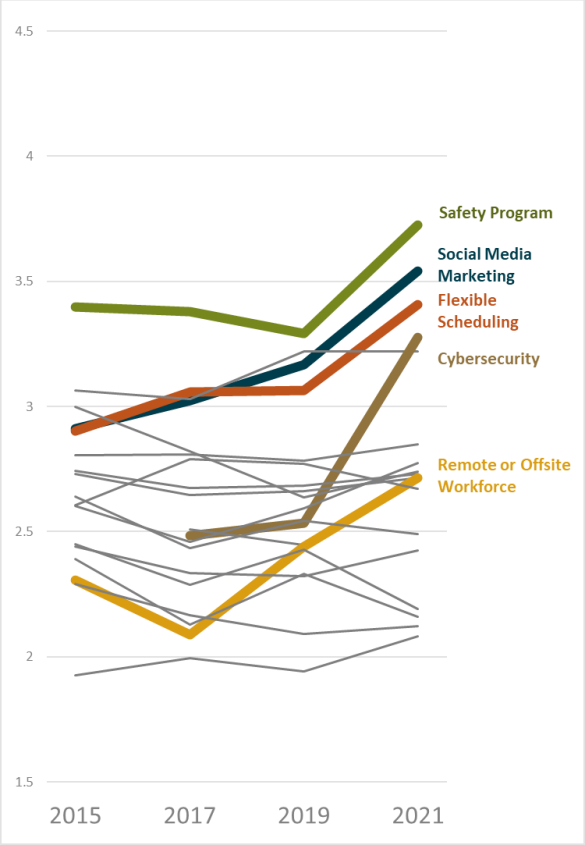


Figure 13: Changing implementation rates.

Safety Programs beyond regulatory requirements have always been the most-implemented initiatives in our survey. Despite the high ranking, we saw this increase substantially compared to previous surveys. This likely reflects the increased COVID-19 controls manufacturers have implemented and sustained through the pandemic. Iowa manufacturers have largely been proactive and aggressive in ensuring that they implemented effective controls to reduce the risk to their people and their business. Through our weekly and biweekly pandemic roundtables and other forums, CIRAS regularly encountered manufacturers that were experimenting and adjusting COVID-19 safety controls as society's understanding of the disease changed. While many pandemic related controls will continue to wind down as the pandemic declines, we expect manufacturers to maintain a variety of best practices such as clarified and more flexible sick leave policies.

Social Media Marketing continues to grow in implementation rates and has high market penetration among Iowa manufacturers. In this survey, implementation is meeting expectations for the first time. Manufacturers report using social media marketing for both customer engagement (business-to-consumer, business-to-business) and for employee recruiting. In the past several years, most manufacturers have been able to identify specifically which aspects of social media marketing work for their specific business model and needs. As a result, they can limit their time and financial investments to strategic approaches that generate returns.

Flexible Scheduling and **Remote or Offsite Workforce** dramatically increased compared to previous surveys. While some of this is certainly due to pandemic-driven needs there are indications that this is part of a long-term trend. The increase in use of flexible scheduling was in line with the trend and increase of remote or offsite workforce was similar to the previous survey's increase. While COVID-19 may have accelerated change, we believe that manufacturers understand changing needs and expectations of today's workforce and are implementing creative solutions to meet those needs. Manufacturers of all sizes have implemented flexible scheduling at similar rates. Smaller manufacturers are less likely to have implemented a remote or offsite workforce. Our analysis showed that rural and urban manufacturers are equally likely to implement either initiative.

Cybersecurity use among manufacturers has increased substantially over the past two years. 65% of respondents indicate some implementation of a cybersecurity program, compared to 48% in the previous survey. Overall, this is a very promising step. Respondents continued to indicate that implementation met expectations. Cybersecurity protections have become a generally accepted part of doing business. In-depth discussions with manufacturers as part of the Industry 4.0 roundtables hosted by Iowa's community college network provided additional insights into implementation. Participants discussed the use of internal or external resources to improve basic cyber hygiene within their business: firewalls, passwords, and some basic anti-phishing training. As manufacturers continue to modernize, it will be critical to expand cybersecurity from an "Information Technology" (IT) discussion to an

"Operational Technology" (OT) discussion. The addition of connected machines, web-based analytics, and even simple tools such as connecting time clocks to outsourced payroll systems adds new risks to manufacturers of all sizes. We will need to continue to refine the definition of effective security and provide smaller manufacturers with the information and tools to effectively maintain safe equipment.

The implementation gap continues to persist in Iowa manufacturing. The traditional gap that we have highlighted in the past remains strong: small manufacturers are less likely to implement change. Yet when they do, they typically see results compared to expectations like those of their larger counterparts. In addition, two additional gaps are emerging.

The first is the risk-driven gap. We regularly hear from manufacturers that know they can benefit from implementing an initiative but state they do not have the resources to do so. Sometimes these resources are needs where a business does not have the internal expertise, capacity, or capital to execute the project. More often, there is a risk-adjusted decision process that leads a business to decide they do not have the resources to implement change. In these circumstances, the business has the resources to implement the initiative if it is successful, but failure would cause too many disruptions and loss of time or capital that is critical for success. As a result, the manufacturing leader chooses the safer option, which results in lower near-term risk at the expense of long-term risks. Recent use of grants to incentivize technology implementation among manufacturers[8] have shown potential for small reductions in risk to drive immediate change. Continuing to increase sources of risk reduction will bring positive change in this gap.

The second gap is specific to implementation of productivity initiatives. Many manufacturers have implemented and sustained a continuous improvement program such as lean while others experienced short, failed implementations sometime over the past twenty years. As a result, too many manufacturers have permanently given up on systematic productivity improvement. A critical piece of the workforce solution in the next ten years will be to help manufacturers revisit productivity programs in a simple, results-oriented way.

[8] https://www.iowamfg.com/technology-investment-program/

Industry 4.0

The fourth revolution in manufacturing is occurring worldwide, where the physical and digital worlds are fully integrated (Figure 14). While the impact and path to Industry 4.0 looks different in every business, the reality is that all manufacturers in Iowa are impacted by the new technologies and associated business models that are emerging. For a detailed analysis on the impacts, status, and strategy for Iowa's transition, see *Seizing the Manufacturing 4.0 Opportunity: A Strategic Plan for Iowa's Manufacturing Industry*[9].

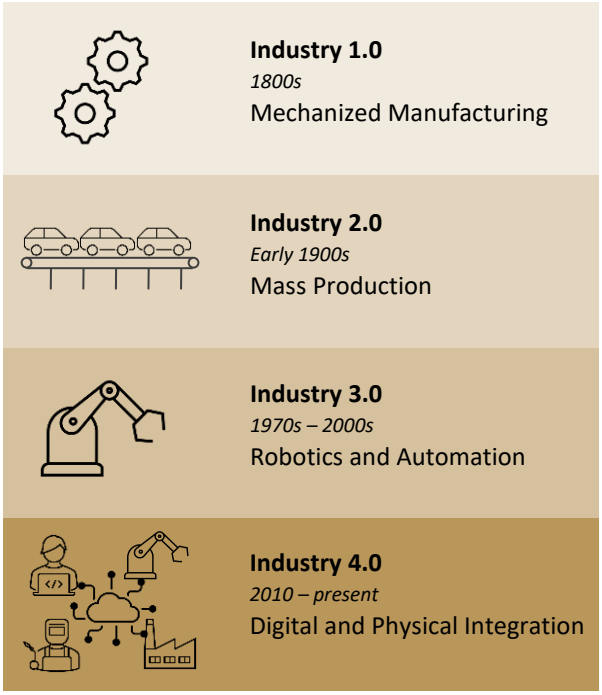


Figure 14: The four industrial revolutions.

In previous surveys, we have asked a variety of technology-related implementation and value questions. In our current survey, we expanded those questions to address a broad variety of Industry 4.0 technologies (Figure 15). In addition, we asked a follow up question to better understand the top challenges in implementing Industry 4.0.

While there is progress to be made in Industry 4.0 among Iowa manufacturers, the results of this survey are promising. Overall, 87% of survey respondents started implementation of at least one Industry 4.0 technology. In line with most initiatives, size was a major factor in implementation, with all manufacturers over 100 employees reporting at least one Industry 4.0 implementation. While this view of the data is promising, additional context from manufacturers illustrates that companies are just beginning their journey in Industry 4.0.

87% of survey respondents started implementation of at least one Industry 4.0 technology or enabling technology

Most businesses that have implemented Industry 4.0 technologies have typically implemented a first step into that space, as was described specific to cybersecurity. In the past, implementing a given initiative was typically a large, focused effort followed by long-term sustaining at a lower level of investment. This approach worked well for initiatives such as ISO-9001 and lean. However, the connectedness, speed of change, and new business models associated with Industry 4.0 require a new strategy. Indication of implementing one of these initiatives means that they have begun that journey, not completed it.

3D CAD and Advanced Engineering Tools was identified as the most-implemented technology set, with 48% of respondents indicating that they have implemented and are sustaining this core enabling technology (Figure 15). Cybersecurity and cloud computing are rapidly catching up with significant ongoing implementation efforts.

Overall, 85% of respondents that implemented an Industry 4.0 technology stated that it met or exceeded expectations. 3D CAD and advanced engineering tools, robotics and automation, and simulation tools were the most likely to exceed expectations. Conversely, augmented or virtual reality, and internet of things implementations were most likely to be below expectations.

[9] Iowa Economic Development Authority, January 2021, https://www.iowamfg.com/UserDocs/pages/IAMfg4_0_Plan.pdf

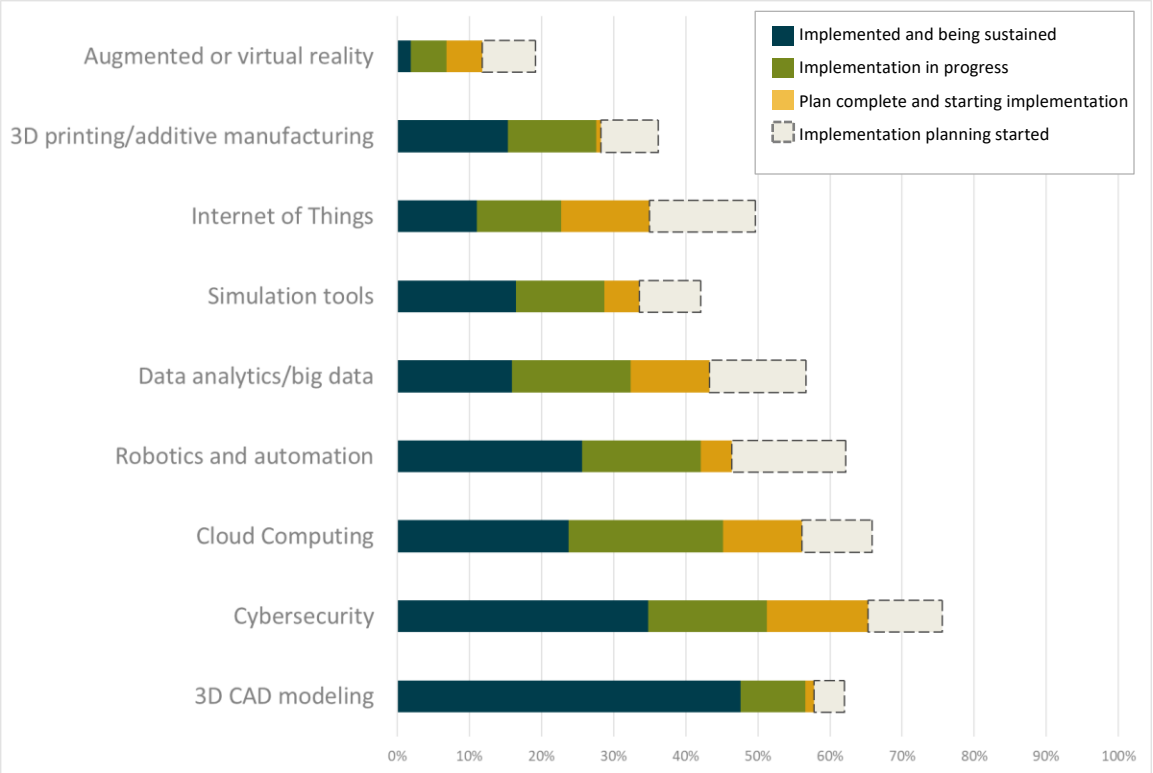


Figure 15: Industry 4.0 implementation among survey respondents.

