THE EVANSVILLE REGION'S STRATEGIC MANUFACTURING ROADMAP

Prepared for: Evansville Regional Economic Partnership (E-REP)
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TECONOMY PARTNERS LLC

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EXECUTIVE SUMMARY

Since the Evansville Region's emergence as a major industrial production center during World War II, manufacturing has played a critical role in driving economic growth and prosperity.

The region has proven resilient to broader macroeconomic trends over time, even against the backdrop of recent pandemic-related disruptions to manufacturing industries worldwide. Today, manufacturing-related industries play a significant role in the region's employment and economic activity:

- Comprising 21 percent of total private-sector employment in the region,
- Accounting for 41 percent of total economic activity in the region, and
- Growing by 7.7 percent from 2017-2021.

As a result, while the Evansville Region's manufacturing base currently finds itself in a position of relative strength when compared against broader national trends, the future of the industry cluster is not assured in the face of powerful market and demographic headwinds, including:

- Rapid adoption of digital technologies driving massive changes to traditional operating models as well as the skill sets and experience needed by workers.
- Resiliency of supply chains.
- The convergence of several demographic trends: aging workforce demographics, knowledge drain from experienced workers leaving the industry, and historically tight labor markets.
- High materials costs and intense competitive pressure from global markets that force manufacturers to find new ways to manage efficiency and reduce waste.

This competitive landscape presents stark challenges for manufacturers, who must be prepared to respond to these trends in order to maintain their competitiveness in a global marketplace and supply chain. Across the globe, the adoption and integration of the suite of technologies known as Industry 4.0, also sometimes referred to as Manufacturing 4.0 or Smart Manufacturing, is one key way that manufacturers are positioning themselves to respond to changing market conditions.

However, in the Evansville Region, despite the current strong employment footprint of manufacturing, the share of the workers most aligned with Industry 4.0 skill sets and roles make up a smaller portion of overall manufacturing employment relative to the nation. Perhaps more concerning is the fact that the Evansville Region has lost a share in its Industry 4.0-enabling occupations since 2017. As digital technologies become

more pervasive in manufacturing environments, the alignment of talent in the region may present a limiting constraint on the rate of adoption and integration.

Survey responses from regional manufacturers reinforce the conclusion that talent dynamics are already proving challenging for the cluster amidst a highly competitive broader national labor market. The region's ability to supply talent across key positions is lagging behind demand from manufacturers, limiting the operational implementation of new technologies and digital applications. Additional conversations with regional manufacturing companies make it clear that talent represents a key challenge for the future, with concerns regarding the ability to attract talent from other regions of the country, looming waves of retirements from experienced senior workers and associated knowledge drain, and high levels of turnover in entry-level positions. A potential warning sign for the region's ongoing ability to sustain growth was the recurring message that the "digital literacy" of workers in the region is not keeping pace with the changes in technology required to be competitive in a modern manufacturing enterprise, particularly at entry- and mid-level technical positions.

In addition to challenging talent dynamics, it is important to ensure that SMEs are not left behind in the ongoing transition to Industry 4.0 frameworks. Regional manufacturers identified cost-related obstacles as the greatest barrier to achieving Industry 4.0 technology implementation objectives, which presents a particularly challenging outlook for small- and mid-sized manufacturers who lack the broader corporate resources to drive internal R&D, capital investments, and pilot projects. Conversations with SMEs indicated a recognition of the urgency of investing in Industry 4.0 but a gap in knowledge of best practices, coordination of the regional cluster ecosystem, and support for de-risking large investments in new technologies and systems.

These challenges point to significant risks for the region's manufacturing cluster in coming years that threaten its legacy of successful growth. To help position the Evansville Region's manufacturing industries for ongoing success, a cluster-based strategic manufacturing roadmap is necessary in order to focus programmatic efforts on providing the guidance, resources, and organizational capacity to help industry "bridge the gap" to large-scale implementation of Industry 4.0 technologies and frameworks.

The Evansville Region's Strategic Manufacturing Framework

If the Evansville Region is to succeed in maintaining the economic competitiveness of its manufacturing industry base, thereby helping ensure the economic prosperity of its citizens, it must focus on overcoming the cluster's current and future challenges by:

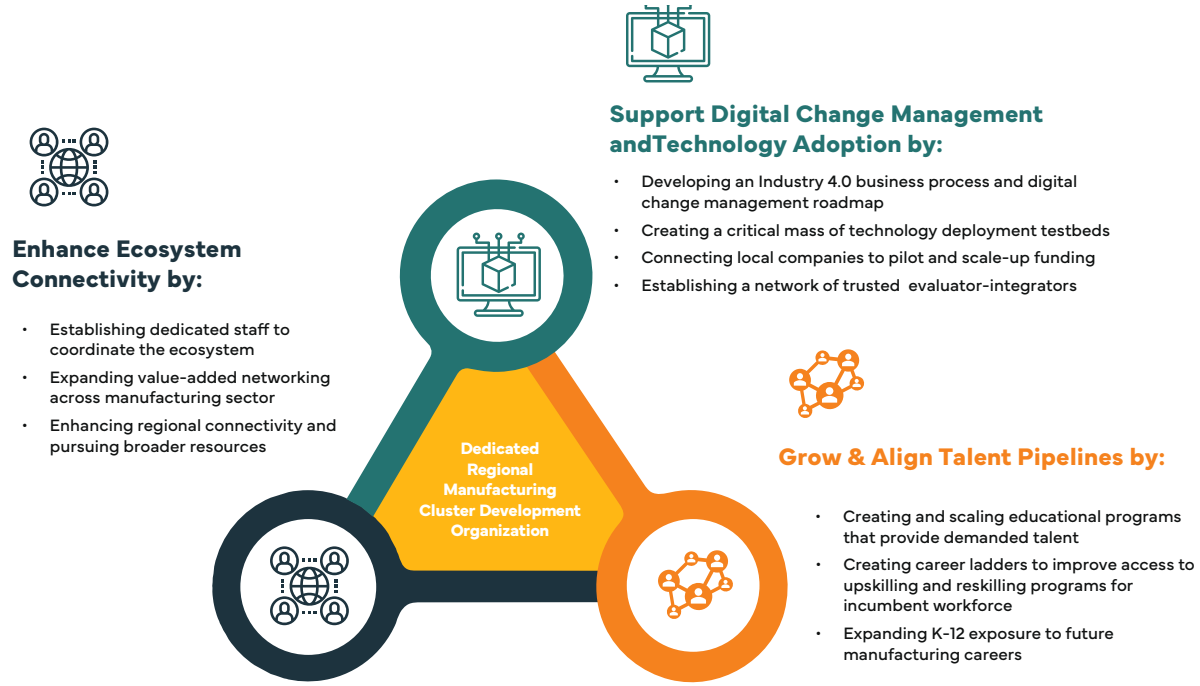
- **Supporting digital change management and technology adoption,**
- **Growing and aligning talent pipelines, and**
- **Enhancing ecosystem connectivity.**

By focusing on these three thematic areas, the Evansville Region will help ensure the region's future economic vitality. Anticipated economic and societal impacts that will be realized through the successful implementation of this Strategic Roadmap include:

- Better-paying jobs with higher growth potential
- Ability to weather future economic challenges, and
- Inspired future generations who reach their full potential.

Generating these outcomes does not happen on its own but rather through a series of intentional, strategic, and proactive decisions. The Strategic Roadmap is driven by public-private partnerships that capitalize on the Evansville Region's strengths while ensuring that future programmatic investments are focused on building the ecosystem that will help ensure the robustness of the region's manufacturing cluster for years to come (Figure ES-1).

Figure ES-1: A Strategic Roadmap to Support the Evansville Region's Manufacturing Cluster



Source: TEConomy Partners, LLC.

It is recommended that the Evansville Region—through a dedicated regional manufacturing cluster development organization— advance a set of three strategies and an associated set of ten actions to drive the continued economic viability of the region's manufacturing sector.

Strategy One: Support Digital Change Management and Technology Adoption

Across the Evansville Region general attitudes about Industry 4.0 are positive, with many manufacturers indicating that Industry 4.0 adoption is perceived as necessary to remain competitive and is a positive investment for growth regardless of company size and industry. However, while very few companies have zero capacity for digitization of key systems, only a minority of companies have the physical capacity to fully implement Industry 4.0 technologies today in key dimensions of their operations, thereby indicating a significant capacity for the region to expand the scope of technology deployment.

To remain competitive in an increasingly digital manufacturing industry, the region needs to accelerate digital change management and technology adoption across its base of companies, particularly SMEs, by helping to reduce identified barriers to adoption in the context of these dynamics. While larger companies require investment in talent pipelines aligned with technology investments, many regional multinational companies have also expressed a desire for increased knowledge-sharing and cooperation in non-competitive technology use cases. For SMEs, the region must find ways to help provide resources and expertise to accelerate Industry 4.0 technology investment so that SMEs can keep pace and position themselves for future needs as critical suppliers within the manufacturing value chain.

To address these challenges, four actions are recommended:

Action 1: Develop an Industry 4.0 Business Process and Digital Change Management Roadmap for regional manufacturers, leveraging best practices from leading companies.

- Create a digital change management roadmap using a structured process that incorporates a variety of industry stakeholders and made publicly available to the manufacturing community.

Action 2: Create a critical mass of technology demonstration testbeds by linking private and academic technology assets with SMEs.

- Provide a network of demonstration and deployment testbeds across the regions where companies can de-risk the process of integrating new technology is often a critical component of Industry 4.0 strategies.

Action 3: Connect local companies to pilot and scale-up funding.

- Create a matchmaking functionality to educate and connect regional companies with funding opportunities that de-risk initial investments in technology.

Action 4: Establish a network of experienced evaluator-integrators.

- Support an Industry 4.0 evaluation or assessment process designed to help regional companies identify gaps and use cases and coordinate existing integrators (and/or create a regional integrator if existing supply doesn't meet demand) through a centralized technology supplier base model to help foster an innovation ecosystem and support new integrator firms advancing relevant technology solutions that are of utility to regional manufacturers.

Strategy Two: Grow and Align Talent Pipelines

The adoption of Industry 4.0 technologies is fundamentally changing the nature of work and job functions in the modern "smart" factory. The Evansville Region's manufacturers embracing digital technologies require existing employees to be regularly and periodically "upskilled."

In interviews with industrial leaders across the region, concern was expressed that applied manufacturing skills are in short supply. Overall, the Evansville Region's manufacturers are facing significant talent supply barriers to advance new digital systems and operations, which hinder their ability to adopt Industry 4.0 technologies. The technology adoption initiatives outlined in Strategy 1 will not have a high likelihood of success unless there is an adequate skilled workforce available. The region's talent pipeline must be aligned to meet industrial needs.

To address these challenges, three actions are recommended:

Action 4: Create and scale educational programs that develop specialized technical talent in greatest demand by industry.

- Establish training program "hubs" at regional educational providers that specialize in different priority areas that address industry talent demand (e.g., operations analytics, industrial controls, and IT and cyber.)

Action 5: Create career ladders to attract entry level workers as well as catalyze upskilling and reskilling of the incumbent workforce.

- Develop a set of defined career ladders with local high schools, community colleges, 4-year institutions, and workforce training programs to effectively coordinate the region's educational institutions with the workforce needs of the region's manufacturers.

Action 6: Expand existing initiatives around K-12 exposure to future manufacturing jobs.

- Create a multi-faceted communications campaign to inform the populace of the current occupational opportunities that are forecasted to be in demand in the future.

Strategy Three: Enhance Ecosystem Connectivity

Currently across the Evansville Region, there is low engagement by manufacturing furthers to engage in programs and services that are designed to boost Industry 4.0 adoption. While some firms positively noted the work of the Tri-State Manufacturers' Alliance (TSMA), many also expressed concerns regarding the general lack of regional coordination to meet the needs of manufacturers across the region to adopt Industry 4.0 practices.

To address these challenges, three actions are recommended:

Action 8: Establish dedicated staff to coordinate the region's manufacturing ecosystem.

- Fund dedicated staff to actively engage in outreach, partnership-building, and matchmaking services focused on Industry 4.0 adoption and integration outcomes in coordination with state programs and institutions.

Action 9: Expand value-added networking across the region's advanced manufacturing sector.

- Work to organize manufacturing peer networking groups focused on regular sharing of Industry 4.0 use cases, site tours, and discussions of regional challenges.

Action 10: Enhance regional connectivity and pursue broader resources.

- Many of the issues outlined in this Strategic Roadmap are similar to those facing the manufacturing industry in surrounding communities. By working together, a more holistic ecosystem of support can be developed to address common problems/issues.

Conclusion – A Call To Action

The strategies and actions have been developed with the intent of helping the region's manufacturers accelerate their integration of Industry 4.0 by addressing the key challenges they face today: barriers to digital change management and technology adoption, gaps in the supply and alignment of talent, and a need to more aggressively coordinate the region's assets to build a critical mass that can drive broad impacts. However, for this Strategic Manufacturing Roadmap to be successful, a unified regional economic development initiative must be formed. This will require the buy-in and organization of key champions and stakeholders from across the private sector manufacturing cluster, the educational system continuum, and local economic development leaders who can spearhead and lead the various components of strategy implementation. By proactively supporting this vital industry sector, the Evansville Region will be proactively working to ensure its long-term economic prosperity. The time is now for decisive action.

INTRODUCTION

Among the many industries that drive regional economies in the United States, manufacturing sectors play an especially critical role in Midwestern states in enabling long-term growth.

As noted by researchers at the Federal Reserve Bank of Chicago in an analysis of Midwestern manufacturing employment growth over the last two decades:

> *Manufacturing has long been recognized as an important driver of local employment growth because it produces "traded" goods—i.e., goods that are sold nationally or internationally rather than only locally. Traded goods industries—such as oil and gas extraction, manufacturing, finance, and software development—support employment in other industries that primarily provide services locally—such as retail, health care, and education. This means that new employment in traded goods industries can have a "multiplier" effect because it also tends to lead to new employment in local industries. Thus, in theory, growth in a region's traded goods industries should be a good predictor of growth in overall employment in a region.*[1]

However, the share of employment in manufacturing industries in the United States has been steadily declining since the mid-1900s. This trend has had an especially large impact on Midwest states, given their outsized concentration in manufacturing jobs relative to other parts of the country. Thus, while the industry is critical to the success of these regions of the country, it is vulnerable to a "hollowing out" effect that can leave these regions at a competitive disadvantage in growing their economies and labor forces. In fact, since 2000, there has been a demonstrable negative correlation between a state or metro area's share of manufacturing employment and their overall employment growth, including in non-manufacturing industries.[2]

As a result, understanding and supporting manufacturing's role as a regional economic driver is more critical than ever. Amid the changing dynamic of manufacturing's role in the U.S. economy, a number of other disruptive forces are fundamentally reshaping the way manufacturing industries do business.

First, over the past decade, various industry sectors have rapidly adopted digital technologies. Manufacturing in particular has embraced these technologies to improve operations. For example, to stay competitive and boost productivity, manufacturers are now seeking new technologies and third-party

1 Szurkowski, P. & Walstrum, T. (2020). The Role of Manufacturing in Explaining Employment Growth in the Midwest Since 2000. Midwest Economy Blog. Federal Reserve Bank of Chicago.
2 Ibid.

technology service providers to automate and streamline their operations. This move is aimed at reducing costs while maintaining high-quality products. In turn, this shift is driving massive changes to traditional manufacturing "factory floor" operations models as well as the skill sets and experience needed by workers.

At the same time, manufacturing industries everywhere are facing cost competitiveness, supply chain resiliency, and demographic dynamics that have disruptive potential for businesses worldwide. The global COVID-19 pandemic highlighted the vulnerability of manufacturing supply chains and production operations to disruption, resulting in a new emphasis on reshoring vulnerable supply chains and maintaining the ability to withstand further disruption as a priority among manufacturers.

Similarly, manufacturers are grappling with the convergence of several demographic trends: aging workforce demographics, knowledge drain from experienced workers leaving the industry, and historically tight labor markets. All of these factors have caused labor supply and retention issues for companies in this sector that limit the ability to grow and expand operations.