Augmented or virtual reality clearly stands out as the least commercially ready technology for manufacturing overall. There are use cases that have clear return on investment in augmented and virtual reality. However, the lack of market penetration and frequency of the technology not meeting manufacturer expectations indicates that those use cases are at the limits of current technology and more niche applications than widespread solutions.

We also performed an analysis to look for correlation among implementation of various technologies. While there is not sufficient data over time to identify common paths to industry 4.0, there is enough data to identify core groupings of technology that tend to be common. 3D CAD modeling has moderate correlation with robotics and automation, simulation tools, 3D printing and cybersecurity. In addition, simulation tool implementation has moderate correlation with 3D printing, cybersecurity, augmented or virtual reality, and internet of things implementation. While there are not necessarily clear paths to implement, these findings do identify potentially complimentary technologies.

When considering Industry 4.0 technologies, survey respondents identified training of existing and emerging workforce, identification of applications that will create value, and availability of technical talent to implement and maintain new technology as the top three concerns (Figure 16). While there are numerous efforts ongoing to develop and deploy programs focused on Industry 4.0, there will be a continual challenge in training the current workforce to identify opportunities, implement, operate, and maintain these new technologies.

The suite of technologies that comprise Industry 4.0 have low market entry barriers compared to Industry 3.0 technologies. As a result, the current market is segmented with hundreds of competitors in spaces where there would traditionally be just a few. Training now requires a two-tier approach: First, training on a generic capability then additional training specific to the technology purchased.

Available capital was identified as a constraint by 25% of respondents, indicating that while capital access is important for technologies, it is accessible by manufacturers. This survey and previous surveys have identified that most manufacturers with more than 20 employees do not have issues with access to capital. This identified similar patterns with respect to Industry 4.0, as very small manufacturers were two to three times more likely to identify capital as a constraint to implementing these technologies.

Training emerging workforce, in contrast to training existing and emerging workforce was the second lowest concern. This indicates that companies are generally positive that those entering the workforce, through universities, community colleges, and other paths, are more well prepared for the new technologies than current employees. Risks of implementing new technologies identified as a key constraint for less than 20% of respondents.

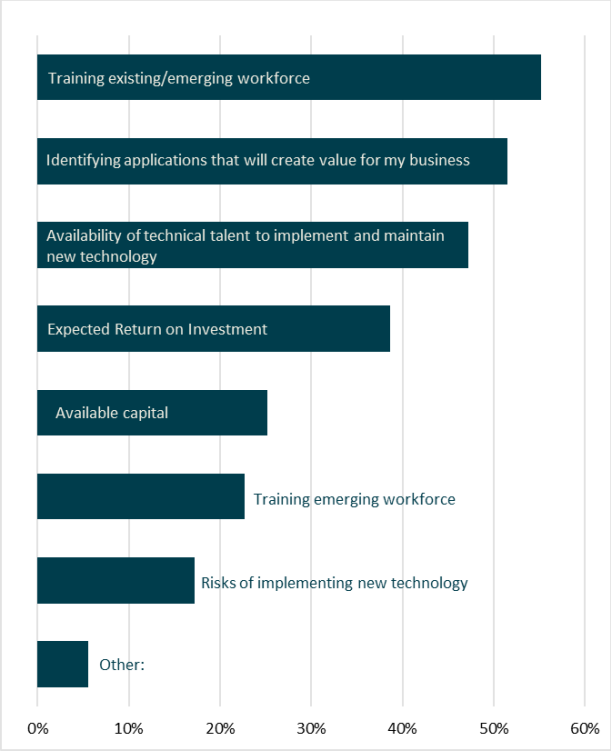


Figure 16: Top concerns limiting Industry 4.0 implementation (identify up to 3).

What Do Companies Really Need?

Based on our 2021 process, CIRAS has identified a handful of core issues that will drive Iowa manufacturing into the future.

WORKFORCE

NEED 1: Transition to company-specific, actionable workforce solutions.

As manufacturers look towards the future, it is clear Iowa's population trends and demographics mean that manufacturing workforce needs will be a constraint for at least the next decade. While broad-based programs to attract people to Iowa and Iowans to manufacturing are valuable and necessary, they are not sufficient for an individual manufacturer to thrive. Each manufacturer must be able to develop and deploy a plan for themselves to succeed in a workforce-constrained world.

There are solutions to solving workforce gaps within an individual business. Proven strategies include improving retention through becoming an employer of choice, automating low-value tasks to increase output and wages, executing a continuous improvement system to reduce waste, and targeting specific subsets of the population. The problem is not the lack of solutions, rather the number of manufacturers that have successfully developed and executed a plan for their workforce. Increased access to information, practices, and resources to build and execute plans will help alleviate some of the workforce stress.

NEED 2: Continue to increase workforce collaboration.

While individual businesses must begin to develop and execute specific plans to solve their workforce needs, businesses must begin to work together in order to make real progress in fulfilling workforce needs. Competition among manufacturers for people is a beneficial and necessary part of a regional economy. The best places to work get the best people.

However, when businesses collaborate to share practices to optimize their workforce, provide career development opportunities, they can shift from being a great business to work in, to a great community to work in. While there will be necessary spaces where manufacturers will compete for talent, finding sustainable models that allow collaboration for common needs must continue to increase.

LEADERSHIP & GROWTH

NEED 1: Support to thrive in uncertainty.

The macroeconomic events of the past three years combined with geopolitical uncertainty create risks and opportunities for Iowa manufacturers. Supply chains are shifting, transportation and raw material costs are dynamic, and other risks continue to upend the status quo for manufacturers. The choice to invest in a technology is influenced by a business' workforce strategy and can be immediately changed by a shift in global supply chains.

The next several years will require leaders to make informed, risk-adjusted decisions on a regular basis. Access to trusted tools, networks, and expert cross-functional advice will be more needed than ever. Continued collaboration across the manufacturing ecosystem in Iowa, plus new collaborations among manufacturers, service providers, and others will be required for success.

NEED 2: Build the leadership pipeline.

Iowa's population continues to age and change. We are in the process of undergoing two changes that will significantly impact manufacturers. First, our current population distribution (Figure 17) shows that when the current baby boomer population retires there simply aren't enough people in the 40-

54 age group to replace them. While this has implications for the general workforce, it creates pressing issues for senior leadership. As experienced leaders at manufacturers retire, there will not be enough people with experience to replace them. This will create issues at all levels of companies, and is not on the radar of most executives, as evidenced by the low rating of ownership or leadership transition in the survey. Action will be needed over the next three to five years to rebuild this pipeline.

The second issue regarding the leadership pipeline is one of diversity. Iowa's younger population is a significantly more diverse population. Analysis of 2020 census data from the Brookings Institution[10] shows that 26.5% of Iowa's population under the age of 18 is non-white, and these diverse populations are the driver of population growth in the state. As the new generation of leaders emerge, we must consider the diversity of those leaders and the ability effectively lead a diverse workforce.

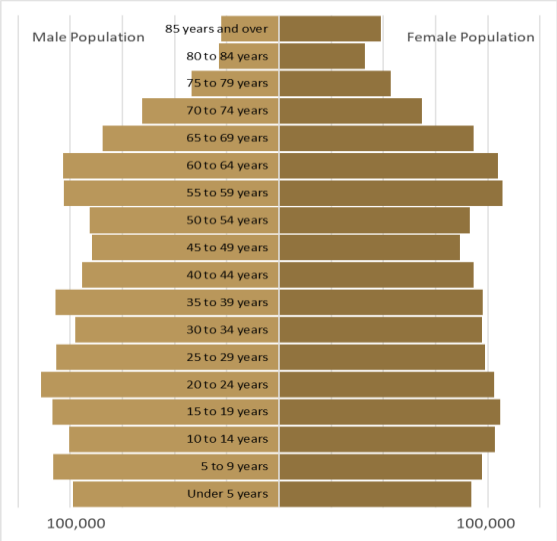


Figure 17: Population distribution by five-year age group (2019 American Community Survey, U.S. Census Bureau).

NEED 3: Improve supply chain connections.

As Iowa's manufacturers of all sizes navigate increasingly complex supply chains, this will create opportunities for Iowa to thrive. Given current geopolitical trends, opportunities for growth through exports and emerging global markets will likely remain depressed. As a result, traditional growth strategies may become less effective. In parallel, supply chain and procurement leaders throughout the Midwest are actively looking for new sources of product closer to home.

Deliberate efforts must be made to connect sales and marketing leaders with procurement leaders outside of their current networks and supply chains. After decades of growth through specialization in a supply chain, diversification based on manufacturing process strength may become a core source of growth. Assisting these connections will require technology, personal networks, and technical advisors to help bridge network, process, and jargon gaps.

TECHNOLOGY & PRODUCTIVITY

NEED 1: Leverage technology to create productivity leaps.

Iowa manufacturers are not keeping up with productivity gains in the rest of the nation. In order to compete nationally and globally in the coming years, implementation of productivity systems alone is not sufficient. Manufacturers must aggressively pair technology with traditional manufacturing productivity techniques in a focused manner.

Beyond general support in Industry 4.0 implementation, manufacturers need better access to planning and decision tools regarding productivity. Some of this is in the decision process, such as alternate ways of analyzing the return on

[10] https://www.brookings.edu/research/new-2020-census-results-show-increased-diversity-countering-decade-long-declines-in-americas-white-and-youth-populations/

investment of a purchase in a workforce-constrained world. Other support is more complex, including guidance on redeployment of individual operators, maintaining productivity gains, and benchmarking best in class output measures.

NEED 2: Build on early success with Industry 4.0.

Manufacturers are taking their first steps in Industry 4.0, and data from this survey suggests that overall, businesses have seen outcomes that meets or exceeds their expectations for many technologies. We see three core building blocks for the next phase of Industry 4.0 in Iowa.

First, continued support in the fundamentals of manufacturing processes to identify, specify, and implement opportunities in a way that makes business sense. Independent evaluation of opportunities helps manufacturers best select technology spaces and helps technology providers reduce their up-front investments in applications that will not fit for their given technology.

Second, we need to continue to increase collaboration among manufacturers. Throughout this assessment process, manufacturers and stakeholders have continually praised the value of seeing detailed information on technology implementation by peers. Increased forums for companies to do this along with increased willingness of companies to share non-competitive information is a needed step.