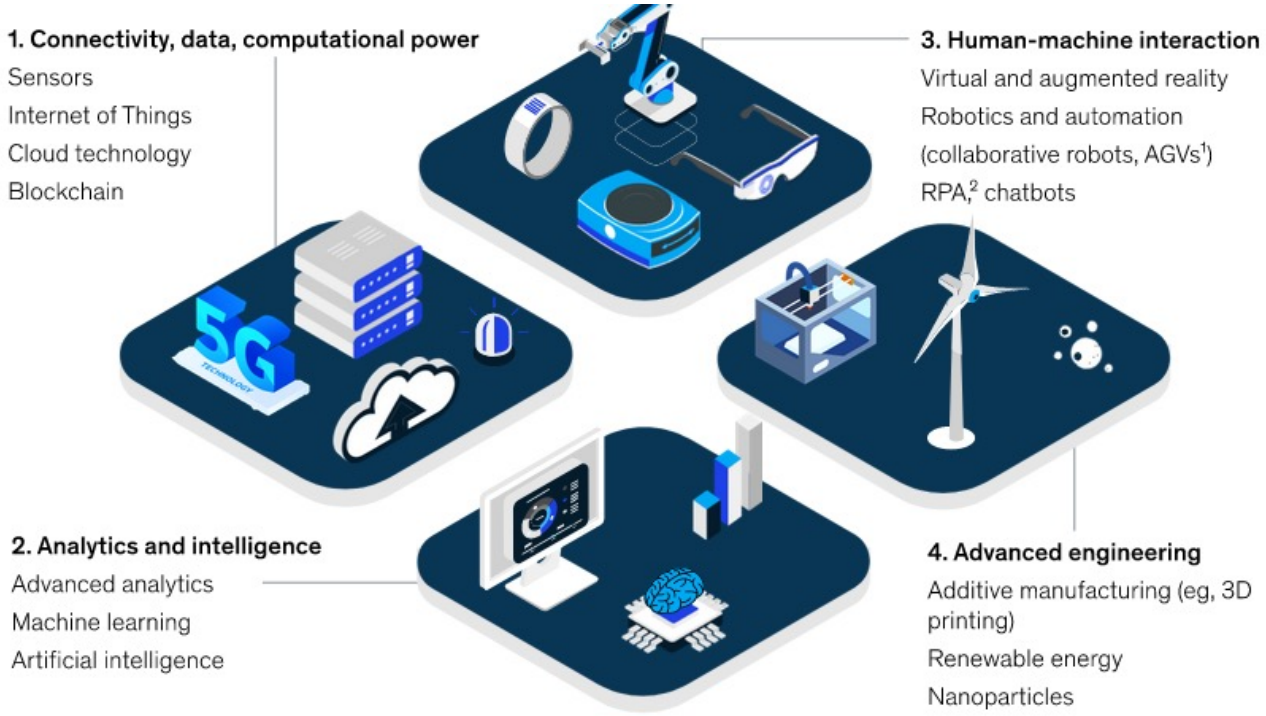
Finally, high materials costs and intense competitive pressure from global markets have forced manufacturers to find new ways to manage efficiency and reduce waste.

This competitive landscape presents stark challenges for regional and local manufacturers, who must be prepared to respond to these trends in order to maintain their competitiveness in a global marketplace and supply chain. **The adoption and integration of the suite of technologies known as Industry 4.0, also sometimes referred to as Manufacturing 4.0 or Smart Manufacturing, is one key way that manufacturers are positioning themselves to respond to changing market conditions.**

The Evolution of Manufacturing Technologies: What is Industry 4.0?

Originally rooted in Germany's national strategy for adoption of smart manufacturing systems, the term Industry 4.0 (often used interchangeably with the term Manufacturing 4.0 and/or Smart Manufacturing) is now widely used to refer to the portfolio of technologies, capabilities, and services that manufacturers are using to shift traditionally labor-intensive production enterprises towards digital and automated operations models. These advanced technologies are designed to work together seamlessly, allowing the creation of "smart factories." They encompass various data-gathering technologies, including Industrial Internet of Things (IIoT) sensors and machines, as well as automation and robotics. Additionally, digital design and precision machining are key components alongside emerging technology areas enabled by Industry 4.0 environments, such as additive manufacturing. Additional capabilities such as predictive analytics and digital supply chains leverage these environments and the data they generate to provide insights and improve efficiency across the manufacturing value chain (see Figure 1).

Figure 1: Illustrative Examples of Technology Platforms Within the Industry 4.0 Portfolio



[1]Autonomous guided vehicles
[2]Robotic process automation

Source: Industry 4.0: Reimagining manufacturing operations after COVID-19, McKinsey; Eloot, Mancini, Patel, July 2020.

Rather than a single technology or system, Industry 4.0 instead represents a portfolio of technologies enabled through the integration of digital capabilities, including areas such as:

- **Data Sharing (Internet of Things—IoT):** Connecting physical objects and devices to the internet, allowing them to communicate and share data.
- **Cloud Computing:** Leveraging remote servers to store and process data, providing scalability, accessibility, and collaboration capabilities.
- **Additive Manufacturing (3D Printing):** Building objects layer by layer using digital models, allowing for rapid prototyping and customized production.
- **Robotics:** Utilizing robots and automated systems that can perform tasks with precision, flexibility, and efficiency.
- **Big Data and Analytics:** Collecting and analyzing large volumes of data generated by various sources to gain insights, optimize processes, and make data-driven decisions.
- **Cyber-Physical Systems (CPS):** Combining the physical and virtual worlds, where sensors, actuators, and other devices interact with the physical environment.
- **Artificial Intelligence (AI) and Machine Learning (ML): I**mplementing intelligent algorithms and systems that can learn from data, adapt, and make autonomous decisions.

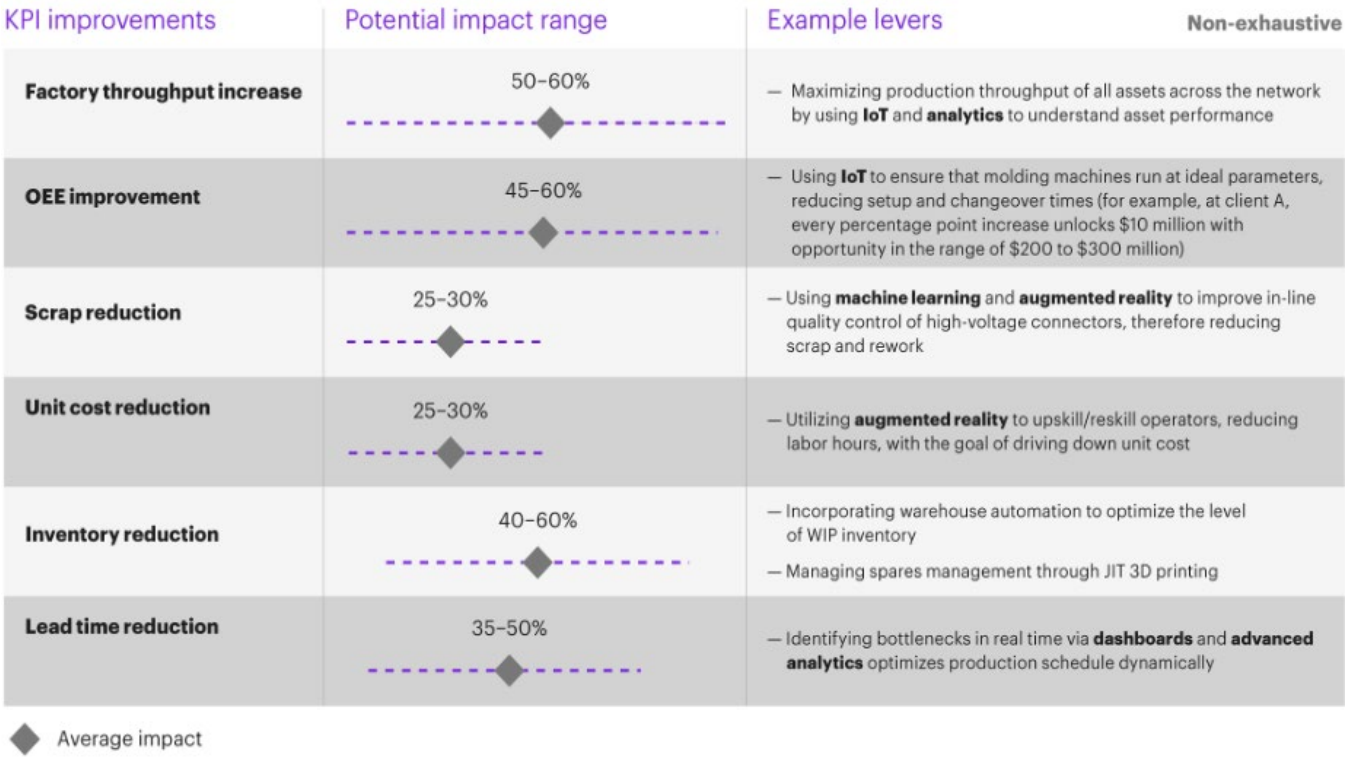
The end goal of Industry 4.0 is a digital production environment that is able to meet several key goals:

- **Interconnectivity**—generation of Big Data, machine-to-machine, and machine-to-human communication.
- **Decision support**—use of analytics for predictive action and autonomous decision-making.
- **Customization and flexibility**—the ability to create highly tailored production runs with minimal downtime and waste.
- **Decentralization**—outsource low-level tasks and decision-making to machines and increase modular capabilities of production assets.

These goals also extend across the supply chains and service providers, meaning that adoption and integration of Industry 4.0 will be just as critical for Small and Mid-Sized Enterprises (SMEs) in manufacturing as it is for large, multinational companies as the industry increasingly looks to interconnect various supply chains and production operations between companies as much as within companies.

Adoption and integration of Industry 4.0 technologies, systems, and frameworks will be critical to the future competitiveness of regions with a strong manufacturing base driving their economy. The use of these technologies and systems drives productivity, efficiency, quality, flexibility, and cost reduction improvements that ensure regional manufacturers can compete in a global marketplace. As noted below in Figure 2, once fully deployed, these technologies are expected to drive major impacts on Key Performance Indicators (KPIs) such as overall throughput, equipment effectiveness, unit cost reduction, and lead time reduction, with potential impacts estimated from 25-60 percent improvement over baseline. These impacts can have real, differentiating potential for regional manufacturing ecosystems, particularly SMEs, in growing a vibrant industry base amid broader market trends.

Figure 2: Illustrative Example of Potential Impacts from Adoption of Industry 4.0 Technologies



Source: Kearney, A brave new world for manufacturing: The State of Industry 4.0, 2019.
Note: OEE denotes Overall Equipment Effectiveness

Study Purpose and Scope of Work

Given the aforementioned market landscape, challenges, and importance of Industry 4.0 adoption and integration, the Evansville Regional Economic Partnership (E-REP) approached TEConomy Partners, LLC (TEConomy) regarding developing a Strategic Manufacturing Roadmap to guide and advance both the near- and longer-term competitiveness and growth of the region's advanced manufacturing sector. E-REP seeks to develop programs and initiatives that are informed by quantitative and qualitative regional analysis that will ultimately accelerate and sustain this critical regional industry cluster.

At the onset of this effort, E-REP gathered a steering committee of 18 thought leaders to help guide the strategic effort. Representing a cross-section of industrial and academic leaders, this committee played an indispensable role throughout the process. The members of the steering committee can be found in the textbox.

To inform the development of strategic recommendations, TEConomy conducted a series of analyses and engaged with manufacturing-focused organizations and assets in the Evansville Region as well as broader stakeholders identified through the strategic assessment of the Evansville Region's position in the manufacturing industry. Recommendations were developed based on a series of key inputs, including:

- **Quantitative analyses** of the Evansville Region's manufacturing industry, spanning key metrics that outline the economic vibrancy of the region, such as employment and productivity trends, talent and workforce profiles, and key industry support assets located in the region (see Appendix A for the complete analysis).
- A **survey** of regional manufacturers focused on Industry 4.0 adoption as well as challenges, which included 67 total survey responses (see Appendix B for the complete analysis of the survey responses).
- **Interviews** with key regional manufacturing stakeholders to discuss in further detail the state of Industry 4.0 technology adoption as well as a situational analysis of the Evansville Regional ecosystem in manufacturing.
- **Regional focus groups** vetted these findings and helped adjust, refine, and modify the situational analysis and identify ways that businesses, academe, and government can collaborate to advance the manufacturing cluster across the region.

The next section of this report includes a synthesis of both the qualitative and quantitative input. The analysis points to significant risks that the region's manufacturing industry will face in the coming years that threaten its legacy of economic growth and prosperity. To counter these risks and support the ongoing success of the manufacturing industries in the Evansville Region, the report's third section presents a strategic roadmap. This roadmap aims to assist the region's manufacturing industry by providing guidance, resources, and organizational capacity to help companies adopt Industry 4.0 technologies and frameworks. By doing so, the region can prepare itself to face disruptive industrial challenges and stay competitive in the future.

Project Steering Committee

- **Randy Bauer**, VP of Support Services, Jasper Engines
- **Beverly Brockman**, Dean of College of Engineering and Business, University of Evansville
- **Ted Brown**, VP, Toyota Motor Manufacturing Indiana
- **Scott Butrum**, Site Digital Lighthouse Lead, AstraZeneca
- **Paulo Dutra E Mello**, Vincennes University and Telamon
- **Kevin Koch**, President and CEO, KEI
- **Matthew Nix**, President, NIX Companies
- **Dom Poggi**, Director, Small Business Development Center
- **Evan Quinley**, Operations Manager, Kaiser Aluminum
- **Jenna Richardt**, VP of Business Development, Ports of Indiana
- **John Rohlman**, VP of Global Business Development, Warehouse Services Inc.
- **Brock Ryan**, Director, Site Operations, SABIC
- **Scott Spaeth**, Director of Corporate Automation, Berry Global
- **Steven Stump**, Director, Center for Applied Research, University of Southern Indiana
- **Daniela Vidal**, Chancellor, Ivy Tech Community College
- **Jake Ward**, VP of Manufacturing, Anchor Industries
- **Josh Armstrong**, SVP of Regional Economic Development, Evansville Regional Economic Partnership
- **Tyler Stock**, Executive Director of Talent EVV, Evansville Regional Economic Partnership

THE STATE OF THE EVANSVILLE REGION'S MANUFACTURING CLUSTER

Industry stakeholders and policymakers have long recognized that successful long-term development of advanced industries such as manufacturing is dependent on the growth of industry clusters rather than individual companies.

As defined by the Indiana Business Review in 2015:

> *Industry clusters are regional concentrations of related industries. Clusters consist of companies, suppliers and service providers, as well as government agencies and other institutions that provide education, information, research and technical support to a regional economy. One might say that clusters are a network of economic relationships that create a competitive advantage for the related firms in a particular region. This advantage then becomes an enticement for similar industries and suppliers to those industries to develop or relocate to a region.*[3]

Developing industry clusters is rooted in Michael Porter's critical work on defining the key industry clusters of the United States and their importance in driving economic growth.[4] His work points out that "*developing industry clusters has become a key goal for regional economic development as clusters have been shown to strengthen competitiveness by increasing productivity, stimulating innovative new partnerships, even among competitors, and presenting opportunities for entrepreneurial activity.*" As a result, cluster-based economic strategies have become a primary way that states and regions seek to grow their economies and develop long-term industry bases.

In manufacturing, cluster formation and growth play an outsized role in determining the eventual success of a state or region's industry base. Manufacturers are particularly tied to both upstream and downstream suppliers and distributors, with significant production costs tied to the transportation of goods across large distances. Similarly, manufacturers are also reliant on access to regional partnerships driven by

3 Slaper, T. & Ortuzar, G. (2015). Industry Clusters and Economic Development. Indiana Business Review. Volume 90, No. 1.
4 Porter, M. (1998). Clusters and the New Economics of Competition. Harvard Business Review. Volume 76, No. 6.