Finally, we must continue to explore, experiment and deploy new training approaches for Industry 4.0. The current partnership between Iowa's Community Colleges, CIRAS, the University of Northern Iowa, the Iowa Economic Development Authority, Iowa Workforce Development, Iowa Department of Education, the Association of Business and Industry, and Professional Developers of Iowa provides an infrastructure to do this. The next steps will be continued investment in time and resources by participants to drive implementation.

Appendix: Profile of Iowa Manufacturing

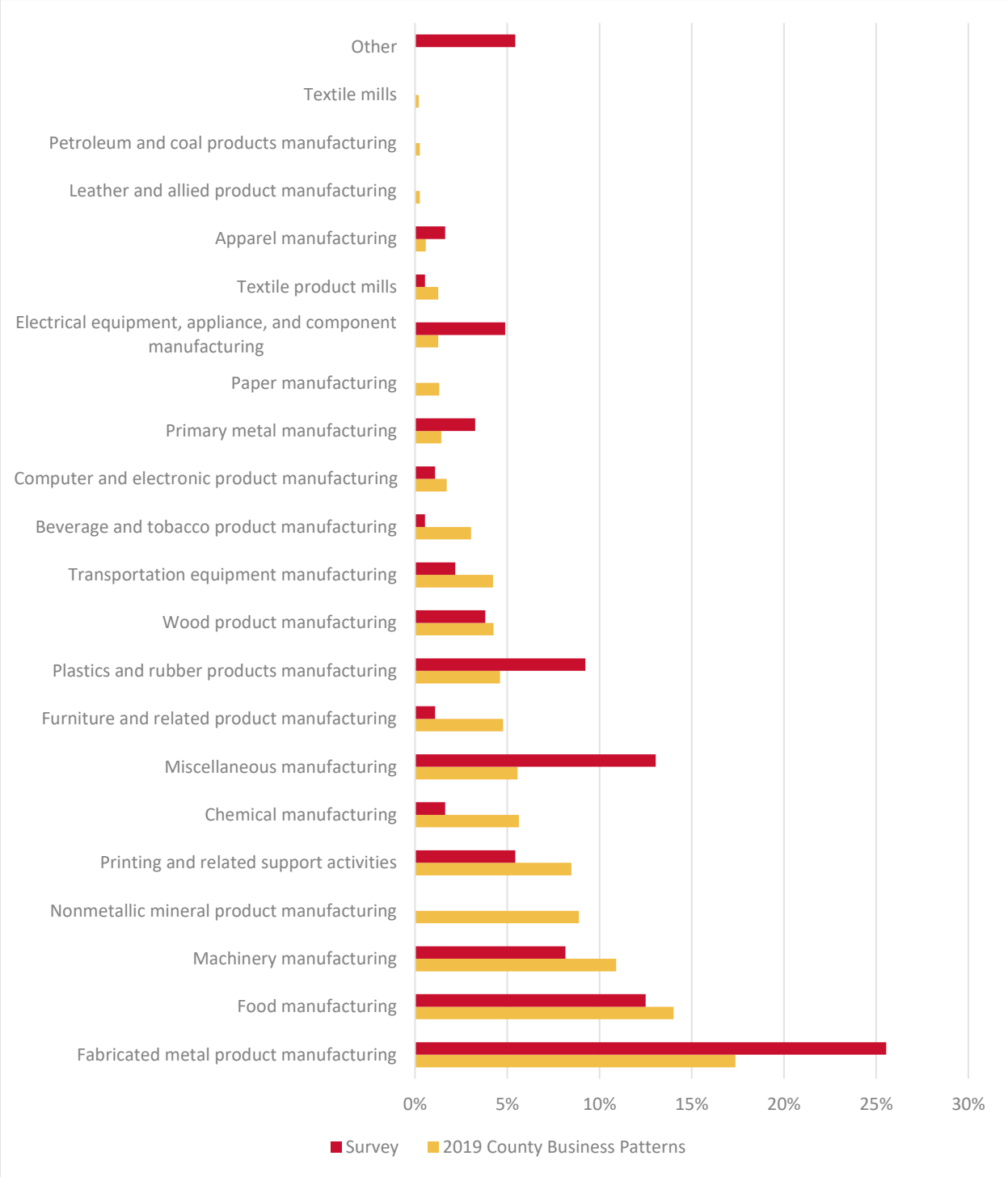
Survey Respondents

This survey was conducted during June through October 2021. Survey outreach was to Iowa manufacturing leaders through email. Only one survey was completed per manufacturing location.

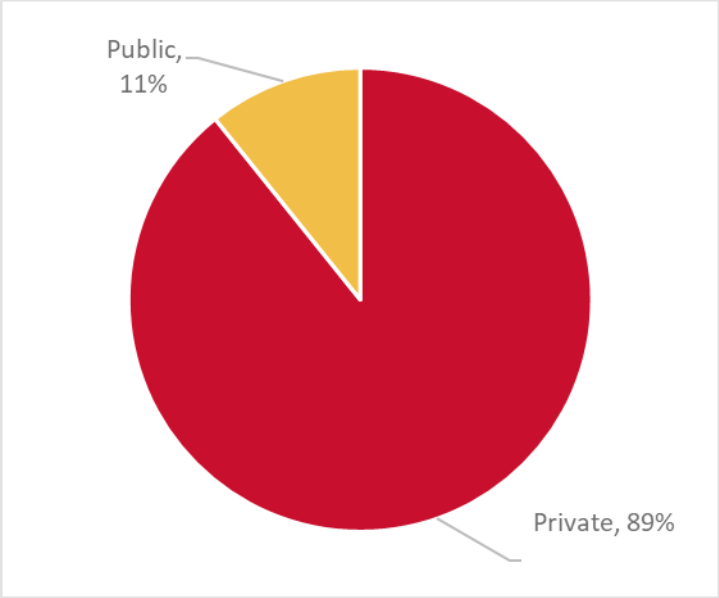
The final response rate was 9.5%, totaling 213 manufacturing leaders representing a broad array of company types, sizes, industries, and geographical locations. The charts that follow summarize the raw data received during the survey process. When there were sufficient respondents in a given industry, strategy, or other relevant grouping, those groupings are also provided.

Company Size and Industry

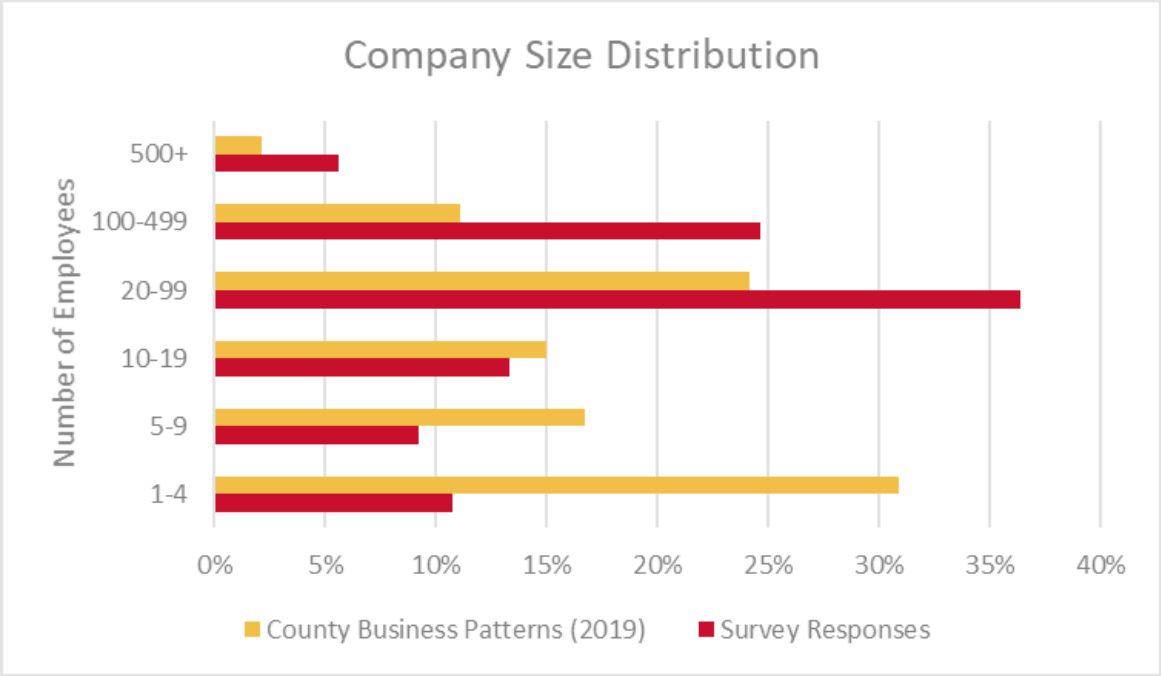
Which category best represents your primary industry?



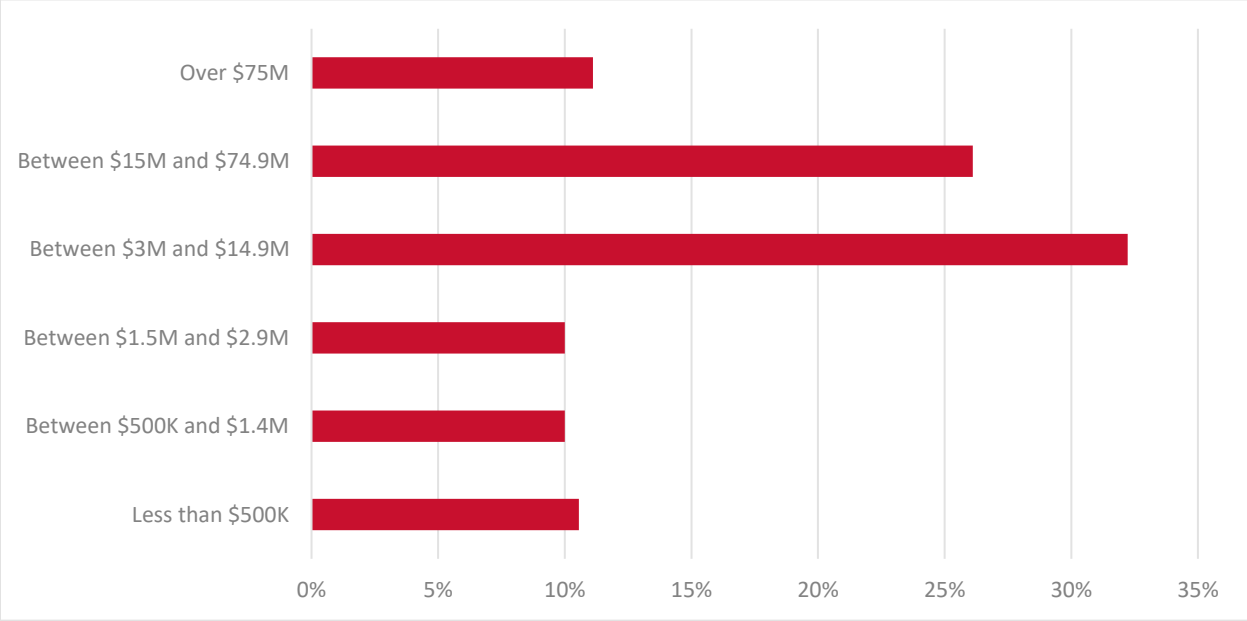
Is your business publicly or privately owned?