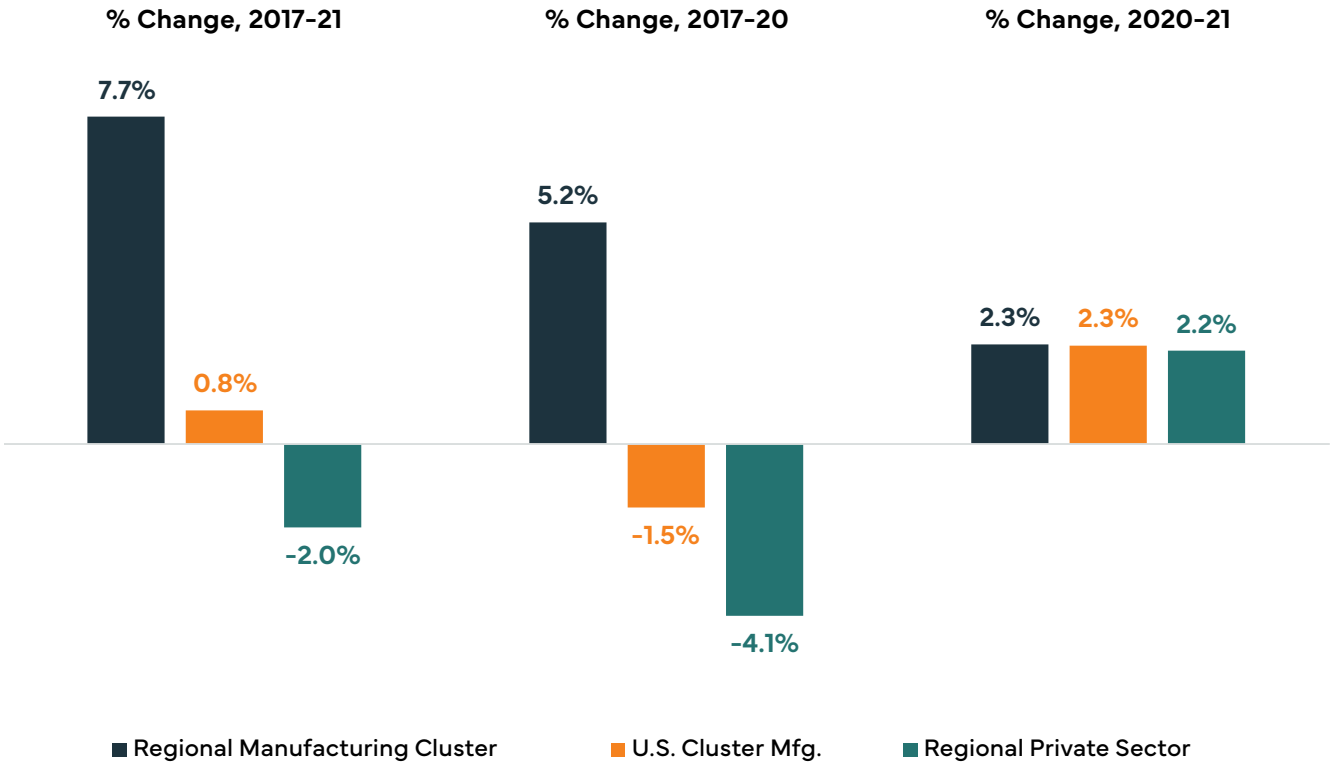
cluster formation, both for services relating to installation and maintenance of production infrastructure as well as third-party business support services providers. The importance of manufacturing cluster growth is especially acute for individual regions of a state, where anchor companies with large operations must continually evaluate competitive advantages to geographic locations on the basis of cost and access to local advantages driven by industry clusters, often basing significant investment and expansion decisions upon the presence of robust cluster ecosystems.

For the Evansville Region, the formation and ongoing growth of manufacturing industry clusters has played a crucial role in driving the region's economic fortunes and will remain critical in the coming decades. For a detailed definition and analysis of the Evansville Region's manufacturing clusters, please see Appendix A.

The Evansville Region's Manufacturing Cluster Today

Since the region's emergence as a major industrial production center during World War II, manufacturing has played a critical role in driving the Evansville Region's economic growth and prosperity. **Manufacturing-related industries play a significant role in the region's employment and economic activity, comprising 21 percent of total private-sector employment in the area compared to only 6 percent nationally. These industries also account for 41 percent of total economic activity (GRP) in the region, which is considerably higher than the national average of 8 percent. This is largely due to the presence of several highly specialized sectors and key anchor companies.** The region has also proven resilient to broader macroeconomic trends over time—growth in manufacturing jobs has continued even against the backdrop of recent pandemic-related disruptions to manufacturing industries worldwide as well as declines in the region's overall private sector employment. Overall, manufacturing employment levels grew by 7.7 percent from 2017-2021, far outpacing regional private sector growth (-2 percent) and national growth in analogous manufacturing cluster growth (1 percent) (Figure 3).

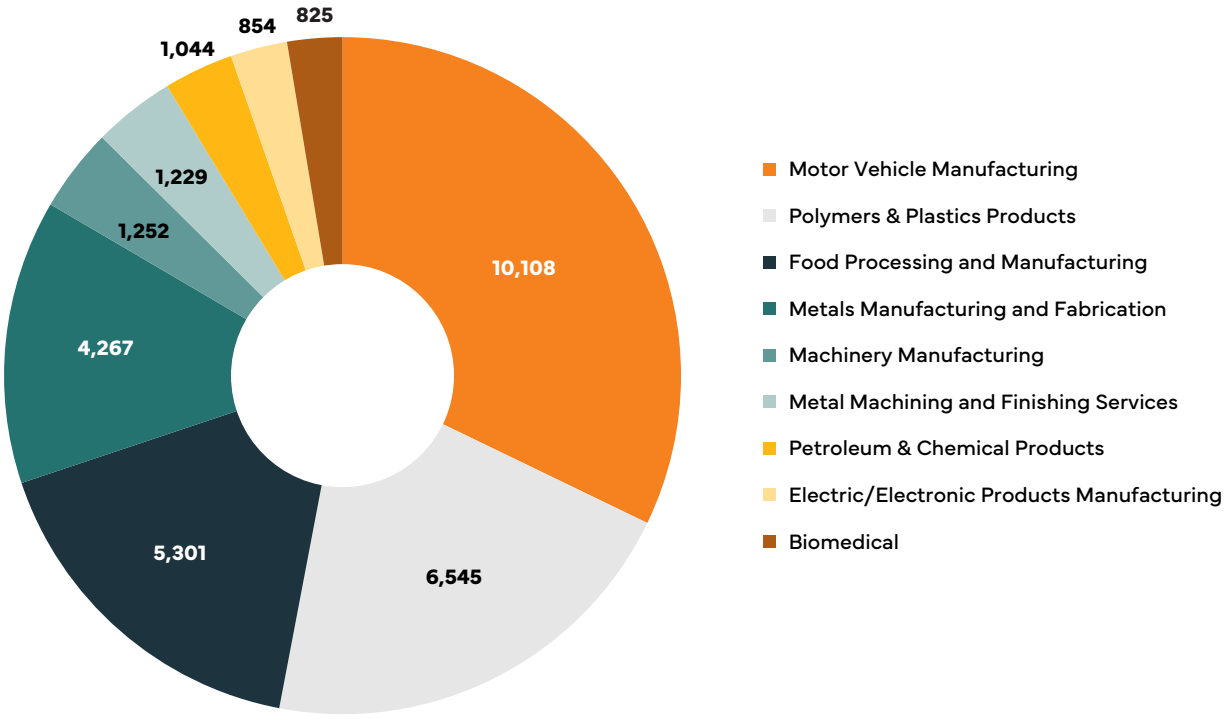
Figure 3: Employment Trends in the Evansville Region's Manufacturing Cluster Industries Relative to Total Private Sector and U.S. Trends



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

The strength of the region's manufacturing sector is not only in its overall employment footprint but also across its diversity of products. As illustrated in Figure 4, the region's employment base is distributed across several key manufacturing subsectors that serve a variety of end markets yet are also highly interconnected across upstream and downstream supplier relationships.

Figure 4: The Evansville Region's Employment in Manufacturing Clusters, 2021

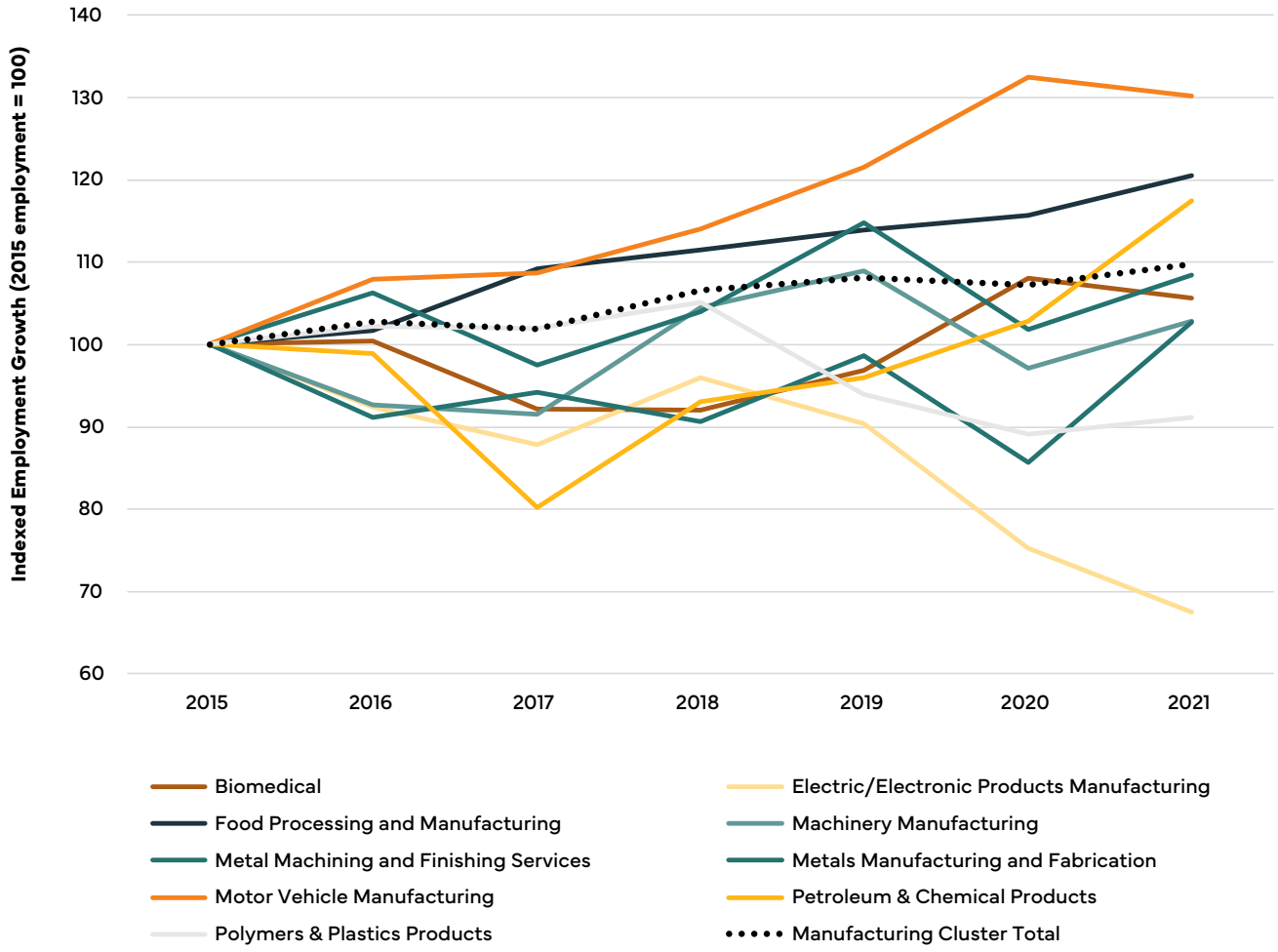


Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

The region is home to a large and extremely specialized (over 9.6 times more concentrated than the U.S.) employment base of over 10,100 workers in motor vehicle manufacturing anchored by Toyota Motor Manufacturing Indiana's (TMMI) operations and its supplier base, which has exhibited a strong growth trend of nearly 20 percent from 2017-2021. Reflecting the region's historical manufacturing growth, there is also a sizeable and specialized (over seven times more concentrated than the U.S.) polymer and plastics products manufacturing sector of over 6,500 employees supported by major anchor company operations at Berry Global, Sabic Innovative Plastics, LyondellBasell, and DSM Engineering Materials, among others (although this industry has declined in employment by nearly 11 percent since 2017). Food processing and manufacturing has experienced significant employment growth of 10 percent from 2017-2021 to its current footprint of over 5,300 workers and is similarly supported by key anchor company operations focused on shelf-stable foods and powder formulation. Additionally, there are other specialized manufacturing industry sectors in metals and machinery manufacturing totaling over 5,500 employees collectively focused on engine and component remanufacturing that have grown in recent years by over 11 percent and nearly 13 percent, respectively, as well as a growing pharmaceutical manufacturing presence focused on solid-dosage therapeutics.

Relative to broader national trends, which saw many national manufacturing industries experience lower job growth over the last five years, the Evansville Region's manufacturing base appears to be forging ahead. In fact, six of the region's subclusters were both specialized and growing over the 2017-2021 period (Figure 5), indicating a vibrancy within the region's manufacturing base that is indicative of a strong fundamental cluster ecosystem.

Figure 5: The Evansville Region's Employment Growth Trend in Manufacturing Clusters, 2015-2021



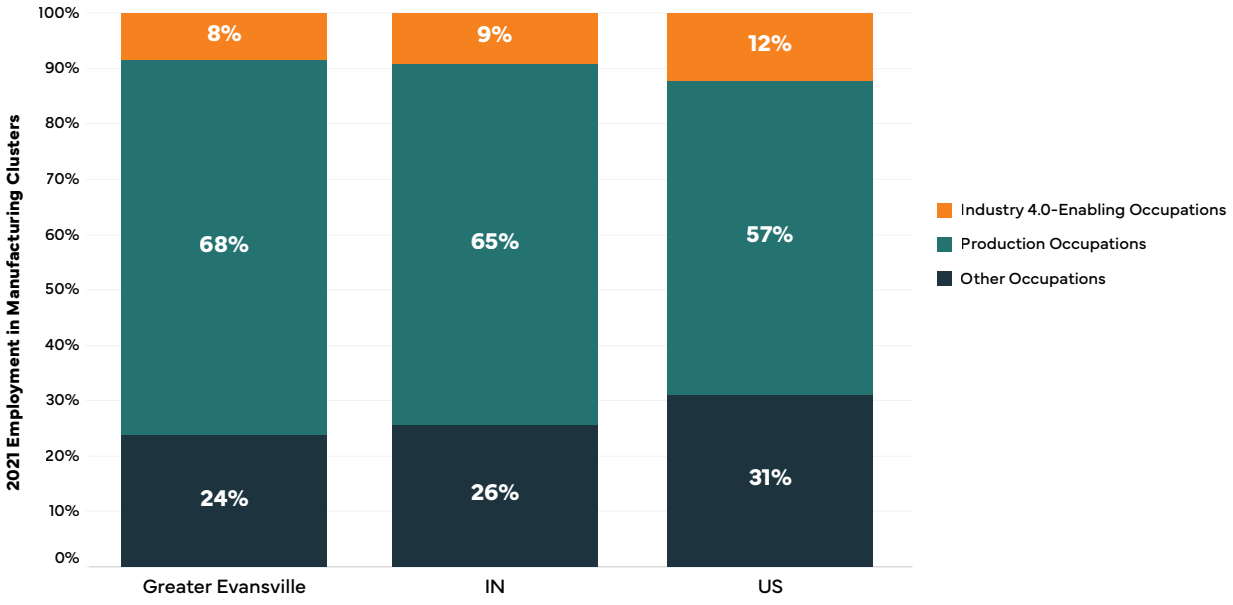
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Challenges Facing the Regional Manufacturing Cluster Ecosystem

As a result of its ongoing growth and diversity, the Evansville Region's manufacturing base finds itself in a position of relative strength when compared against broader national trends. However, the future of the industry cluster is not assured in the face of powerful market and demographic headwinds that are impacting the industry. In particular, a reliance on the operations of key company site locations to anchor the region's clusters and their workforce means that the Evansville Region's existing manufacturing identity is particularly vulnerable to disruptive trends.

Despite the current strong employment footprint of manufacturing in the region, availability and alignment of talent with respect to the skills and competencies needed to fully leverage Industry 4.0 environments will be a critical determinant of the regional cluster's future trajectory. Digitization of manufacturing processes and operations ultimately requires a skilled workforce to implement and oversee adoption of new technologies, and identifying the presence of occupational workforce groupings closely aligned with Industry 4.0 skills deployment within manufacturing clusters is one way to assess the capacity of the region's manufacturers to adapt to changing technology and market dynamics. As shown below in Figure 6, the Evansville Region's share of the workers most aligned with Industry 4.0 skill sets and roles[5] make up a smaller portion of overall manufacturing employment relative to the nation while remaining on par with the state's share. Perhaps more concerning is the fact that the Evansville Region has lost a share in its Industry 4.0-enabling occupations since 2017, falling from 9 percent of total manufacturing cluster employment to 8 percent in 2021 while the state's and nation's share remained roughly the same. As digital technologies become more pervasive in manufacturing environments, the alignment of talent in the region may present a limiting constraint on the rate of adoption and integration.