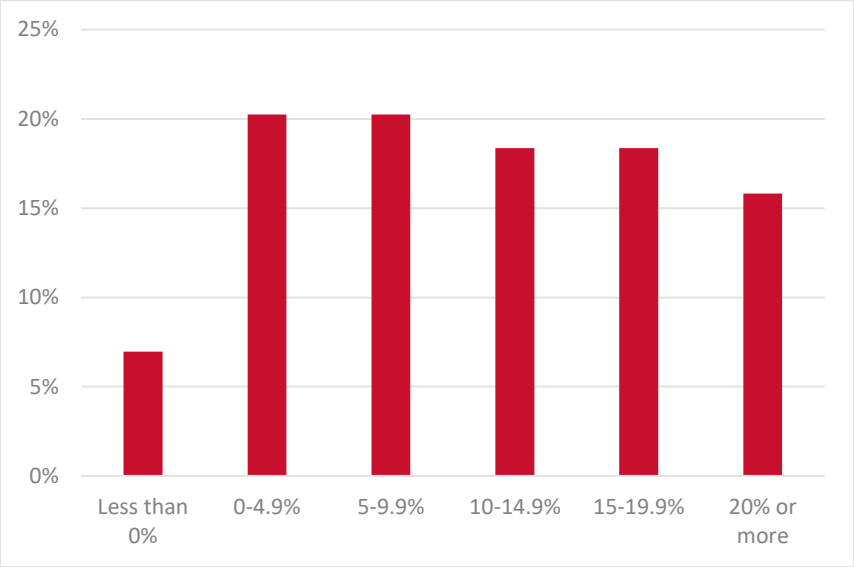
Average Number of Full Time Equivalent (FTE) Employees

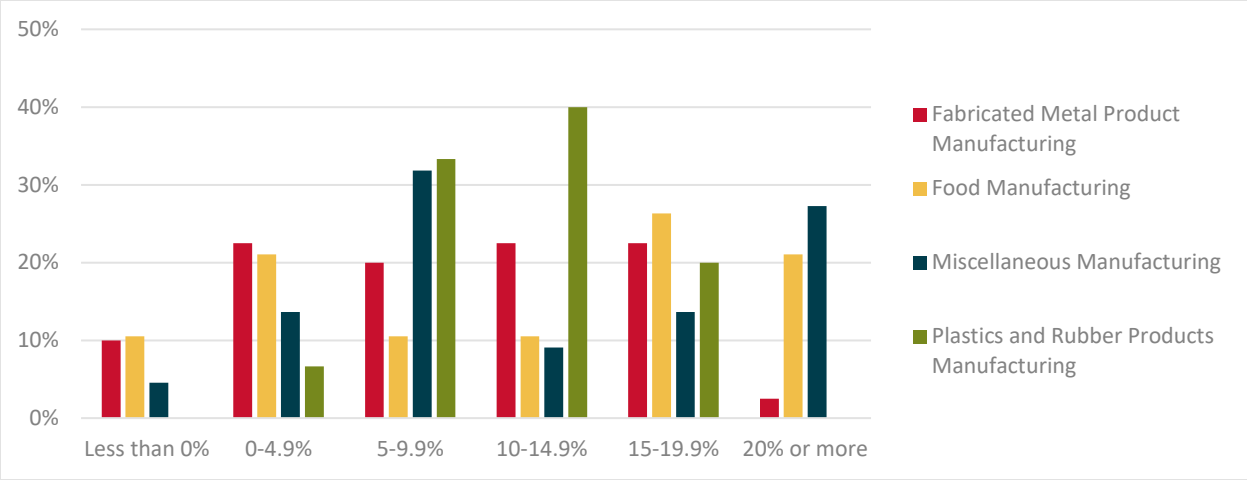


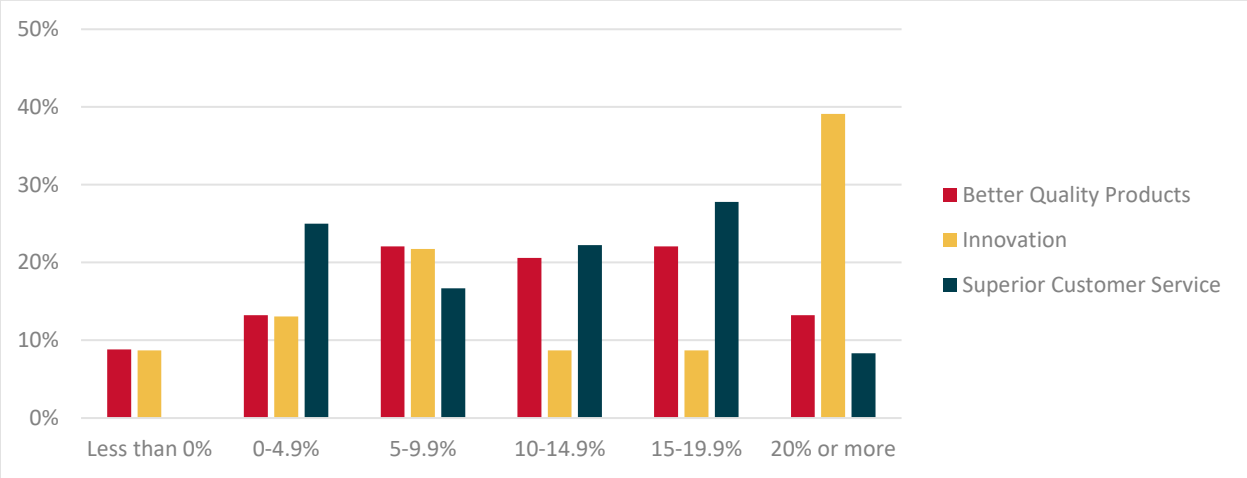
Total Annual Sales (Most recent fiscal year)

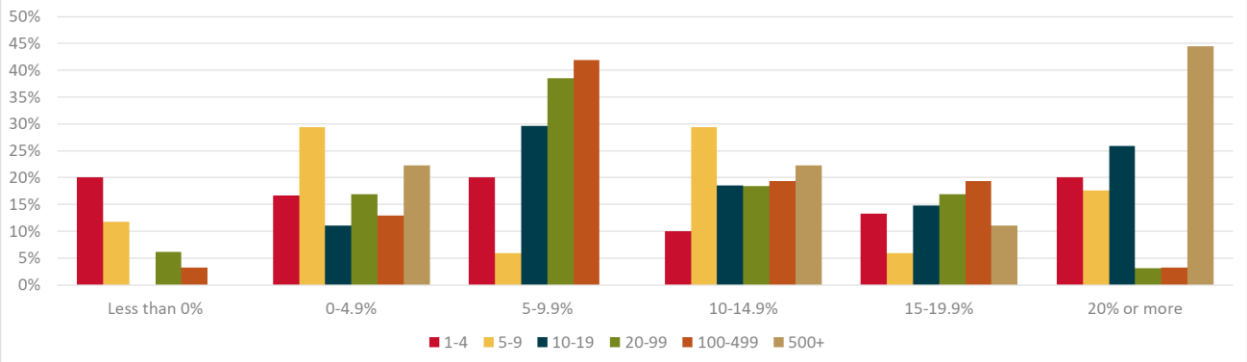


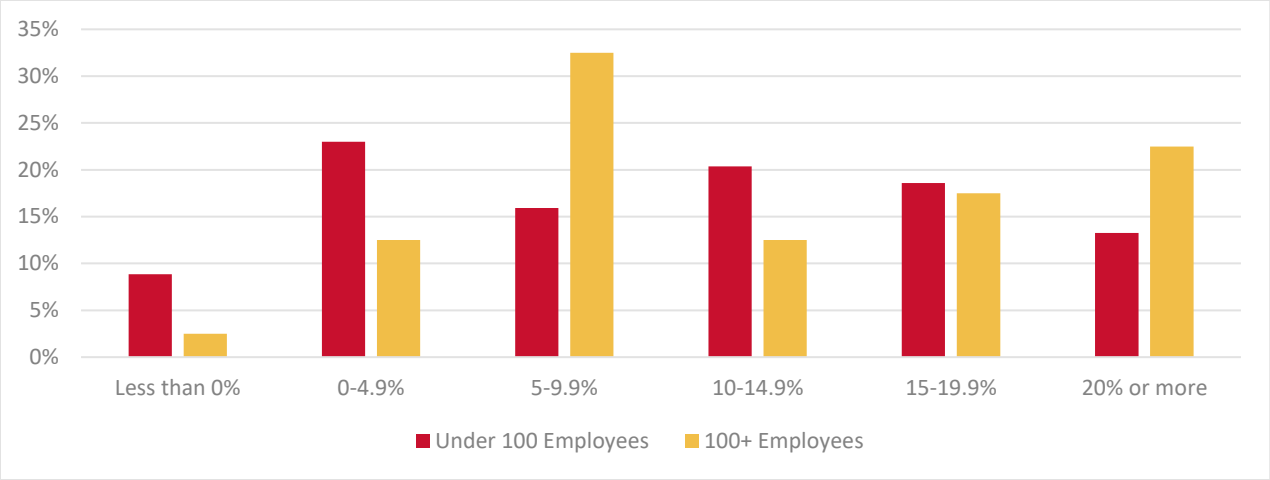
Return on Sales (Most recent fiscal year)




50%
40%
30%
20%
10%
0%
Less than 0%
0-4.9%
5-9.9%
10-14.9%
15-19.9%
20% or more
Fabricated Metal Product Manufacturing
Food Manufacturing
Miscellaneous Manufacturing
Plastics and Rubber Products Manufacturing

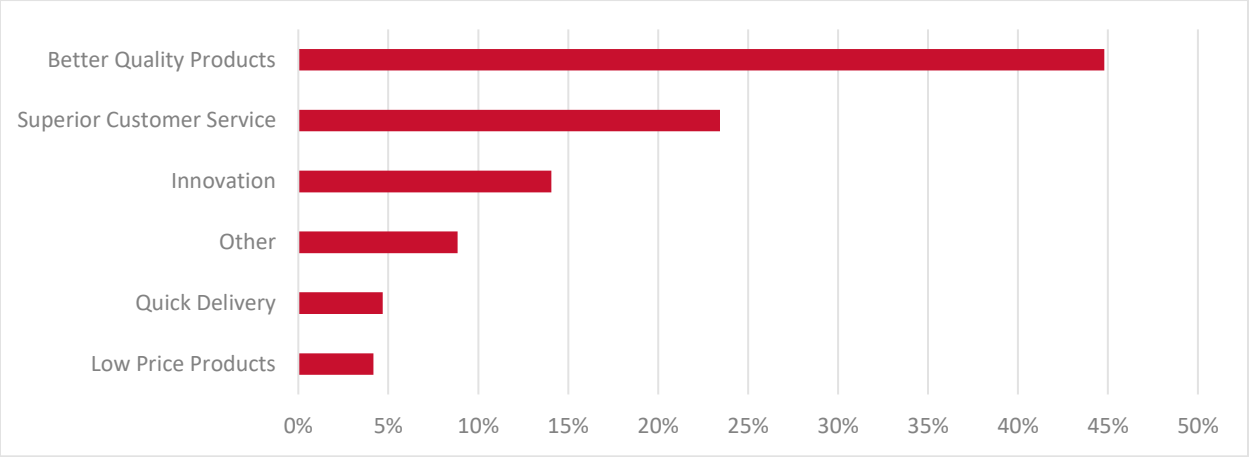

50%
40%
30%
20%
10%
0%
Less than 0%
0-4.9%
5-9.9%
10-14.9%
15-19.9%
20% or more
Better Quality Products
Innovation
Superior Customer Service