Figure 6: Industry 4.0-Enabling Occupational Employment within the Evansville Region's Manufacturing Clusters

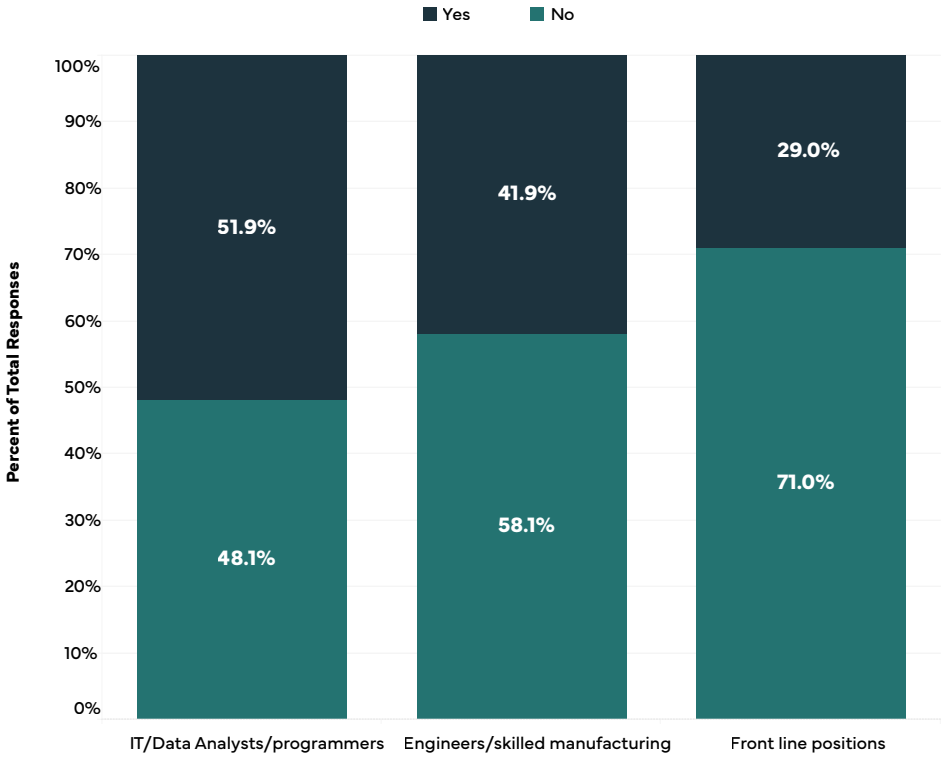


Source: TEConomy's analysis of staffing patterns data from LightCast (release 2023.1); for further details, see Appendix A

5 See Appendix A for detailed definitions of Industry 4.0-Enabling occupations and occupational workforce trends in the region's manufacturing industry clusters.

Survey responses from regional manufacturers (see Appendix B for the complete analysis of the survey responses) reinforce the conclusion that talent dynamics are already proving challenging for the cluster amidst a highly competitive broader national labor market. As shown in Figure 7, the region's ability to supply talent across key positions is lagging behind demand from manufacturers, with several of these positions being critical to the operational implementation of new technologies and digital applications. Additional conversations with regional manufacturing companies make it clear that talent represents a key challenge for the future, with concerns regarding the ability to attract talent from other regions of the country, looming waves of retirements from experienced senior workers and associated knowledge drain, and high levels of turnover in entry-level positions. A potential warning sign for the region's ongoing ability to sustain growth was the recurring message that the "digital literacy" of workers in the region is not keeping pace with the changes in technology required to be competitive in a modern manufacturing enterprise, particularly at entry- and mid-level technical positions.

Figure 7: Regional Manufacturer Survey Responses to Question "Does the supply of talent in the region meet your needs?"

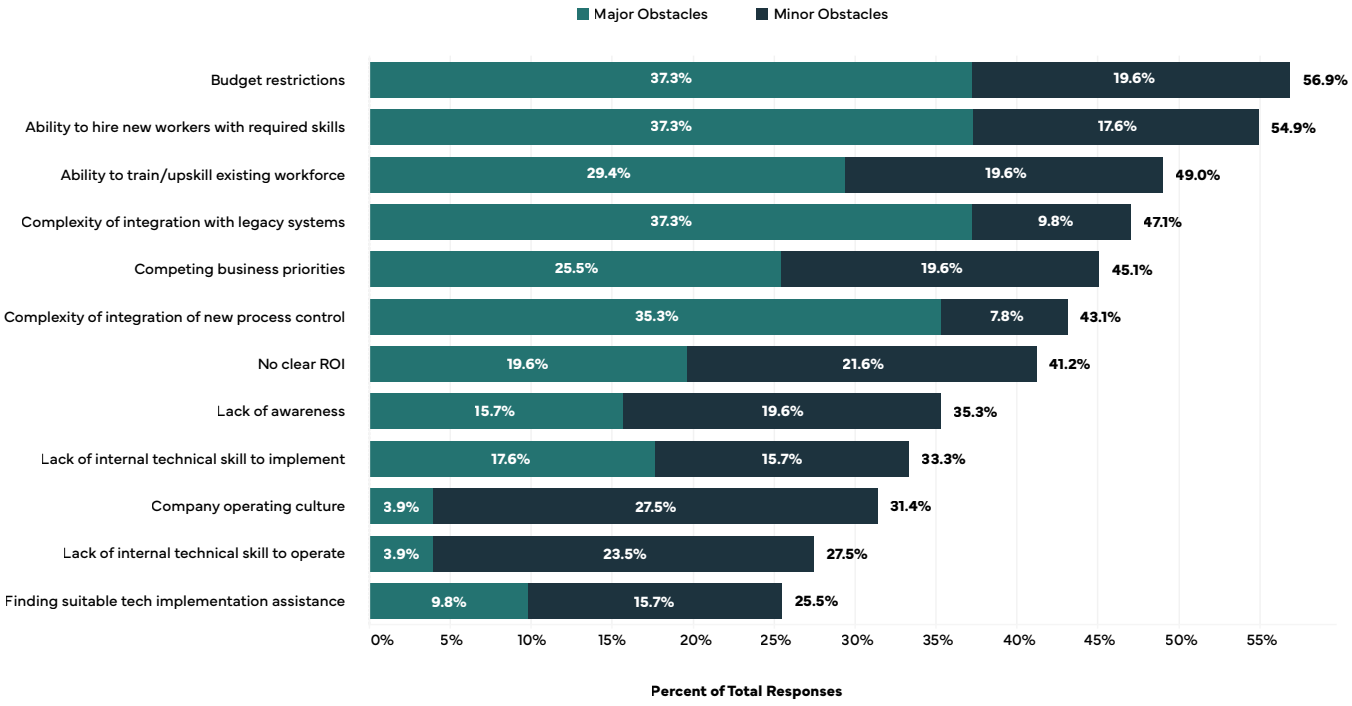


Source: TEConomy's analysis of Evansville Region Industry 4.0 survey; for further details, see Appendix B.

In addition to challenging talent dynamics, it is important to ensure that SMEs are not left behind in the ongoing transition to Industry 4.0 frameworks. Regional manufacturers identified cost-related obstacles as the greatest barrier to achieving Industry 4.0 technology implementation objectives (Figure 8), which presents a particularly challenging outlook for small- and mid-sized manufacturers who lack the broader corporate resources to drive internal R&D, capital investments, and pilot projects. Given the rapidly changing

nature of digital technologies and the competitive race to adopt new cost-saving systems, the base of regional SMEs' risks being hollowed out due to disruptive market effects over time that, in turn, erodes the broader cluster ecosystem that needs a robust set of employers, suppliers, and innovators to remain resilient. Conversations with SMEs indicated a recognition of the urgency of investing in Industry 4.0 but a gap in knowledge of best practices, coordination of the regional cluster ecosystem, and support for de-risking large investments in new technologies and systems.

Figure 8: Regional Manufacturer Survey Responses Identifying Major and Minor Obstacles to Achieving Industry 4.0 Technology Implementation Objectives



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey; for further details, see Appendix B

These challenges point to significant risks for the region's manufacturing cluster in coming years that threaten its legacy of successful growth. To help position the Evansville Region's manufacturing industries for ongoing success, a cluster-based strategic manufacturing roadmap is necessary in order to focus programmatic efforts on providing the guidance, resources, and organizational capacity to help industry "bridge the gap" to large-scale implementation of Industry 4.0 technologies and frameworks. Given the outsized importance of manufacturing industries in driving employment and overall economic activity for the region, focusing cluster-based initiatives and activities around manufacturing is likely to yield significant economic impacts. Conversely, the costs of not successfully navigating the transition to digital manufacturing environments have the potential to be extremely damaging to the region's economic outlook. **The strategies and actions have been developed with the intent of helping the region's manufacturers accelerate their adoption and integration of Industry 4.0 by addressing the key challenges they face today: barriers to digital change management and technology adoption, gaps in the supply and alignment of talent, and a need to more aggressively coordinate the region's assets to build a critical mass that can drive broad impacts.**

A STRATEGIC ROADMAP FOR THE EVANSVILLE REGION'S MANUFACTURING INDUSTRY CLUSTER

If the Evansville Region is to succeed in maintaining the economic competitiveness of its manufacturing industry base, thereby helping ensure the economic prosperity of its citizens, it must focus on overcoming the cluster's current and future challenges.

To this end, it is recommended that the Evansville region focuses strategic efforts on:

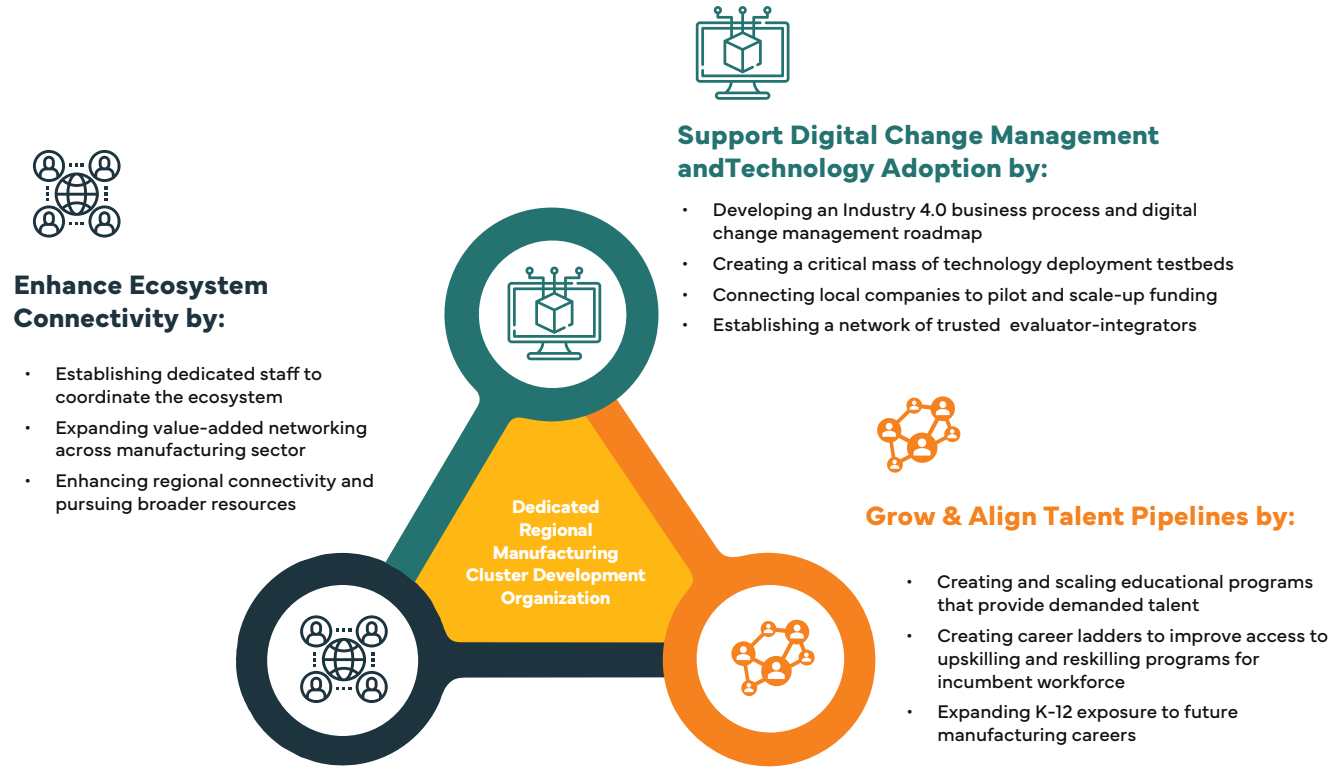
- **Supporting digital change management and technology adoption,**
- **Growing and aligning talent pipelines, and**
- **Enhancing ecosystem connectivity.**

By focusing on these three thematic areas, the Evansville Region will help ensure the region's future economic vitality. Anticipated economic and societal impacts that will be realized through the successful implementation of this Strategic Roadmap include:

- Better-paying jobs with higher growth potential
- Ability to weather future economic challenges, and
- Inspired future generations who reach their full potential.

Generating these outcomes does not happen on its own but rather through a series of intentional, strategic, and proactive decisions. The Strategic Roadmap is driven by public-private partnerships that capitalize on the Evansville Region's strengths while ensuring that future programmatic investments are focused on building the ecosystem that will help ensure the robustness of the region's manufacturing cluster for years to come (Figure 9).

Figure 9: A Strategic Roadmap to Support the Evansville Region's Manufacturing Cluster



Source: TEConomy Partners, LLC.

The details regarding each strategy and subsequent action are outlined in the narrative that follows.

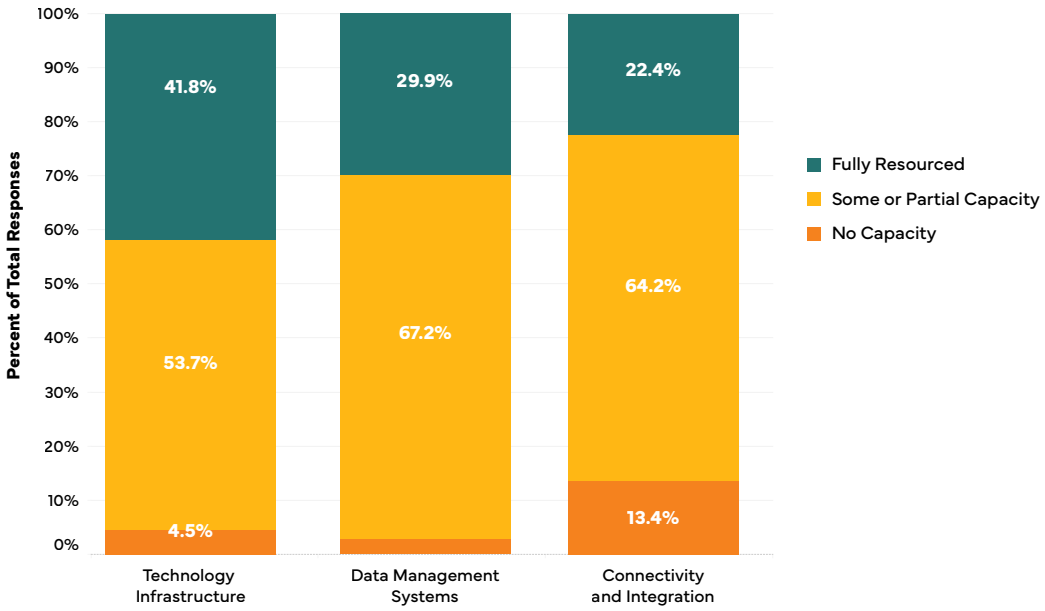
Strategy 1: Support Digital Change Management and Technology Adoption

Strategy Rationale

At its heart, the concept of Industry 4.0 relies upon the successful adoption and integration of technology systems to drive improvements in key performance indicators in manufacturing operations. There are many common denominators in new technologies being leveraged by manufacturers as they transition to digital models, such as streamlining business processes through enterprise resource planning (ERP) software platforms, employing Industrial Internet-of-Things (IIoT) capabilities to gather data from machines and production floors, and digital supply chain and "track and trace" systems. However, the reality of actual "shop floor" implementation varies widely by industry sector, company size, and individual company business operations. As a result, the Evansville Region requires an approach to technology adoption that simultaneously accelerates the pace of technology deployment to remain competitive yet includes a wide variety of potential deployment environments.