50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Less than 0%
0-4.9%
5-9.9%
10-14.9%
15-19.9%
20% or more
1-4
5-9
10-19
20-99
100-499
500+



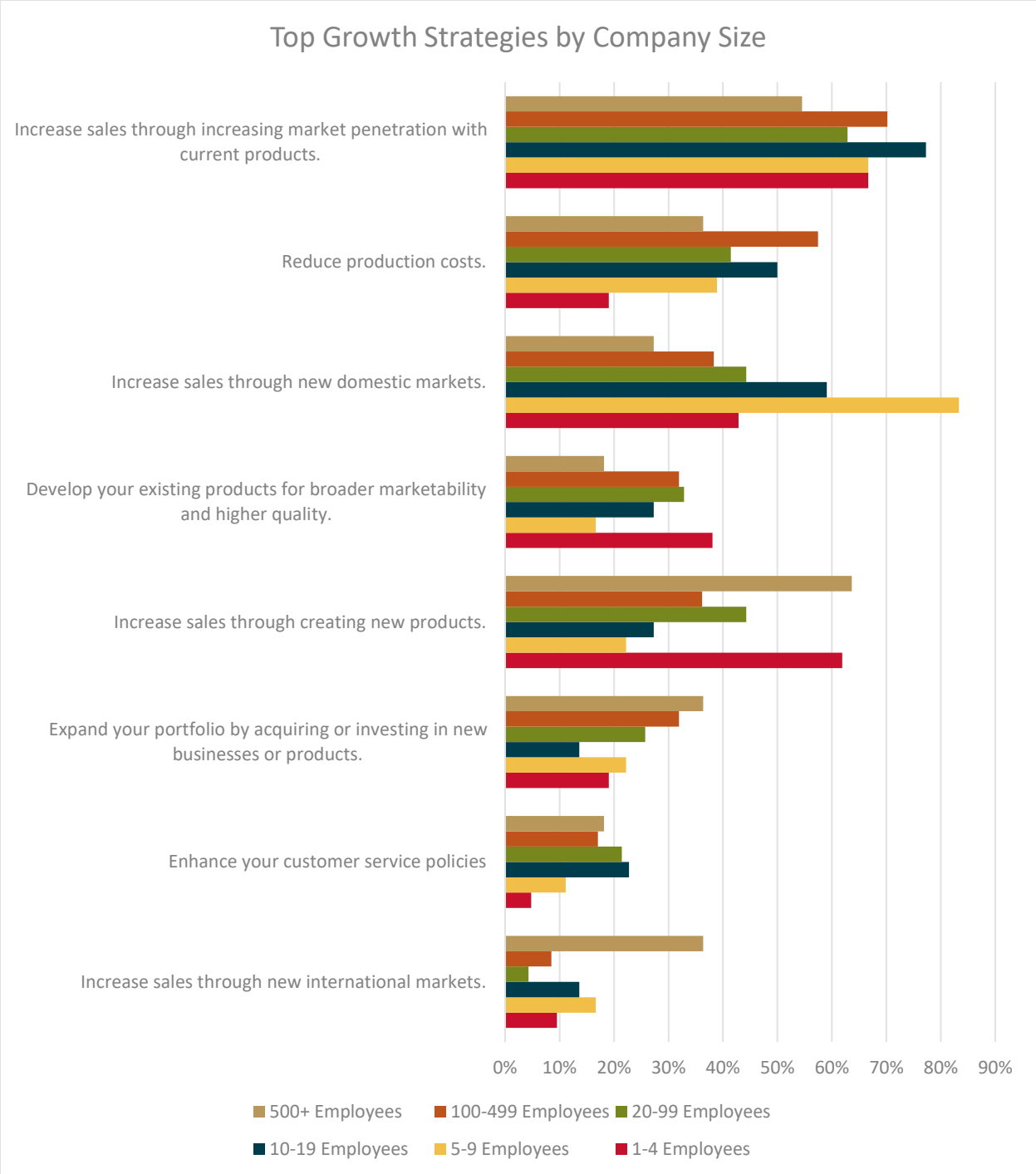
Strategy

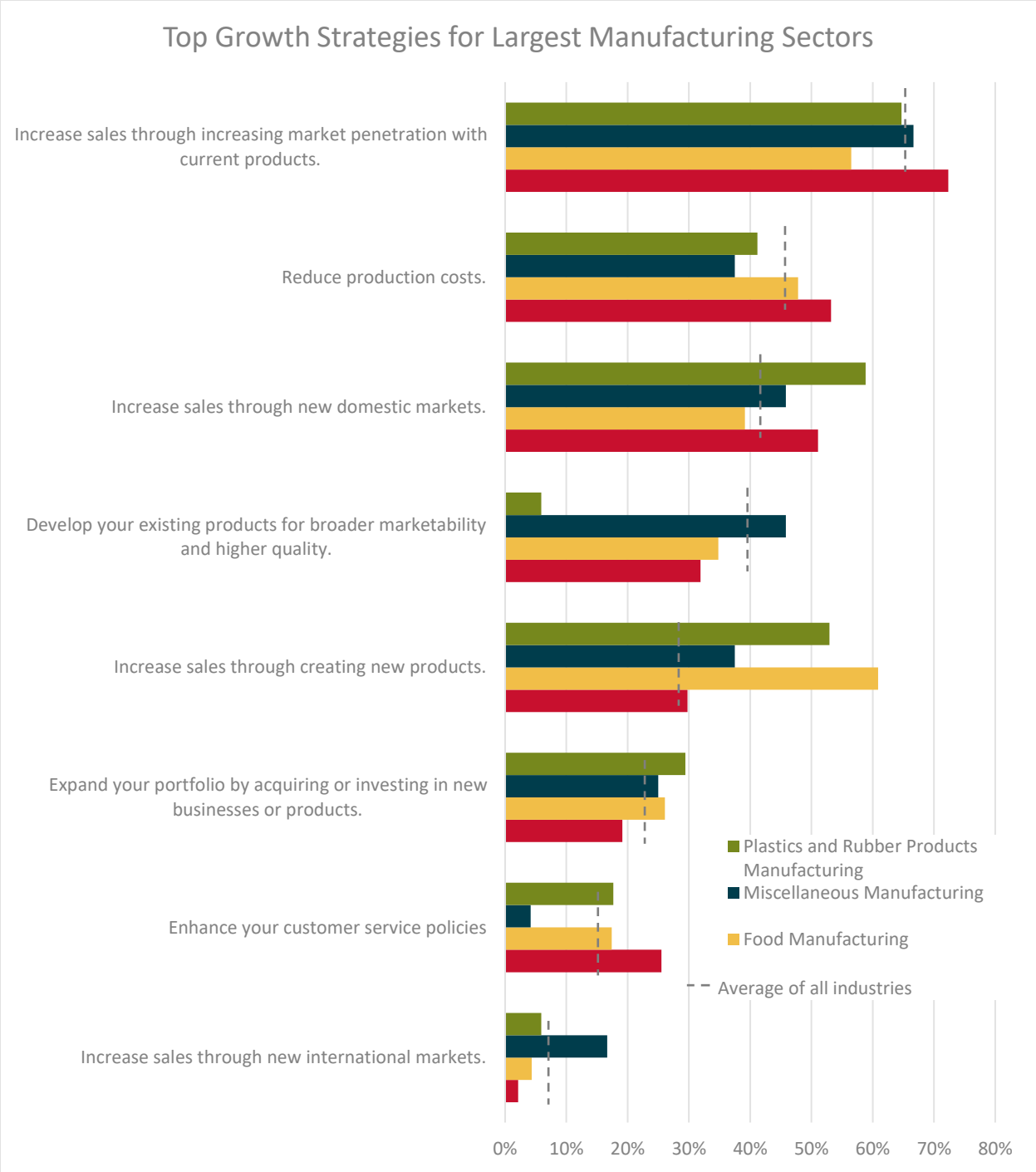
What is your primary business strategy? (Select One)



What do you expect will be your top three drivers for increased profits in the next five years?


Top Growth Strategies
Increase sales through increasing market penetration with current products.
Reduce production costs.
Increase sales through new domestic markets.
Develop your existing products for broader marketability and higher quality.
Increase sales through creating new products.
Expand your portfolio by acquiring or investing in new businesses or products.
Enhance your customer service policies
Increase sales through new international markets.
0%
10%
20%
30%
40%
50%
60%
70%

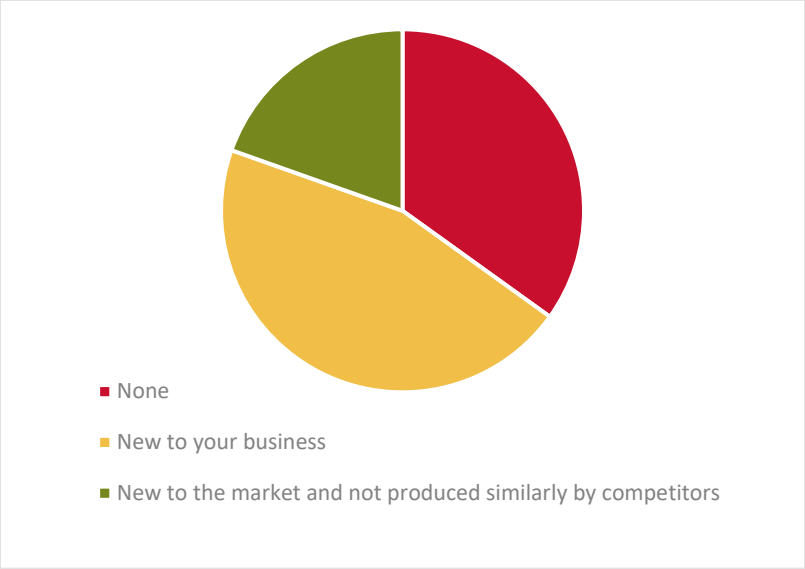

Top Growth Strategies by Company Size
Increase sales through increasing market penetration with current products.
Reduce production costs.
Increase sales through new domestic markets.
Develop your existing products for broader marketability and higher quality.
Increase sales through creating new products.
Expand your portfolio by acquiring or investing in new businesses or products.
Enhance your customer service policies
Increase sales through new international markets.
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
500+ Employees
100-499 Employees
20-99 Employees
10-19 Employees
5-9 Employees
1-4 Employees


Top Growth Strategies for Largest Manufacturing Sectors
Increase sales through increasing market penetration with current products.
Reduce production costs.
Increase sales through new domestic markets.
Develop your existing products for broader marketability and higher quality.
Increase sales through creating new products.
Expand your portfolio by acquiring or investing in new businesses or products.
Enhance your customer service policies
Increase sales through new international markets.
Plastics and Rubber Products Manufacturing
Miscellaneous Manufacturing
Food Manufacturing
Average of all industries
0%
10%
20%
30%
40%
50%
60%
70%
80%

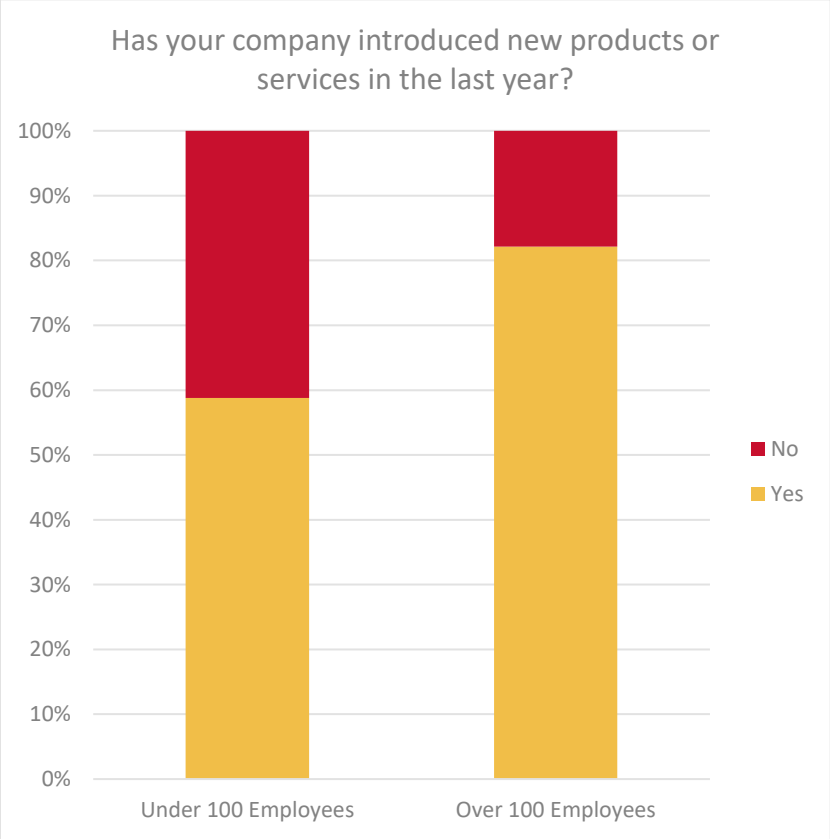
Product Development

Has your company introduced new products or services in the last year?

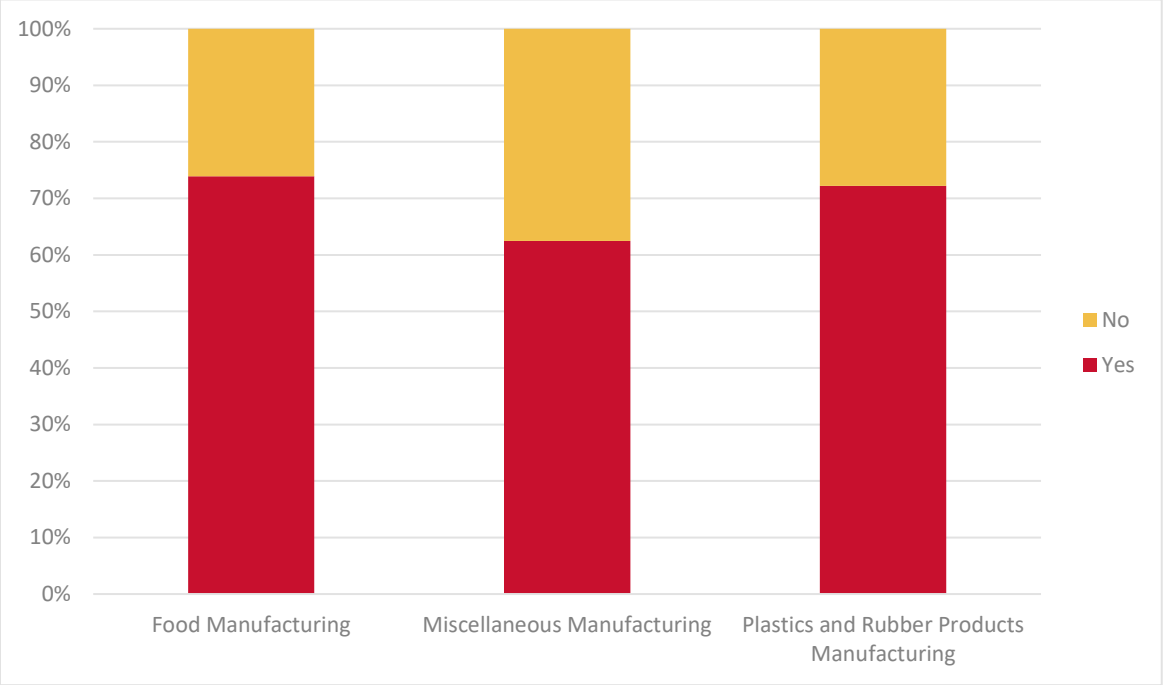
If your company introduced new products or services in the last year, were these products/services new to the market and not produced similarly by competitors or new to your business?



By number of employees:



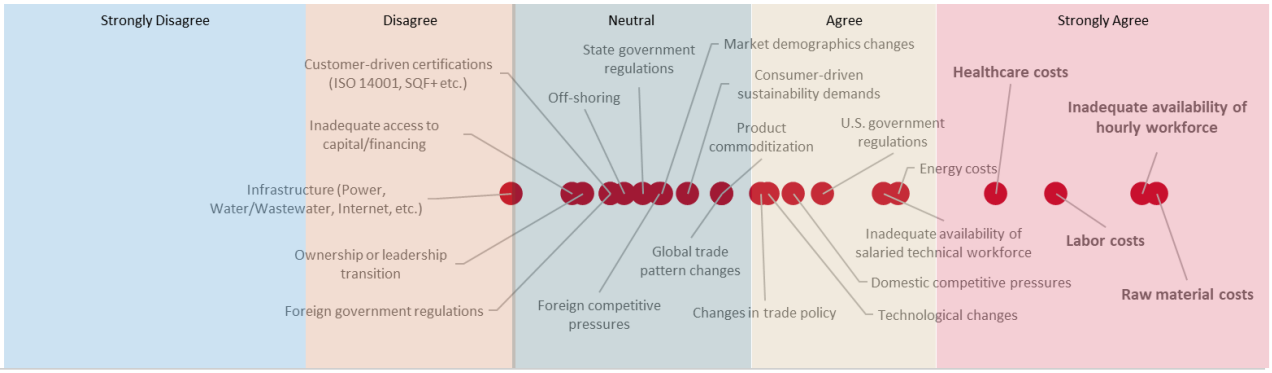
By manufacturing sector:

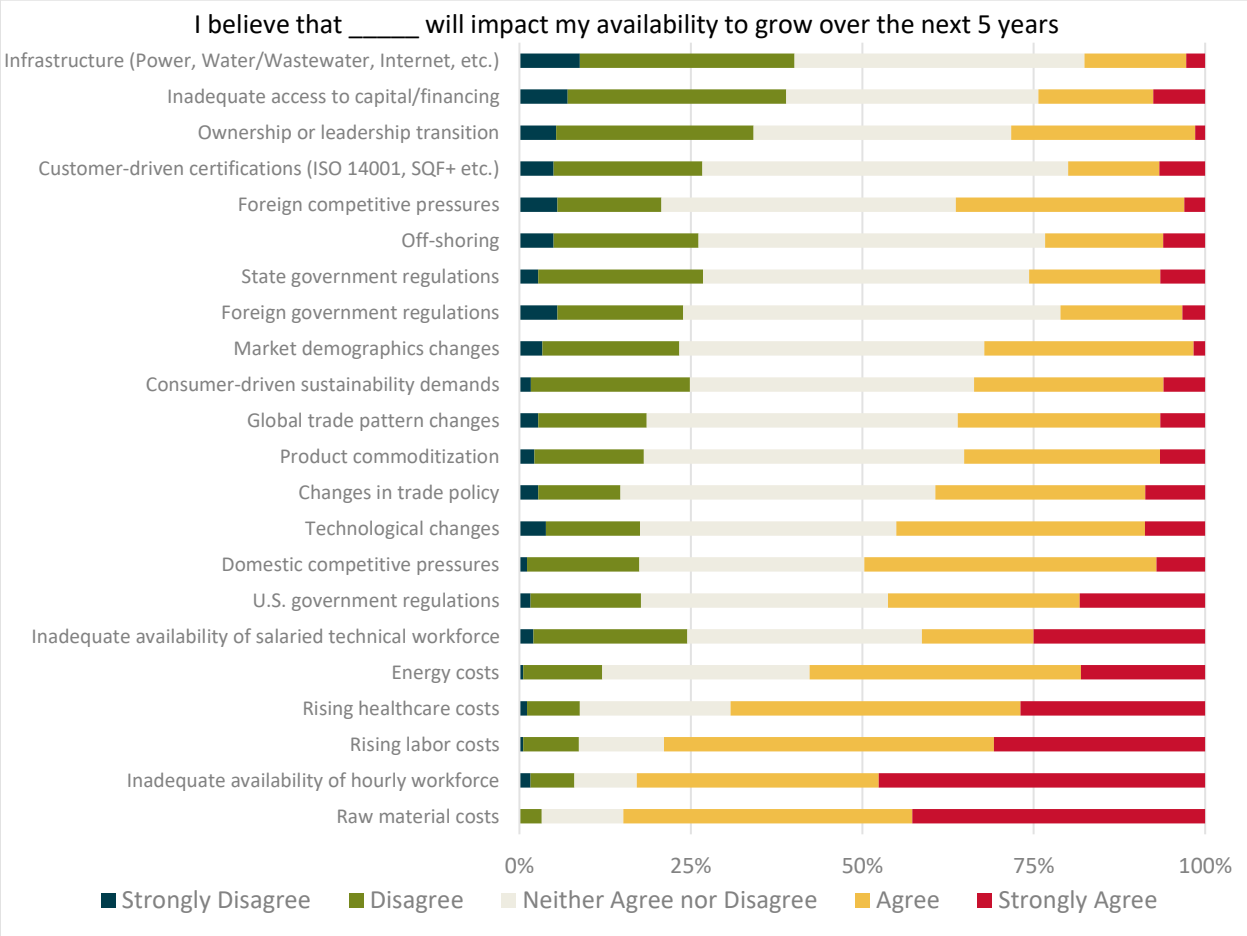


Key Issues and Actions

I believe that _____ will limit growth in the next five years.