Survey responses from regional manufacturers (Figure 10) show that general attitudes about Industry 4.0 are positive, with many survey respondents indicating that Industry 4.0 adoption is perceived as necessary to remain competitive and is a positive investment for growth regardless of company size and industry. While very few companies have zero capacity for digitization of key systems, only a minority of companies have the physical capacity to fully implement Industry 4.0 technologies today in key dimensions of their operations, thereby indicating a significant capacity for the region to expand the scope of technology deployment.

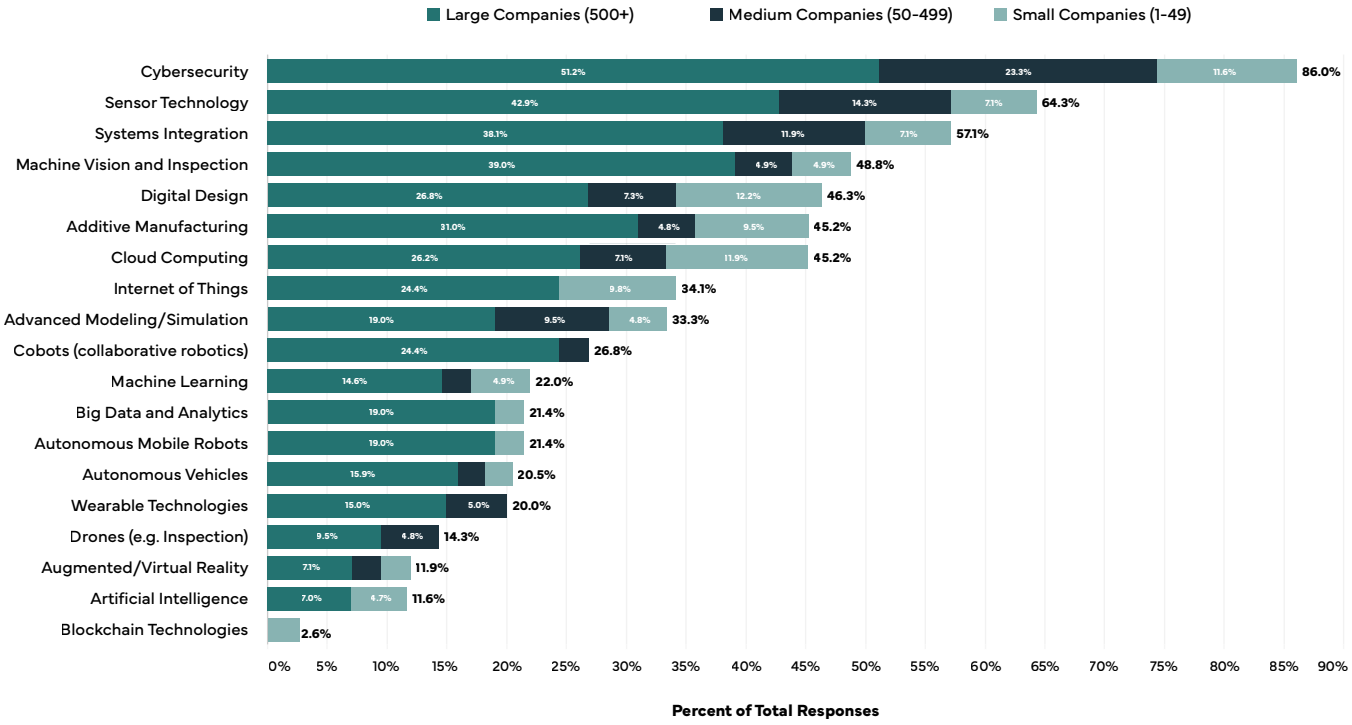
Figure 10: Regional Manufacturer Survey Responses to Question "How would you rate your company's current overall level of technology-readiness (physical capacity) to implement Industry 4.0 Technologies?"



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey; for further details, see Appendix B

Many regional manufacturers have already begun to move towards integrating these systems into their existing operations. Over 65% of surveyed companies had a dedicated budget for adopting Industry 4.0 technologies, with 45% of the respondent companies reporting that they remain in the research and planning stage of implementation and 44% of respondent companies already implementing one or more Industry 4.0 technologies. Regional companies reported that cost reductions, improvements to product quality, productivity enhancement, and increased equipment uptime and capacity were their top reasons for seeking to invest in these technologies, demonstrating a broad awareness of the benefits of a fully realized Industry 4.0 environment. As shown below in Figure 11, companies in the region reported that they are broadly adopting key elements of Industry 4.0 infrastructure, including cybersecurity enhancements, IoT sensor technologies, and broader systems integration tools.

Figure 11: Regional Manufacturer Survey Responses to Question "Which of the following Industry 4.0 technologies (and other directly related technologies) has your company implemented prior to 2023?"



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey; for further details, see Appendix B
NOTE: Rows do not add up to 100% due to multiple answer selections allowed for this question

However, as noted in the Challenges section, cost barriers to adoption remain a key obstacle, particularly for smaller manufacturers. Nearly 57% of survey respondents cited budget and cost restrictions as a perceived barrier to successful implementation, the most highly cited barrier among those listed in the survey. As a result, there are significant disparities between the state of large company adoption and integration of technologies versus SMEs, as observed in the significantly higher shares of large companies reporting existing implementation across the portfolio of Industry 4.0 technologies shown in Figure 11. In addition, discussions with regional companies indicated that day-to-day operations vary considerably by company

size, with many smaller manufacturers reporting that they tend to have a wide variety of highly customized tasks within the context of their production environment, making large-scale industrial automation impractical. Technology solutions with demonstrated outcomes are also critical to driving investment and adoption for SMEs, since failure of a technology solution has outsized impacts on the smaller margins and tighter budgets these companies typically operate under.

As a result, the Evansville Region's manufacturing community currently has two "tiers" of technology adoption among its cluster companies. Large companies are generally adopting and integrating the latest technologies based on corporate strategies with multinational scale and internally funded efforts leveraging significant resources but are struggling to find the supporting talent within the region that complements these capital investments. Meanwhile, Small and Mid-Sized Enterprises tend to lag behind in the adoption of Industry 4.0 due to the medium- and high-mix "job shop" nature of work, with resources and the ability to leverage subject matter expertise being key barriers to success. Notably, SMEs overwhelmingly acknowledge the importance of modernizing but need resources to de-risk upfront investments and guidance on what technology use cases already exist that deliver effective returns on investment. Due to the nature of many of these businesses in dealing with smaller volume production runs and re-machining of existing components, tech adoption in many SMEs is likely limited to only portions of the shop floor due to diminishing returns on capital-intensive machinery and robotics, with the most significant opportunities for impact around digital modernization of administrative, supply chain, and other "back office" logistical functions. Demonstrated use cases with associated outcomes metrics are key to SME receptivity to new technology solutions and are often derived from best practices observed at larger companies that have had success in integrating Industry 4.0 solutions.

To remain competitive in an increasingly digital manufacturing industry, the region needs to accelerate digital change management and technology adoption across its base of companies, particularly SMEs, by helping to reduce identified barriers to adoption in the context of these dynamics. While larger companies require investment in talent pipelines aligned with technology investments (discussed in Strategy 2), many regional multinational companies have also expressed a desire for increased knowledge-sharing and cooperation in non-competitive technology use cases. For SMEs, the region must find ways to help provide resources and expertise to accelerate Industry 4.0 technology investment so that SMEs can keep pace and position themselves for future needs as critical suppliers within the manufacturing value chain.

The following actions are intended to help support digital change management and technology adoption across both cohorts of companies by addressing key constraints.

Action 1: Develop an Industry 4.0 Business Process and Digital Change Management Roadmap for Regional Manufacturers, Leveraging Best Practices from Leading Companies

A key gap in the current ecosystem cited by both large manufacturers and SMEs is the need for an overarching roadmap that can be leveraged by regional stakeholders to inform the path forward for technology adoption and integration in a comprehensive way. As noted at focus groups with regional manufacturers, business process improvement and change management underpins the successful deployment and utilization of technology, with some best practices already being advanced at regional multinational companies that have invested resources at the corporate level to develop internal roadmaps. Similarly, the region requires a digital change management roadmap that meets companies wherever they are today and provides clear, standardized guidance on the next steps for change management that incorporate digital technologies and capabilities critical to Industry 4.0 implementation.

Best Practices in Digital Change Management

Notre Dame Industry Labs provides direct services and support to regional manufacturers in the South Bend-Elkhart region using project teams led by Engineers in Residence (ENIRs) in collaboration with other supporting university faculty, researchers, analysts, and technicians. A key service provided by the ENIR teams involves digital process improvement planning, a scope that entails a 10-16 week engagement with a regional company to develop a current state assessment, technology adoption processes with specific technology specifications, and potential technology solutions identification shortlisted solution-providers and/or software tools as well as a preliminary Return on Investment (ROI) calculation. Success stories cited by the program include projects that outlined process improvement strategies for RFID tagging implementation and ERP system transition preparation.

The Evansville Region should create a digital change management roadmap for its manufacturing companies that meets the following requirements:

- Provides clear guidance on best practices in digital change management for manufacturing companies, outlining priorities and actions for achieving key milestones in digital transformation for various stages of company maturity in deploying Industry 4.0 technologies.
- Seeks to standardize processes around replicable Industry 4.0 use cases and impact metrics in key dimensions such as maintenance, production efficiency, logistics, networking, and other critical domains.
- Promotes interoperability and common protocols across the manufacturing value chain in order to more closely interconnect regional manufacturing supply chains around common data and information transfer protocols.

The Roadmap should be developed using a structured process that incorporates a variety of industry stakeholders and made publicly available to the manufacturing community. Critically, the Evansville Region should seek to leverage the experiences and knowledge bases of several regional manufacturers who have undertaken digital change management initiatives to inform best practices, specifically TMMI and the broader Toyota Production System (TPS) framework. The cluster development organization should seek to develop the roadmap with a specific perspective toward organizing a digital transformation "toolkit" for SMEs that

outlines specific steps and milestones in the Industry 4.0 process. The organization can also leverage existing "community of practice" groups at the Tri-State Manufacturing Alliance (TSMA) to promote a renewed emphasis on communities of practice for digital transformation in key domain areas such as those listed above.

Additionally, a working group of major manufacturers in the region should be convened to explore options for adopting a standardized electronic data interchange (EDI) framework similar to those used by major automotive manufacturers in their supply chains.6 Recognizing the regional scale of this strategy, the organization overseeing this effort can seek to connect with broader manufacturing data protocol groups or agencies to adopt and promote a specific EDI framework for the region, or the organization could engage a reputable third-party solutions provider to offer an EDI solution as a service to manufacturers. The concept of standardized data formats and communication protocols used in an EDI framework should be a critical component of the digital transformation roadmap, particularly with respect to communicating the value proposition of digitization to Tier 1 and Tier 2 suppliers of major regional companies.

6 Porsche. (2022, March). Guide to Electronic Data Interchange Between Porsche and its Suppliers, Version 2. . Accessible at: https://newsroom.porsche.com/dam/jcr:46f5e521-51a5-4a85-a518-be0571907d51/EDI

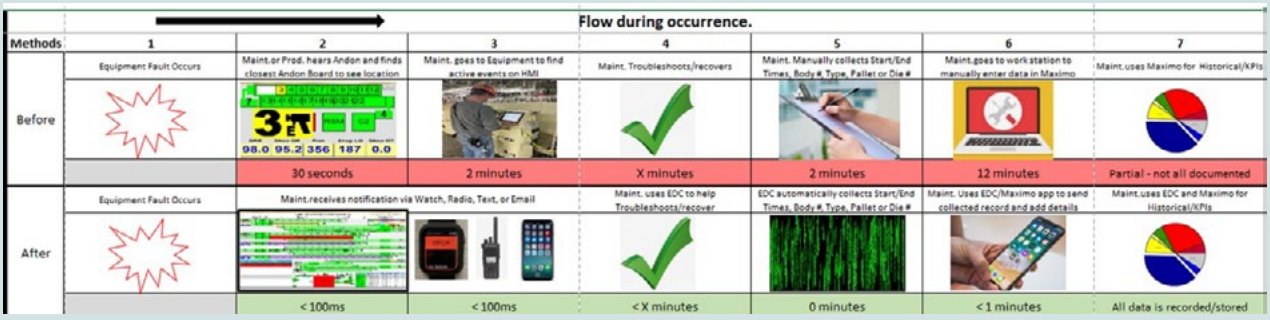
Digital Change Management Case Study: Toyota Motor Manufacturing, Indiana

Toyota Motor Manufacturing, Indiana (TMMI) has developed an operating model that is comprised of three key categories:

- Business Process Management (BPM), which involves identifying value from a business process and understanding manufacturing needs.
- Technology Solution Development, with a focus on scalability.
- Organizational Change Management (OCM) for the delivery and scaling of enhanced technical capabilities throughout the technology adoption and integration life cycle.

One use case for the process internally was floor management operations under the Toyota Digital Maintenance Transformation initiative, which was identified as a key place where the production capability of digital information was high, but a gap in consumption of data by business processes existed. Using the framework to help with integrating Electronic Data Capture (EDC) for equipment fault alarm events was estimated to create a value add of $10 million per year in addition to generating complete data about mean time between failure, which in turn can lead to better measurement of performance indicators over time (see below).

Event Flow for Electronic Data Capture Integration Into Equipment Fault Process



Source: Toyota

This approach is now being more broadly integrated into the enterprise to capture business voice around 'foundational capability' needs and subsequent creation of transformational roadmaps for other operations areas. A similar approach for identifying BPM best practices in manufacturing domain areas of relevance to regional companies can be advanced through the Evansville regional manufacturing cluster organization around key applications areas of common interest, with the resulting digital transformation roadmaps serving as a key resource for the region's industry base.

Action 2: Create a Critical Mass of Technology Demonstration Testbeds by Linking Private and Academic Technology Assets with SMEs

As noted in the challenges outlined above, many manufacturers are risk-averse to potential disruptive impacts on their business operations and, as a result, are often hesitant to adopt unproven technologies. Helping to provide a network of demonstration and deployment testbeds across the regions where companies can de-risk the process of integrating new technology is often a critical component of Industry 4.0 strategies.

In the Evansville Region, significant demonstration, testing, piloting, and other technology deployment assets exist through a robust mix of public and private entities. However, the region does not currently coordinate or network these assets across key areas of focus or distribute information on accessing and interacting with these assets in a centralized place, diluting the ability to scale broader adoption. To address this issue, the region should take several actions to build towards a more cohesive critical mass of activity accessible from a common point of access.

The Evansville Region should first seek to fully inventory and assess the existing assets in the region and segment them into key areas of focus aligned with the Business Process and Digital Change Management Roadmap developed in Action 1. Many industry-sponsored assets in the form of "flagship" company operations were noted by regional stakeholders, and many companies were receptive to a variety of knowledge-sharing activities ranging from plant tours to providing space for hosting demonstration platforms. Key industry assets identified in conversations with regional stakeholders that are advancing Industry 4.0-related technologies that can serve as "living" use case demonstrations of Industry 4.0 include:

- Toyota TMMI's Advanced Automation and Data Lake Capabilities
- Berry Global's ESS Facility
- AstraZencea Digital Lighthouse Programs

Best Practices in Creating a Technology Demonstration Ecosystem

Chicago's mHub HardTech Development & Manufacturing Services helps to coordinate a broad regional manufacturing ecosystem through a central business accelerator organization, including a central prototyping labs site, regional universities, a variety of manufacturing corporate partners, manufacturing associations such as Illinois Manufacturing Excellence Center (IMEC) and the Technology & Manufacturing Association (TMA), technology provider partners, and others. mHub connects regional companies with technology funding, product development, and demonstration resources in key Industry 4.0-related areas of focus such as Industrial IoT hardware devices, endpoint security, and process improvement and also helps to match companies with applied R&D support from relevant partner organizations at various points of the product development lifecycle. mHub members also have access to established corporate partner relationships and mentoring networks in key technology areas such as manufacturing process innovation and IoT devices which SMEs and startups can leverage for knowledge sharing and access in technology demonstration use cases.