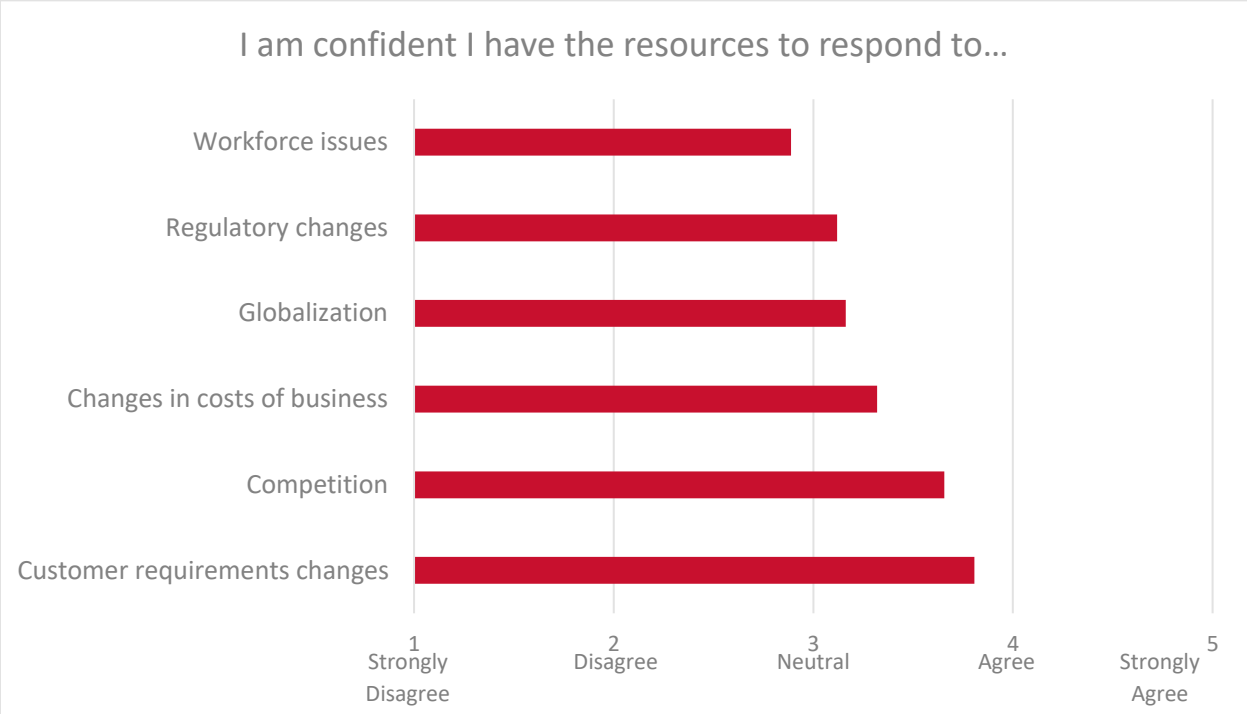
Scale:
Strongly Disagree (1)
Disagree (2)
Neither Agree nor Disagree (3)
Agree (4)
Strongly Agree (5)

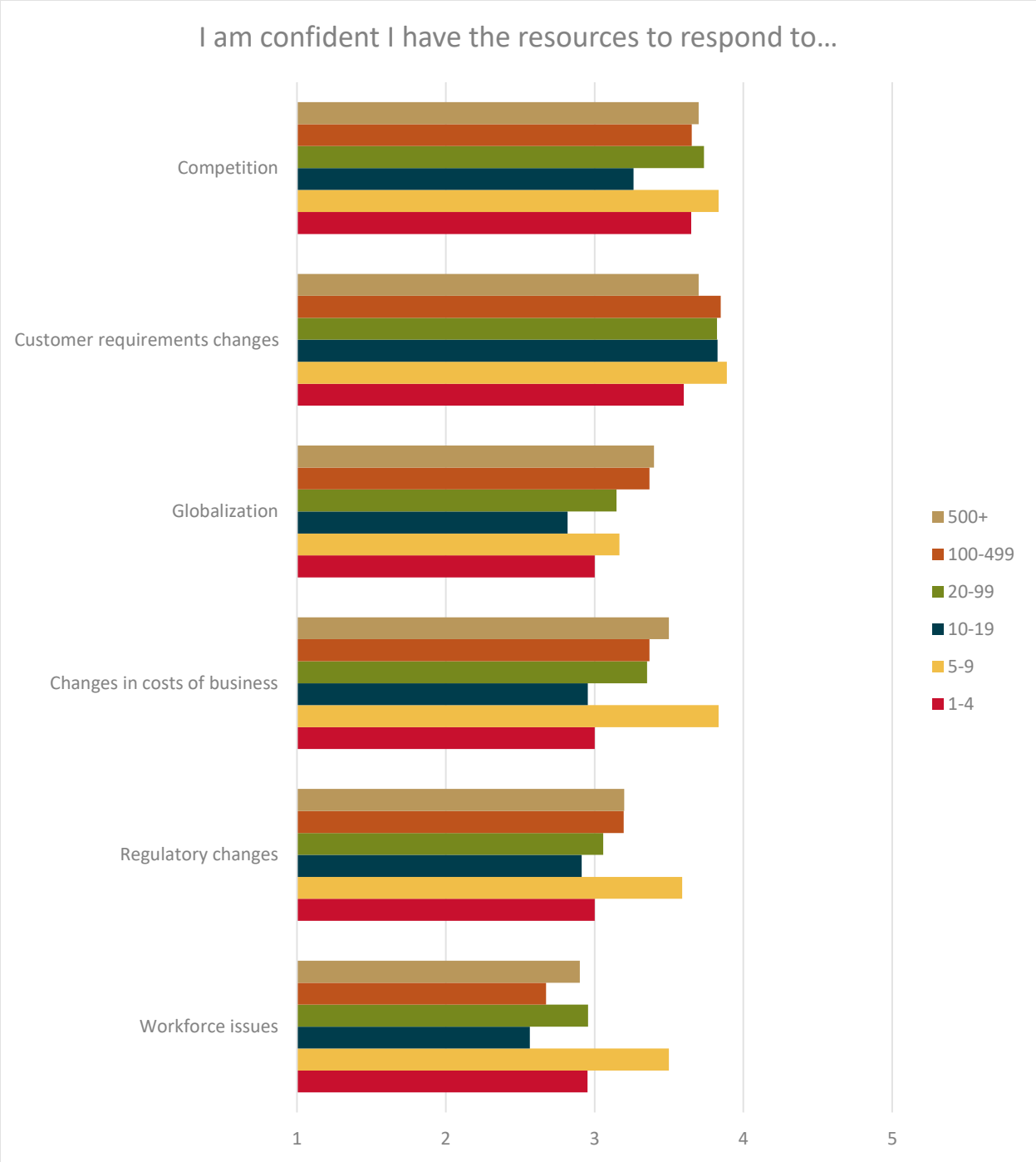


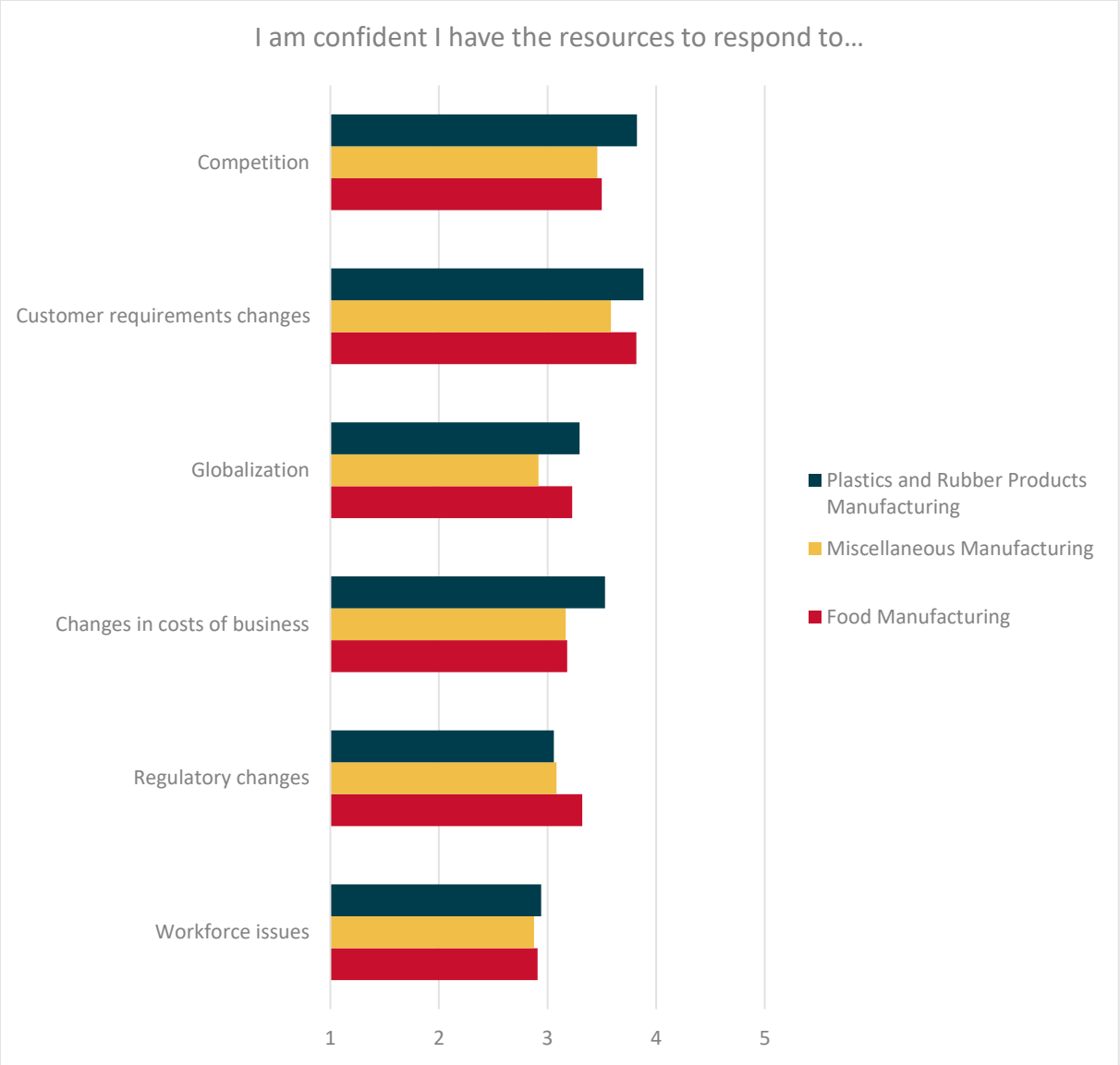


I am confident that I have resources to respond to _____.