As part of this effort, it will be critical to conduct outreach to other firms with a strong regional presence, such as AmerQual, Koch Enterprises, Reckitt Benckiser Group, and SABIC, to learn of their efforts and whether these companies would be willing to serve as additional "living" use case demonstration sites.

The goal would be to engage these industry partners in activities designed to encourage knowledge diffusion throughout the broader manufacturing cluster through activities such as:

- Arranging Industry 4.0 "showcase" plant tours and demonstrations with key anchor companies for SMEs and other industry stakeholders.
- Organizing communities of practice around the key domain areas determined by the change management roadmap in Action 1, with the specific goal of outreach to SMEs to send relevant delegates.
- Conducting strategic information gathering from key companies around demonstrated use cases of Industry 4.0 deployment and acting as the centralized distributor of information on use cases to the broader manufacturing community.

Similarly, there are other technology demonstration and knowledge-sharing assets hosted by universities and institutions outside of industry operations that can help to serve as demonstration, applied research, and piloting centers for new technologies. Several key centers in the region include:

- University of Southern Indiana Applied Engineering Center
- Vincennes University Center for Technology, Innovation and Manufacturing (CTIM) and the Center for Advanced Manufacturing and Logistics
- University of Evansville Change Labs
- Southern Indiana Career & Technical Center (SICTC)

Best Practices in Creating an SME-Focused Industry 4.0 Accelerator

Michigan's Automation Alley Industry 4.0 Accelerator provides Industry 4.0-focused technology accelerator programming, services, and funding to startups as part of broader efforts to grow Michigan's manufacturing industry cluster. The accelerator operates as a partnership between Automation Alley, a nonprofit manufacturer association supported by the Michigan Economic Development Corporation (MEDC), Lean Rocket Lab, a business incubator, and The Centrepolis Accelerator at Lawrence Technological University. The program's profile notes that it *"was established in 2020 with $1.3 million originally funded through the Michigan Economic Development Corporation. Investments are currently available for early-stage companies looking to commercialize products, services or technologies within the Industry 4.0 sector. Through its distinct structure, the Accelerator services expose participating startups to more than thirty corporate partners, including OEMs, Tier One and Tier Two suppliers. Previous investments from the Accelerator include Andonix, which develops worker safety systems that provide operation intelligence directly from the shopfloor, and Autaza, a developer of AI-enabled computer vision systems."*

The accelerator program interfaces with Automation Alley's other programmatic efforts, such as trade visits for Michigan SMEs, public-private partnership building, and digital transformation knowledge-building initiatives for manufacturers.

These assets all have capabilities that can help support regional manufacturers, particularly SMEs, but need broader coordination with industry to scale engagement as opposed to the more sporadic efforts occurring in the region today. In some cases, supporting funding may be necessary to make these assets fully operational. For example, facilities at the University of Southern Indiana (USI) were noted to have significant equipment and technology assets but lacked staffing to provide sufficient operational machine time due to university budget constraints (see text box). It will be critical to identify key regional assets at universities and other non-industry institutions and then map them to functional domain areas where they can better help SMEs with specific digital change management milestones, providing supporting resources where necessary.

USI's Applied Engineering Center: A Regional Smart Manufacturing Asset

The Applied Engineering Center (AEC) housed at USI's Evansville campus is one of a network of key regional assets that can serve as hubs for aggregating activity and delivery of services related to Industry 4.0. The AEC houses a variety of digital production machinery that can be used for prototyping and training, ranging from CNC mills and lathes to a robotic welding work cell. The center is housed in a high bay building that also includes classroom space, offices, a printed circuit board fabrication lab, an automation lab, and a precision instruments lab.

The AEC's automation lab is designed for training on robotics and Programmable Logic Controllers (PLCs), including two robotic training work cells with Mitsubishi RV-2AJ robots, a palletized flexible manufacturing system, a pneumatics/hydraulics trainer simulator system, and twelve PLC trainer simulators. Additionally, the precision measurements lab offers access to a coordinate measurement machine, laser scanner, and a Fortus rapid prototyping 3D printer. AEC's staff can develop specific training modules in coordinate with industry partners designed to reskill and upskill existing workers around digital technologies in a hands-on environment.

Additionally, the facility is also home to USI's Center for Applied Research (CAR), which engages in projects with industry partners to leverage USI's faculty, lab and facility spaces, and students to provide cost-efficient prototyping, product testing, market research, and other subject matter expertise services. As a part of these efforts, CAR hosts the Project Technician program designed to give students a paid internship opportunity while applying their knowledge and skills to real-world challenges. Students are hired by USI to serve as technicians on projects within CAR using a demand-driven approach that recruits students with the skills and academic majors relevant to each specific project. Time spent as a Project Technician can be for the duration of a single project, or on an ongoing basis depending on client needs. Currently, CAR employs ten Project Technicians based on the steady volume of design, fabrication, and electronics projects.

Finally, to be successful, it will be critical that resources are dedicated to supporting the role of "matchmaking" SMEs with key assets in the region based on technical maturity, industry, and key application areas. Dedicated staffing should be tasked with keeping a continual inventory of regional assets and activities and actively seeking to partner with incumbent industries, public institutions, and SMEs in value-added relationships

that can advance technology deployment. Often, a large existing manufacturer will be able to provide a demonstrated-use case and associated knowledge sharing that an SME can leverage, while public institutions can then provide expertise, testing, and demonstration facilities that the SME may not be able to fully support themselves. Building a track record of successful public-private partnerships that include an existing large manufacturer, public or research institution, and an SME can help to rapidly accelerate technology adoption among the local industry base while also providing momentum for follow-on engagements. To the extent possible, the region should seek to engage Purdue's Manufacturing Extension Partnership (MEP) program to provide technology expertise and assistance. Still, it must also be prepared to leverage connections from industry, given the lower levels of MEP activity in the region in recent years.

Through more centralized management of SME engagements and public-private partnerships, the region can more effectively diffuse demonstrated technologies into the cluster supplier base and build a more cohesive network of partnerships between companies.

Best Practices in Creating a Technology Demonstration Ecosystem

Germany's Mittelstand-Digital Initiative represents an ongoing investment on the part of the national government in the country's Industry 4.0 ecosystem. The initiative established 26 competence centers scattered throughout Germany providing information and digitization to SMEs free of charge. Each of the centers provides expertise in key technology adoption use cases, with demonstration and test environments, model Industry 4.0 production lines, and integration services delivered via mobile solutions "labs."

As a key components of the initiative, several centers have more recently formed the SME Digital Network which is focused specifically on small- and mid-sized business. Free offerings for SMEs include lab tours, analyses of current processes, qualification offers, transfer projects, digital strategies and industry networking. The program description notes that *"the concept is that of a "one-stop-shop" that provides a contact point for all SMEs, regardless of their sector and degree of digitalization, with the centers deliberately distributed throughout the whole country. The centers will help companies assess their own digital efforts, develop a digitalization roadmap tailored to their individual needs, and support them as they select and implement specific actions."*

Action 3: Connect Local Companies to Pilot and Scale-Up Funding

While technical expertise is critical to de-risking technology adoption for industry, equally as important is supporting company investment in new Industry 4.0 systems through connecting companies with supporting resources. Local manufacturer survey responses indicated that nearly three-quarters of survey respondents have not yet leveraged the Manufacturing Readiness Grant (MRG) programs launched by Conexus Indiana and the Indiana Economic Development Corporation (IEDC) designed specifically to accelerate Industry 4.0 technology adoption, with almost 39 percent indicating they had not heard of the opportunity. Connecting local companies with these resources has the potential to dramatically accelerate their ability to implement new technologies to better align with the future of the manufacturing industry.

The Evansville Region should seek to create a matchmaking functionality to educate and connect regional companies with funding opportunities that de-risk initial investments in technology. Activities to undertake include:

- Inventory the participation in the state's MRG program among manufacturing firms as well as associated outcomes over time. The aim would be to identify regional manufacturers who could benefit from the program but have not yet applied, as well as ascertain those regional manufacturers who saw demonstrated outcomes from funding that would benefit from additional potential funding rounds from the program. Assist companies in applying for either their first or subsequent rounds of funding from the MRG program by providing direct assistance in writing applications as well as coordinating submission and follow-up with Conexus.

- As an additional source of potential investment, the organization can also seek to connect

The Expansion of State-Led Funding for Industry 4.0 Technology Adoption

Recent years have seen the broad expansion of grant programs designed specifically to aid SMEs in digital technology adoption. Alongside Conexus' Manufacturing Readiness Grant (MRG) program, which awards applicants up to $200k in matching grant funds for qualifying manufacturing technology capital investment and favors SME applications, other state-led grant programs focused on Industry 4.0 now include:

- Iowa's Manufacturing 4.0 Technology Investment Program, which awards both Manufacturing Innovation Equipment Grants up to $50k and Manufacturing Industrial Internet of Things (IIoT) Infrastructure Investment Grants up to $25k, both on a matching basis.

- The Maryland Manufacturing 4.0 Grant which awards up to $500k in matching investment funds in digital equipment or business practices, with lower match requirements for smaller businesses.

- Michigan's Industry 4.0 Technology Implementation Grant, which awards up to $25k in matching funds in eligible technology areas for small businesses in conjunction with an Industry 4.0 assessment by the Michigan Manufacturing Technology Center (MMTC).

- Massachusetts' Manufacturing Accelerate Program (MMAP), which awards up to $200k in matching funds for Industry 4.0-related capital investment and emphasizes connections between manufacturers and non-profit partners such as MassMEP.

regional manufacturers with relevant early-stage risk capital or other traditional debt funding that can support technology deployment applications.

- The region can also explore creating a regional seed fund targeted at technology adoption by manufacturers or increasing access to funding for SMEs through public-private funding models. These funds could serve as subsidized matching resources for companies when pursuing other grant awards, further de-risking the investment in new technology adoption.

Action 4: Establish a Network of Experienced Evaluator-Integrators

In the Evansville Region, the knowledge gap between large, established companies and regional suppliers and SMEs in executing implementations of new technology systems was a recurring theme shared by industry stakeholders. To help address this gap, the region should support an Industry 4.0 evaluation or assessment process designed to help regional companies identify gaps and use cases. This process can be administered through dedicated expert staff employed by a regional cluster development organization or through a third-party provider or regional stakeholder organization such as a university research center that can be trusted to provide impartial assessments of manufacturer Industry 4.0 readiness and maturity.

Best Practices in Facilitating Industry 4.0 Assessments

Iowa State's Center for Industry Research and Service (CIRAS) offers a variety of Industry 4.0-related services to state manufacturers centered around process reviews and opportunity assessments. In partnership with Alliant Energy, CIRAS also operates the Digital Manufacturing Lab and offers no-cost on-site assessments, testing and training, and connections to vendors for project implementation. In support of the Technology Investment Grant Program led by the Iowa Economic Development Authority (IEDA), CIRAS conducted more than 230 on-site assessments in 2023, with many manufacturers leveraging the data provided by the process to prioritize implementation of technology systems that addressed the largest opportunities for impact either through follow-on grant funding or facilitating outreach to solutions providers.

Numerous examples exist of established assessment criteria and processes, including within Indiana through state organizations such as Conexus, as well as regional initiatives such as Industry Labs in South Bend-Elkhart. The intended outcome of this activity would be to adopt an Industry 4.0 assessment framework and then offer the assessment to SMEs in the region as a service, ideally without any costs. These assessments can provide critical knowledge to SMEs in engaging around the digital change management roadmap and help SMEs interface with integrators to partner on implementation projects.

Once demonstrated use cases and resources have been identified for a manufacturer to pursue Industry 4.0 technology adoption, there is often additional involvement on the part of third-party integrators to implement a new machine, system, or piece of software at a company site. While large, established companies often have internal resourcing or business partnerships to meet internal technology deployment

needs, SMEs may have difficulty choosing the right partner for implementation. Third-party integrators and service providers pose a double-edged proposition for manufacturers. On the one hand, they provide critical knowledge about machinery and software systems and can tailor deployment to a manufacturer's specific operational needs. However, they can also pursue the final sale of a product or service beyond its utility to the manufacturer, leaving the company with a deployment that does not fully meet their needs or locks them into service contracts. Identifying third-party integrators with a reputation for well-aligned solutions deployment is critical to ensuring return on investment for manufacturers, and well-functioning manufacturing clusters have developed rosters of experienced integrators committed to long-term strategic relationships with OEMs. Large companies often have extensive service contracts or strategic partnerships with third-party integrators across a spectrum of different technology products and services and can provide valuable insights into the quality and effectiveness of various integrators.

Conversely, SMEs beginning to invest in Industry 4.0 systems may not know where to source contacts for experienced integrators. To help mitigate any knowledge gap as well as build out a cohesive network of third-party integrators within the Evansville Region, the region should coordinate existing integrators (and/or create a regional integrator if existing supply doesn't meet demand) through a centralized technology supplier base model to help foster an innovation ecosystem and support new integrator firms advancing relevant technology solutions that are of utility to regional manufacturers. It will be critical to source lists of integrators and their offerings from anchor companies with existing relationships, validate the relevance of vendor expertise to certain key technology areas, and provide a recommended integrator list to manufacturers in the region as a key resource based on the results of engagements over time.

As companies in the region continue to build relationships with groups of third-party solutions providers, the region can help accelerate the deployment of technology solutions through an increasing volume of demonstrated use cases as successful deployments are cataloged and made available to companies over time as a part of outcomes data tracking associated with the portfolio of recommended integrators. This type of engagement can also lead to a growing base of regional employment in third party integration services providers through an expanding customer base, generating additional spillover effects for the cluster ecosystem.

Developing an Industry 4.0 Integrator Directory

As an example of how supplier and integrator data can be leveraged towards building a knowledge base for manufacturers, The International Society of Automation (ISA) has developed and published a "Directory of Automation" providing profiles on key suppliers and integrators for automation technologies in an accessible, searchable format.

Leveraging the information gathered across the other actions outlined in this strategy, the Evansville Region should seek to develop and maintain its own directory of suppliers and integrators of Industry 4.0-related technologies that have supplied demonstrated solutions and generated meaningful impacts for companies in the region Information can be gathered from both suppliers and relationships of established companies as well as an inventory of smaller and emerging services providers in the region. The cluster development organization should seek to regularly update this database and incorporate relevant metadata about integrators and suppliers, their key areas of technology focus, demonstrated use cases and engagements with regional manufacturers, and contact information.

Strategy 2: Grow and Align Talent Pipelines

Strategy Rationale

In a global economy where jobs are outsourced from one continent to another, it is appropriate to ask whether the workforce is a relevant competitive factor. Is labor a commodity like utilities, and thus unable to create a significant competitive differentiation or advantage, or can it be unique to a firm or region, like location or intellectual property, and confer a significant competitive advantage?

The workforce can and must be an essential part of any strategy by a firm or region to create a competitive advantage. If a firm does not use its workforce as anything more than a low-skill, low-wage, and high-turnover commodity, then it will not generate or retain any type of enduring market advantage in a marketplace that is increasingly emphasizing the use of high-tech tools that add value for suppliers and end customers. So, how does human capital factor into a region's comparative advantage?

Simply put, human capital is one of the few market factors that are locally based and have the potential to create a comparative advantage that can differentiate a region or firm from its competition. A region cannot change its physical location, so its location advantages are fixed. Firms can purchase new and emerging technology, but if these are "off-the-shelf" technologies, they are available to the competition. In contrast, human capital is a locally provided and locally managed resource, thus able to be differentiated from other regions. In addition, human capital is an essential element in implementing advanced technology solutions. The quantity, quality, and management of human capital are competitive factors very much in local control.

Unfortunately, in many regions, there is a lack of human capital that meets the needs of many of the region's leading firms. This lack of human capital, in part, is driven by the lack of understanding and preparation for the jobs that are available. The traditional approaches to worker preparation are rooted in the supply side of the labor market, building the skills of job entrants with minimal input from employers or regard for how these skills are further developed and used in the workplace. A wide gap has emerged between the public training and employment services system and the human resource development strategies and operations of firms. Improving the effectiveness of the workforce development system requires adopting a "demand-side strategy" that builds on employers' economic interests.