Scale:
Strongly Disagree (1)
Disagree (2)
Neither Agree nor Disagree (3)
Agree (4)
Strongly Agree (5)



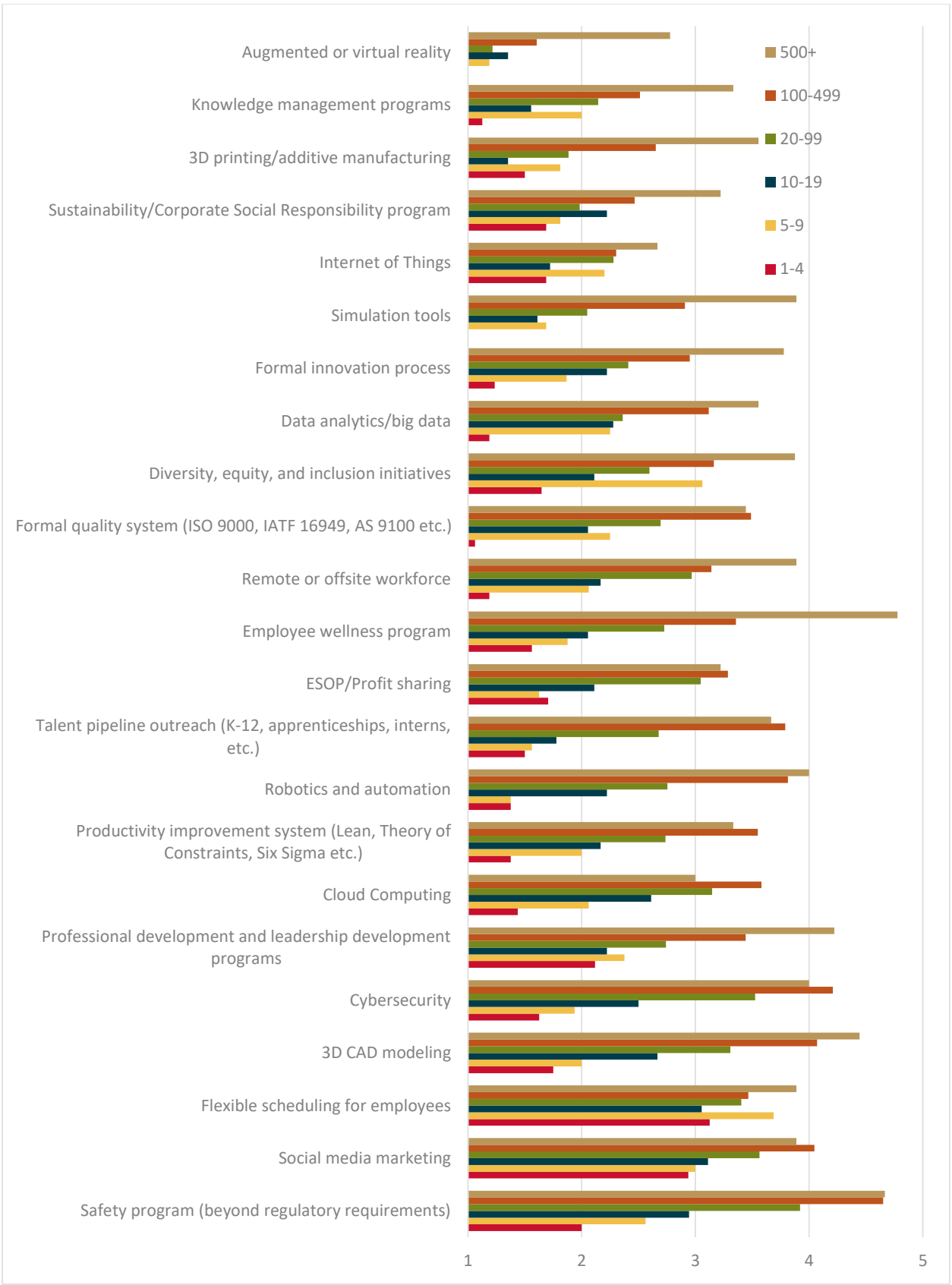

I am confident I have the resources to respond to…
Competition
Customer requirements changes
Globalization
Changes in costs of business
Regulatory changes
Workforce issues
1
2
3
4
5
500+
100-499
20-99
10-19
5-9
1-4


I am confident I have the resources to respond to…
Competition
Customer requirements changes
Globalization
Changes in costs of business
Regulatory changes
Workforce issues
1
2
3
4
5
Plastics and Rubber Products Manufacturing
Miscellaneous Manufacturing
Food Manufacturing

To what extent have you implemented the following in your business?

Scale:
Have not considered (1)
Considered, not implemented (2)
Partial Implementation (3)
Full Implementation in Progress (4)
Implemented (5)

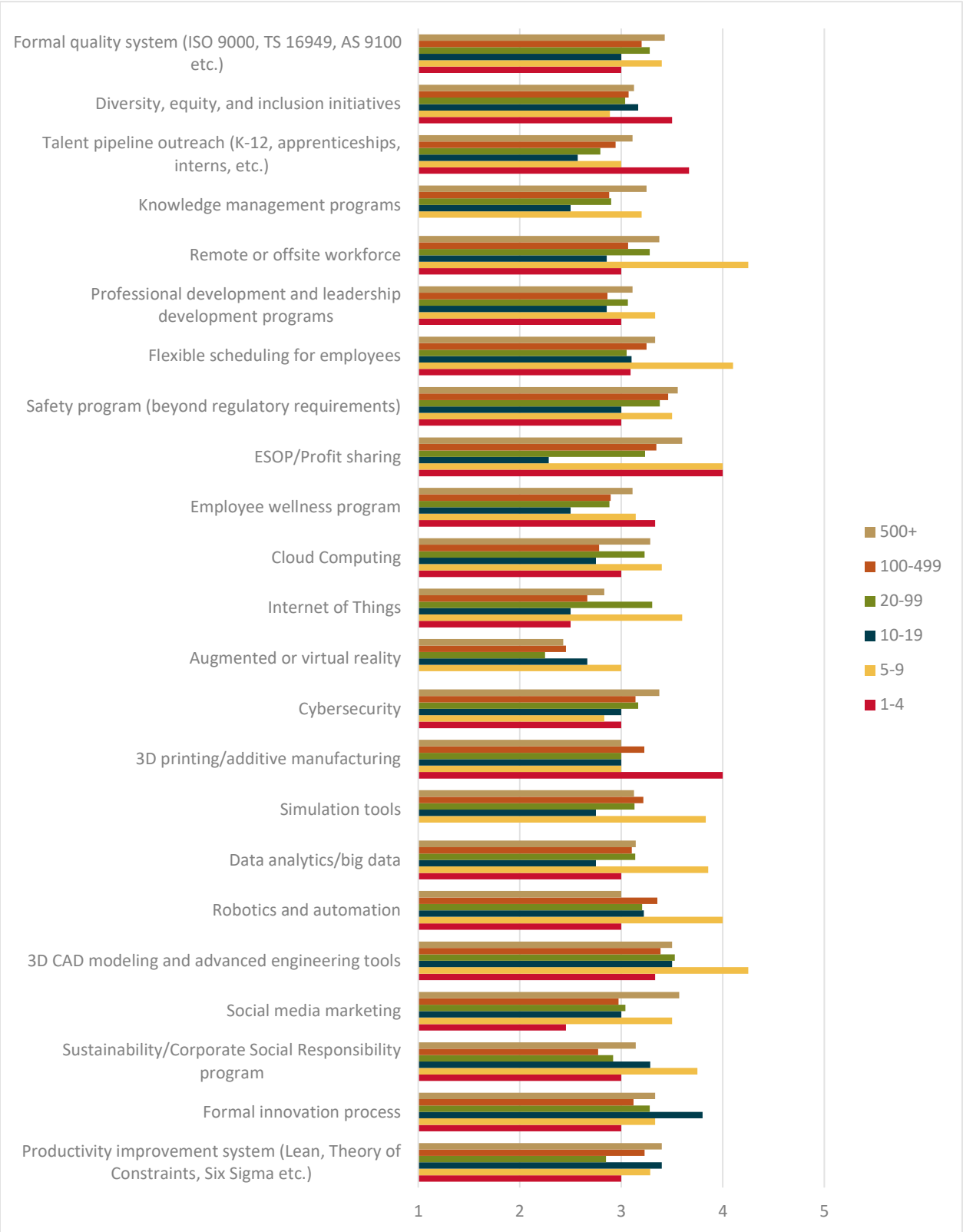
Industry	**Food Manufacturing**	**Miscellaneous Manufacturing**	**Plastics and Rubber Products Manufacturing**
Safety program (beyond regulatory requirements)	3.2	3.3	3.4
Social media marketing	4.1	3.4	3.6
Flexible scheduling for employees	3.1	2.8	3.7
3D CAD modeling	2.2	2.7	3.9
Cybersecurity	2.9	2.9	3.8
Professional development and leadership development programs	3.4	2.7	3.0
Cloud Computing	2.9	2.7	2.8
Productivity improvement system (Lean, Theory of Constraints, Six Sigma etc.)	2.4	2.5	3.3
Robotics and automation	2.6	2.5	3.6
Talent pipeline outreach (K-12, apprenticeships, interns, etc.)	2.3	2.0	2.7
ESOP/Profit sharing	2.0	3.1	3.2
Employee wellness program	2.6	2.6	3.5
Remote or offsite workforce	2.4	2.5	3.0
Formal quality system (ISO 9000, IATF 16949, AS 9100 etc.)	2.8	2.6	3.0
Diversity, equity, and inclusion initiatives	2.8	2.3	3.4
Data analytics/big data	2.8	2.5	3.1
Formal innovation process	2.5	2.6	2.1
Simulation tools	2.1	1.6	2.1
Internet of Things	2.3	2.5	2.3
Sustainability/Corporate Social Responsibility program	2.5	2.9	2.4
3D printing/additive manufacturing	1.8	2.0	3.4
Knowledge management programs	2.4	1.9	1.9
Augmented or virtual reality	2.0	1.3	1.3


Augmented or virtual reality
Knowledge management programs
3D printing/additive manufacturing
Sustainability/Corporate Social Responsibility program
Internet of Things
Simulation tools
Formal innovation process
Data analytics/big data
Diversity, equity, and inclusion initiatives
Formal quality system (ISO 9000, IATF 16949, AS 9100 etc.)
Remote or offsite workforce
Employee wellness program
ESOP/Profit sharing
Talent pipeline outreach (K-12, apprenticeships, interns, etc.)
Robotics and automation
Productivity improvement system (Lean, Theory of Constraints, Six Sigma etc.)
Cloud Computing
Professional development and leadership development programs
Cybersecurity
3D CAD modeling
Flexible scheduling for employees
Social media marketing
Safety program (beyond regulatory requirements)
500+
100-499
20-99
10-19
5-9
1-4
1
2
3
4
5

How much benefit have you seen from implementing the following in your business?

Scale:
Significantly below expectations (1)
Did not meet expectations (2)
Met expectations (3)
Exceeded expectations (4)
Significantly exceeded expectations (5)

Values	**Food Manufacturing**	**Miscellaneous Manufacturing**	**Plastics and Rubber Products Manufacturing**
Productivity improvement system (Lean, Theory of Constraints, Six Sigma etc.)	3.5	3.2	2.7
Formal innovation process	3.5	3.2	2.5
Sustainability/Corporate Social Responsibility program	3.1	3.3	2.9
Social media marketing	3.2	3.0	2.7
3D CAD modeling and advanced engineering tools	3.5	3.4	3.3
Robotics and automation	3.3	3.3	3.0
Data analytics/big data	3.5	3.3	2.7
Simulation tools	3.8	3.5	2.3
3D printing/additive manufacturing	3.0	3.3	3.5
Cybersecurity	3.3	3.2	3.0
Augmented or virtual reality	3.2	2.0	3.0
Internet of Things	3.0	3.2	3.2
Cloud Computing	3.1	3.3	3.4
Employee wellness program	3.0	3.1	2.9
ESOP/Profit sharing	3.3	3. 5	3.0
Safety program (beyond regulatory requirements)	3.6	3.4	3.0
Flexible scheduling for employees	3.2	3.2	3.4
Professional development and leadership development programs	3.1	3.3	2.4
Remote or offsite workforce	3.7	3.1	2.8
Knowledge management programs	3.1	2.9	2.4
Talent pipeline outreach (K-12, apprenticeships, interns, etc.)	2.8	2.6	2.3
Diversity, equity, and inclusion initiatives	3.5	3.1	3.3
Formal quality system (ISO 9000, TS 16949, AS 9100 etc.)	3.8	3.4	2.9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Sustainability/Corporate Social Responsibility program
Formal innovation process
Productivity improvement system (Lean, Theory of Constraints, Six Sigma etc.)
1
2
3
4
5
500+
100-499
20-99
10-19
5-9
1-4