The adoption of Industry 4.0 technologies is fundamentally changing the nature of work and job functions in the modern "smart" factory. To achieve its goals and benefits and compete in this environment, digital and "hybrid" skills are vital, learning must be continuous and lifelong, and preparation for modern manufacturing careers requires new methods of education/instruction. The Evansville Region's manufacturers embracing digital technologies require existing employees to be regularly and periodically "upskilled."

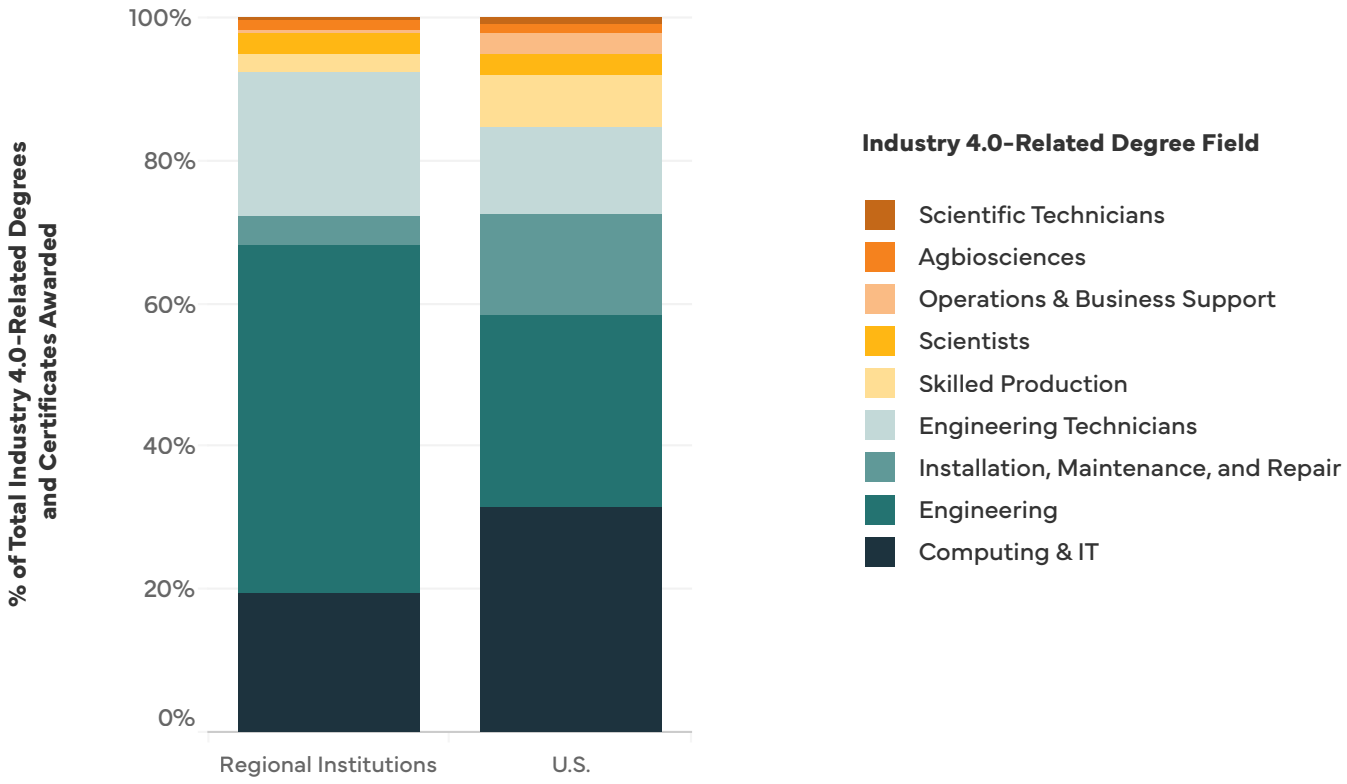
As previously noted, the digitization of manufacturing processes and operations requires a skilled workforce to implement and oversee the adoption of new technologies. It is concerning that the Evansville Region's share of the workers most aligned with Industry 4.0 skill sets and roles make up a smaller portion of overall manufacturing employment relative to the nation. Perhaps even more concerning is that the Evansville Region has lost a share in its Industry 4.0-enabling occupations since 2017. As digital technologies become

more pervasive in manufacturing environments, the alignment of talent in the region may present a limiting constraint on the rate of adoption and integration.

Furthermore, while the supply of talent in relevant credentials has increased over time, the fields in which the credentials are awarded is not aligned with areas of Industry 4.0's greatest demand. As Figure 12 illustrates, while the talent generation from regional institutions in Industry 4.0-enabling programs has grown to nearly 7,700 total certificates and degree completions, relative to broader national trends, regional institutions are generating lower concentrations of completions in key talent gaps cited by industry, including:

- Computing and IT talent to support industrial IoT and digital machinery,
- Engineering technicians who can work at the intersection of traditional engineering, digital machinery, and data analytics, and
- Installation, maintenance, and repair technicians to support production line and shop floor operations,

Figure 12: Composition of Industry 4.0-Related Certificates and Degrees Awarded by Field, 2019-22



Sources: TEConomy's analysis of Integrated Postsecondary Education Data System (IPEDS), NCES, with additional data provided by Ivy Tech Community College

In one-on-one interviews with industrial leaders across the region, concern was expressed that applied manufacturing skills are in short supply. Concerns voiced include the inability to attract talent from other regions of the country, the looming retirement wave and associated knowledge drain and the impact this will have on the company's future, and the need to retain and upskill existing talent with local roots. Across the board, industry expressed a need to further engage regional academic institutions throughout the K-16 system to help meet the demand for talent. Figure 13 provides a summary of key talent needs.

Figure 13: The Evansville Region's Manufacturing Talent Needs

	Entry-Level "Shop Floor" Talent	Skilled Mid-Level Talent Technical Talent	High Skills Senior Talent
Stakeholder Summary of Current Regional Dynamics	High turnover and competition amongst major employers, difficult to find workers with sufficient skill sets to support digital applications	Major gap in existing talent base – nearly all mid-level talent is "home-grown"	Senior talent at college degree level exists, but lack of applied manufacturing knowledge creates misalignment and hard to recruit from outside region
Key Skills Needed for Industry 4.0 Operations	Digital literacy; ability to interface with PLCs and other machine controllers; CNC machining	Data capture and manipulation skills; troubleshooting of digital devices and workflows; electronic and automation control systems	Data analytics; IT systems, connectivity, and cyber; process and industrial operations; business technologists
Perception of Talent Supply From Regional Training & Educational Institutions	Major skills misalignment in entry-level talent training with general lack of exposure to digital manufacturing technologies and production operation workflows	Little awareness of any technical programs serving this mid-tier segment	Traditional engineering degree program graduates often do not have applied production line experience; many "engineers" who work at SMES do not have formal credentialing so difficult to standardize

Source: TEConomy Partners, LLC.

Overall, the Evansville Region's manufacturers are facing significant talent supply barriers to advance new digital systems and operations, which hinder their ability to adopt Industry 4.0 technologies. The technology adoption initiatives outlined in Strategy 1 will not have a high likelihood of success unless there is an adequate skilled workforce available. The region's talent pipeline must be aligned to meet industrial needs. To this end, the following actions are intended to help grow and align talent pipelines to meet industrial demand.

Action 4: Create and Scale Educational Programs that Develop Specialized Technical Talent in Greatest Demand by Industry

Industry 4.0 is revolutionizing manufacturing processes and, as a result is changing the technical skills required of its workforce. The World Economic Forum estimates that, by 2025, 50 percent of all employees will need reskilling due to the industry's adoption of new technologies. Five years from now, over two-thirds of skills considered important in today's job requirements will change. A third of the essential skills will consist of technology competencies not yet regarded as crucial to today's job requirements.[7] The training, reskilling, and upskilling of the future-ready workforce in the era of Industry 4.0 and beyond will be critical for the Evansville Region. Life-long learning must be part of the region's Strategic Roadmap. Individuals, companies, and academic institutions must commit to developing training, reskilling, and upskilling programs relevant to Industry 4.0 demands.

Similar to the situation described under Action 2, the Evansville Region, educational and workforce training programs exist that are of relevance to the region's manufacturing base through a robust mix of public and private entities. However, the region does not currently coordinate or network these assets across key areas of focus or distribute information on accessing and interacting with these assets in a centralized place, diluting the ability to scale broader adoption. To address this issue, the region should establish training program "hubs" at regional educational providers that specialize in different priority areas that address industry talent demand (e.g., operations analytics, industrial controls, and IT and cyber.)

Micro-Credentialing and the Role of Continuing Education in Upskilling the Industry 4.0 Talent Base

The landscape of postsecondary education is changing with the emergence of new credentials that are designed to promote continuous learning and allow working professionals to add certifications and credentialing in a rapidly changing technology environment, and without the need for completing an entire degree program. These modular programs, dubbed "micro-credentials," involve small, individual learning units that provide value-added skills and have the ability to combine (or "stack") into broader, cohesive qualifications over time. Micro-credentials often focus on highly applied skills and technologies that are relevant to current industry needs and represent the space between single courses and full degrees.

The spectrum of micro-credentialing includes a variety of terms and options, such as:

- **Academic Certificates:** Academic certificates recognizing the completion of an organized learning activity awarded by an academic institution. These may or may not confer academic credits toward degree programs.
- **Professional/Industrial Certificates:** Certificates awarded by professional bodies, industries or product vendors following completion of an examination.
- **Digital Badges:** Virtual representations of completion of learning units that are shared to show

7 Li, L. (2022). Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond. *Information Systems Frontier*. Pp 1-16.

accomplishment of certain skills/knowledge, which may or may not be related to an academic program of study. Some programs allow combinations of badges, or "stacks," to grant certificates or credentialing.

Micro-credentials have expanded their scale considerably as a consequence of rising demand for upskilling and reskilling, as well as a sharp reduction in the unit cost of provision made possible by digitalization. Higher education institutions, businesses, and other institutions are actively offering alternative credentials that help learners acquire new skills, update their existing skills, and signal the competencies they already have.* This is especially true in manufacturing industries, where a lack of qualified talent can relegate new technologies such as industrial robotics ineffective. Despite a focus on increasing STEM talent within manufacturing industries over the last decade, many companies are still reactionary in addressing workforce skills gaps and find themselves needing to quickly augment their workers' skill sets after the fact when a new automation, robotic, or data-driven system is installed on the production line. Manufacturers also often face challenges in upskilling existing workforces through formal degree-based programs, which take significant time and capital investment and risk being out of date by the time that talent can fully utilize new skills.

Micro-credentialing attempts to address these programs through a modular, flexible, and responsive framework in order to generate skilled workers in short time frames. Although still in their early adoption phase, a variety of institutions are advancing micro-credentialing programs that are attempting to bridge the gap towards broader industry recognition of these credentials and focusing on ongoing skills-based learning for manufacturing workers. Several high-profile examples include:

- **MIT Smart Manufacturing Certificate**, consisting of a highly accessible set of 10 modules focusing on introduction to smart manufacturing, manufacturing processes, data modeling, sensors, and data analysis. The program is designed for plant managers working in manufacturing and design and manufacturing engineers seeking to learn about data and modeling in a manufacturing environment.
- **Purdue University Micro-credentialing and Badge Programs**, which offer a "Design for Security" Cybersecurity Digital Badge program that focuses on companies that produce cyber or cyber-physical systems and their components as well as a Data Intelligence Micro-credential that is designed to provide applicants with exposure to the analytical methods and tools used by organizations.
- **Yaskawa Academy Digital Badges**, an example of an industry-driven effort to develop micro-credentialing in partnership with Intelitek, a developer of manufacturing workforce training solutions, that expands traditional in-person industrial robotics controller certification training on Yaskawa Motoman systems to include a mix of hands-on and virtual learning that grants "digital badges" in robotic systems integration and operation.

* Organisation for Economic Co-operation and Development, "The Emergence of Alternative Credentials," March 2020.

At these hubs, it will be critical to develop and implement Industry 4.0-specific "micro-credentialing," certificate programs, and otherwise applied "stackable" credentials to train, upskill, and retrain the incumbent workforce, particularly targeted toward the SME technician workforce and in digital skills and data analytics. Educational Hubs will need to create Introductory Industry 4.0 courses and credentials that provide instruction and leverage case studies, site visits, etc., focused on data analytics, cybersecurity, and other key topics. It will be critical to utilize an industry board or council for developing, standardizing, and approving credentials to ensure they are meeting the greatest industrial demands of the region's manufacturers.

Action 5: Create Career Ladders to Attract Entry Level Workers as well as Catalyze Upskilling and Reskilling of the Incumbent Workforce

As the economy becomes more complex and competitive, the labor market becomes more complex and confusing for students, parents, job seekers, employees, employers, and educational leadership. For younger and many middle-aged employees and employees-to-be, the rules of job success and likely career paths in the economy they are entering are vastly different than the economy that shaped either their prior experiences or, for existing students, their parents' experiences and careers. This is one place where it is difficult for older generations to pass on experience and knowledge to the next generation. Previous education and career paths do not work as well, or in some cases are not even available, in the global economy.

This drastic change in labor market expectations and pathways has extremely significant implications for the Evansville Region's manufacturing cluster. When there is confusion and lack of knowledge in any marketplace, people will fall back on the tried-and-true "certainties" that they believe they know, and they will avoid areas that are unfamiliar to them (or their parental or educational advisors). This risk-avoiding behavior is natural, and the labor market is no exception. In this case, it means that students, parents, employees, and institutions will tend to gravitate toward educational activities and careers in "known" fields with clear career ladders and industry awareness, such as healthcare, public administration, teaching, and finance. In contrast, the region's manufacturing cluster's career fields are not as well-known, and they have careers and jobs that range between invisible and unattractive. In summary, the changing labor and career marketplace has created challenges for all industries, but for manufacturing sectors that are complex, confusing, and poorly known, these challenges are a much more significant problem.

On an institutional level, the educational and workforce training career structures, linkages, and job advancement practices that served to provide skills and knowledge to a past generation are now no longer adequate for a new generation of employees and a new set of economic challenges. The labor market rules of success and failure have been and are continuing to be reinvented by the forces of globalization. Because of this, there is a critical need to reinvent not only individual knowledge of how the labor market now works ("career literacy") but also to create a new set of structural relationships between students, employees, educational institutions, and industry. Many would argue that it is misleading to put students through an education and training process designed for the economy of the 1960s to 1980s and expect them to succeed in the dramatically reinvented global economy of 2023 and beyond.

One tool essential in helping the Evansville Region's workforce to these new opportunities is the creation and support of "career ladders." Career ladders is a somewhat multipurpose term covering activities focused on more effectively coordinating a community's or region's educational institutions with the workforce needs of the region's economy.

If the Evansville Region's manufacturing cluster aspires to build a competitive advantage based on its workforce and human capital assets, then developing a set of defined career ladders with local high schools, community colleges, 4-year institutions, and workforce training programs is a critical action step.

The following are several core tasks that would be involved in building various career ladders:

- Create a joint industry, education, and public sector collaborative to illuminate in detail the region's workforce supply and demand situation and, with that information, select the most pressing employment needs upon which to focus.
- Create a series of linked education and training opportunities and curricula so that students from middle school through college can understand the kind of knowledge they need to acquire to create career opportunities for themselves within the manufacturing field.
- Develop a detailed understanding of the internal recruiting, internal corporate training, promotion, and job progression path that exists within and among companies for existing employees (the "internal" career ladders).

It should be noted that there is no single career ladder within the manufacturing field. Career ladders vary because this is a new tool for education-industry partnerships to use and because different jobs require different education and skill levels. For instance, a career ladder for occupations that primarily require certificates differs significantly from that for jobs that require formal, post-graduate education.

Common Features of Career Pathways

Career pathway programs and structures vary greatly, given the variation between industry and job targets; however, common elements are as follows:

- Jointly produced occupation "road maps" that show how education and industry intersect for occupation and advancement potential.
- User-friendly linkages between remedial, educational, and occupational training.
- Heavy reliance on specific occupational data, job progression patterns, and job requirements.
- Course content defined in terms of competencies required for jobs and, where possible, tied to industry skill standards and certifications.
- Training and education offered in modules that represent clear stepping stones to advancement.
- Training offered at times, places, and with support services to enable maximum participation.
- Outreach and bridge building to middle, high, and vocational schools.
- Blending of private and public funding

In addition, the ability of students to move seamlessly from one level of education to the next in their chosen field of study without missing a beat in obtaining their ultimate educational goal, whether it be post-high school certifications, an associate's degree, bachelor's degree, or advanced degree, is critical. This seamless integration is achieved through

enhancing real partnerships between all educational institutions and workforce development training organizations in the Evansville Region across the various levels that result in students achieving their long-term learning goals. With the Federal Workforce Investment Act's (WIA) funding priorities focused intently on working more closely with industry, as well as Indiana's Department of Workforce Development's Next Level Jobs Initiative, it will be important to align the various resources to meet the needs of regional manufacturing industry by creating career ladders.

Action 6: Expand Existing Initiatives Around K-12 Exposure to Future Manufacturing Jobs

The lack of understanding of the types of jobs available within the region's manufacturing cluster is a problem for developing a pipeline of future workers. To help overcome this issue, the region must begin a multi-faceted communications campaign to inform the populace of the current occupational opportunities that are forecasted to be in demand in the future. Using a range of communication and organizing tactics, this campaign will target not only educational providers, such as teachers throughout the K-12 system, administrators, and guidance counselors, but also the students, parents, regional leadership, and community thought leaders about employment opportunities within the manufacturing cluster. The following types of efforts for the talent campaign should be explored:

Employee Ambassadors. Current employees are important targets for an industry education campaign. Providing speakers at various educational events and community gatherings (chambers, service organizations, etc.) as well as to K-12 academic leadership (principals, teachers, and guidance counselors) will be an essential component of spreading the word about career opportunities.

Summer Camps. Most parents are looking for ways to keep their kids busy during summers, which provides an interesting opportunity to engage children at a younger age to seek experiential learning opportunities related to manufacturing opportunities. In recent years, there has been a rise in the number of manufacturing and engineering-oriented summer camps, each of which aims to inspire and equip youth with tangible and exciting real-world experiences and expose them to manufacturing career opportunities.

Widespread Participation and Regional Coordination of Manufacturing Day. Each year, Manufacturing Day is held on the first Friday in October to show students, parents, and the public what modern manufacturing is all about. Together

Nuts, Bolts, and Thingamajigs Summer Camp

One example of a successful national model of summer camp targeted at manufacturing is the Nuts, Bolts, and Thingamajigs (NBT), which has been created and continues to be supported by the foundation of the Fabricators & Manufacturers Association, International. With week-long camps spread throughout the country, NBT provides middle school-aged and high school-aged kids the opportunity to ideate, design, and build products. They get to learn about and use technology such as Computer Aided Design (CAD) software, as well as different types of manufacturing machinery such as CNC machines and lathes (under professional supervision of course).

with the National Association of Manufacturers, The Manufacturing Institute, MEP Centers, and federal agency partners, the Manufacturing USA network provides an opportunity for manufacturers to highlight what's taking place on factory floors across the country and to energize a future pipeline of skilled workers by showcasing the potential of modern manufacturing and fostering interest in manufacturing careers. Regions that have embraced this national event often coordinate tours and site visits with the local K-12 school systems and then work to keep these relationships active throughout the school year.

In summary, many communication techniques are available to increase targeted manufacturing cluster visibility significantly. Many initiatives are currently ongoing throughout the region but are often focused within a specific school district or locality. In order to build scale and reach a critical mass that can begin to impact the overall attitudes and culture of the entire Evansville Region, it will be imperative that lessons are learned, and best practices are emulated so that a systemic regional initiative can be developed and scaled to reach across the entire region by catalyzing and coordinating K-12 outreach initiatives to better scale delivery of content relevant to future-ready manufacturing careers.

The Evansville Region can also learn from its neighbors to the Northeast by examining the suitability and replicability of ROI's Ready Schools Initiative. This design-thinking framework supports school districts in aligning their PK-12 curricular and programmatic offerings to the educational and workforce needs of the Indiana Uplands. ROI, to date, has worked with 15 school districts representing 77 schools, eight counties, and more than 32,000 students throughout the region, and all 15 school districts are implementing plans for locally specific and regionally relevant strategies aligned with the region's key industry sectors. Some examples of implemented programming include digital fabrication labs, maker spaces, an automation and robotics academy, career resource labs, district-wide project-based learning, Project Lead the Way, and more.

Core principles of the Ready Schools initiative include:

- Every student is engaged in a relevant path to success.
- Students graduate high school ready for post-secondary and career success.
- Meaningful and ongoing collaboration occurs among schools, industry, and community.
- Teaching and learning are grounded in relevancy.
- K-12 schools are aligned around a common vision of student success.
- Schools embrace the significant role they play in achieving regional prosperity.

Strategy 3: Enhance Ecosystem Connectivity

Strategy Rationale

As noted previously, best practice in economic development recognizes that each region has a set of targeted industry sectors or "industry clusters" in which it can differentiate itself, thereby building comparative advantage within competitive global markets. Increasingly, emphasis is being placed on technology and innovation as drivers of 21st Century economic development. The ability of a region to lead in technology innovation and deployment is becoming a critical and defining driver of economic competitiveness. As the National Governor's Association set out to advise states and regions across the nation on best practices for global competitiveness:

> *Each state must exploit the unique advantages it has relative to other states and build on the strengths found in its local "clusters of innovation"—distinct groups of competing and cooperating companies, suppliers, service providers and research institutions.*[8]

At the same time, there is a growing recognition that the long-term economic challenges to advancing an economy are rising. Increasing globalization, the fast pace of technological change, and the growing strength of developing nations in generating highly educated and skilled talent threaten the economic competitiveness of all regions in the United States. As the report by the National Research Council Report, Rising to the Challenge, notes:

> *U.S. regional economies face mounting global competitive challenges. No longer do U.S. states and cities primarily compete among themselves for talent, investment, and entrepreneurs in technology-intensive industries. They also compete against [foreign]*

The value of a strong cluster is that it spurs growth and competitive advantage. With a vibrant cluster, the typical economic gains are substantial, including:

- Rising productivity of companies in the cluster, creating a competitive edge for the region;
- Accelerating pace of innovation resulting in new products and services;
- More frequent start-up of new, high-growth-potential businesses;
- Stronger supplier –networks, increasing the economic multiplier impact of the cluster for the region;
- Larger pools of specialized workers and education and training programs geared to the particular cluster needs, introducing significant cost savings for firms and increasing the breadth and depth of employment opportunities for workers in the cluster; and,
- Growing demand for high-wage professional services such as legal, accounting, marketing, management consulting and finance, as well as for many other support services such as conferences, restaurants, and entertainment.

8 National Governor's Association (2002). A Governor's Guide to Trade and Global Competitiveness.

national and regional governments that are executing comprehensive strategies that seek to create innovation clusters in many of the same important emerging industries.[9]

Industry clusters offer regions the opportunity to specialize by gaining specific core competencies and knowledge that allow the region to compete effectively and by allowing public investment and other resources to be focused on where they will bring the most economic benefit. The value of industry cluster development is found both in advancing a region's economic competitiveness and in helping to organize its economic development efforts.

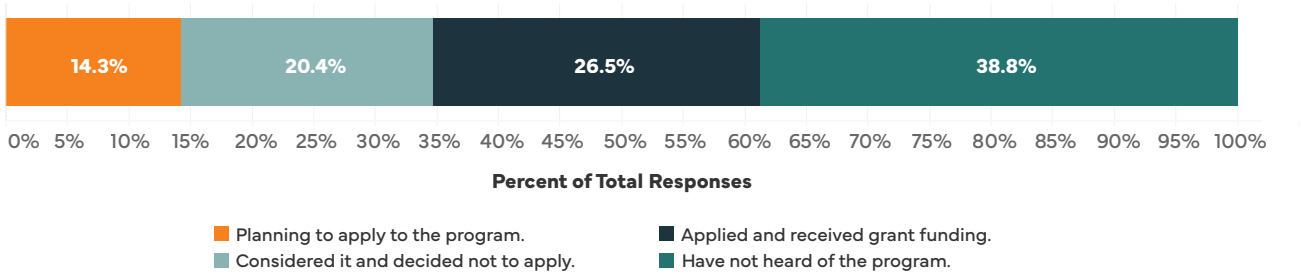
Industry clusters are a powerful means for organizing a region's economic development efforts. Pursuing industry cluster development provides more than just a focus for economic development efforts; they provide an organizing framework. This framework includes:

- Rather than assisting one firm at a time, cluster development efforts require solving related problems and addressing the common needs of groups of firms. This is most effectively done by having individuals leading the effort who have direct industry experience, subject-matter expertise, and economic development knowledge.
- Cluster development makes it essential that a region define its identity, which can be a powerful tool for outreach marketing and attraction efforts.
- Because of its broad reach within a region, cluster development calls for the importance of public-private partnerships that can leverage resources and bring the region together for a common purpose.
- Most importantly, cluster development brings a new level of accountability to economic development that requires having an impact at a broad scale that can advance the economic well-being and quality of life in a region.

Currently across the Evansville Region, there is low engagement by manufacturing furthers to engage in programs and services that are designed to boost Industry 4.0 adoption. For example, when surveyed, nearly three-quarters of manufacturing respondents have not yet leveraged the Manufacturing Readiness Grant programs launched by Conexus Indiana and the Indiana Economic Development Corporation (IEDC) designed specifically to accelerate Industry 4.0 technology adoption, with almost 39 percent of firms indicating they had not heard of the opportunity (Figure 14).

9 Wessner, C.W., & Wolff, A. W. (Eds). (2012.) *Rising to the Challenge: U.S. Innovation Policy for the Global Economy.* The National Academies Press. p. 431

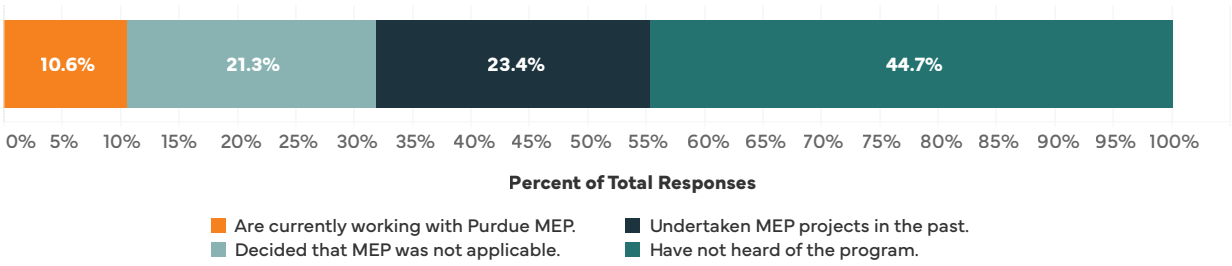
Figure 14: Regional Manufacturer Survey Responses to Question, "Have you participated in the MRG program?"



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey; for further details, see Appendix B.

Similarly, nearly 45 percent of survey respondents are unaware of Purdue MEP's services for manufacturers (Figure 15), and discussions with industry stakeholders indicated that interactions for those who did work with the program tended to be one-off projects without longer-term, ongoing engagement.

Figure 15: Regional Manufacturer Survey Responses to Question "Have you worked with the Purdue MEP program?"



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey; for further details, see Appendix B.

During one-on-one interviews, while some firms positively noted the work of the Tri-State Manufacturers' Alliance (TSMA), many interviewed also expressed concerns regarding the general lack of regional coordination to meet the needs of manufacturers across the region to adopt Industry 4.0 practices, noting:

- Engagements around technology adoption and talent development have tended to be one-off or superficial despite longstanding partnerships with some universities.
- There is a significant desire to foster manufacturing community dialogue around sharing of case studies and best practices across industries, recognizing regional competition for talent but potential for cooperative efforts around technology.
- There is a need for a coordinating function that can answer key questions, such as:
- Who do I talk with to determine if there are technologies that I might be interested in?
- How do I access funding resources?
- Who might be the best outreach partner for my business or industry?

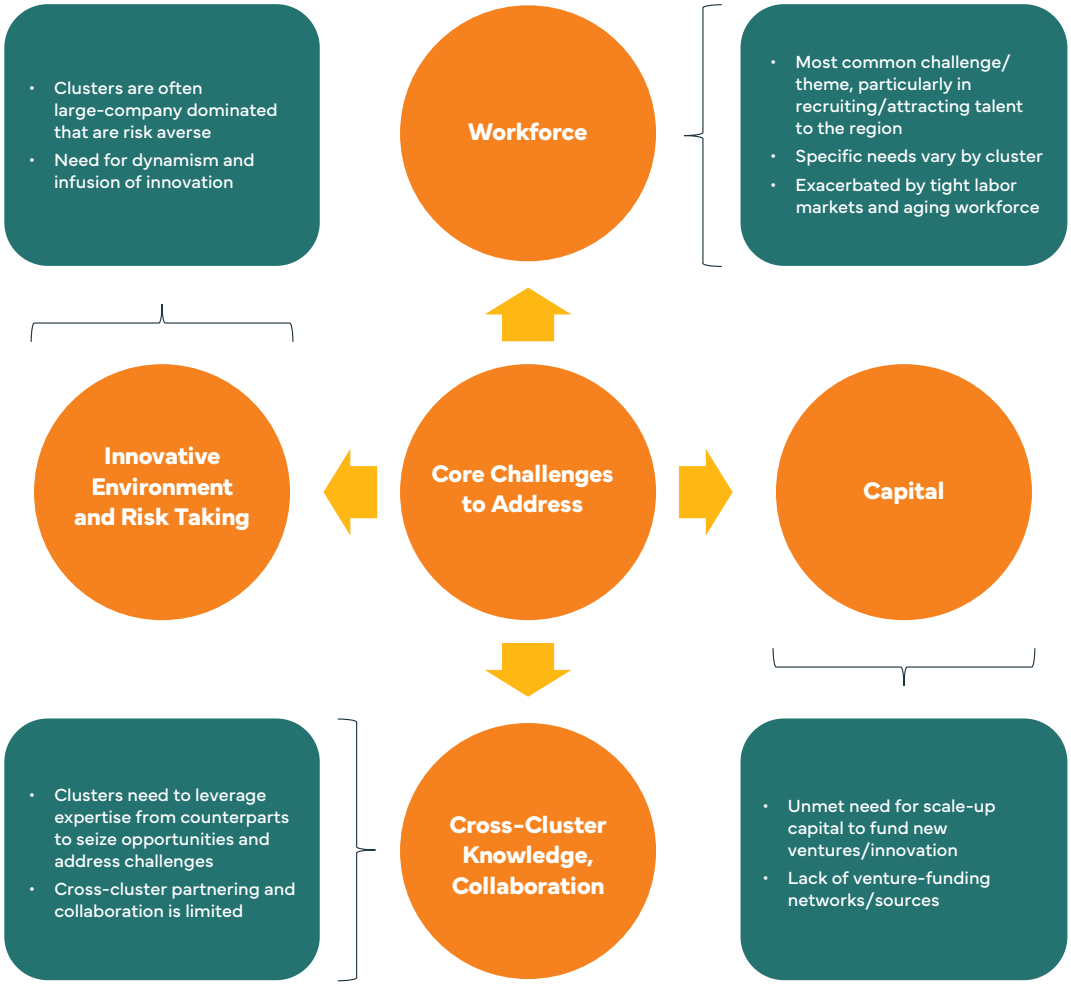
- How do I receive training for my employees or provide input into educational programs?
- Where can I engage with other manufacturers to learn what they are doing in this space?

The bottom line is the fact that the Evansville Region faces a key gap relative to its competitors in coordinating its ecosystem in order to meet the challenges faced by manufacturers with scalable solutions. To this end, the following actions are intended to help build ecosystem connectivity by addressing key constraints.

Action 8: Establish Dedicated Staff to Coordinate the Region's Manufacturing Ecosystem

Research finds that, across regions, there are common challenges for growing and scaling industry clusters. Examples of common challenges are illustrated in Figure 16.

Figure 16: Core Challenges Facing Industry Clusters



Source: TEConomy Partners, LLC.

Raising awareness and building relationships is a foundational building block for establishing stronger collaborations between industry, academia, and the public and non-profit sectors. However, the Evansville Region currently lacks the region-wide, systemic, reproducible, and sustainable mechanisms that allow firms to learn about each other's approaches and capabilities. A sustainable ecosystem that builds connectivity between firms requires dedicated staffing.

In order to achieve a connected ecosystem across the Evansville Region that supports its manufacturing cluster, the region must fund dedicated staff to actively engage in outreach, partnership-building, and matchmaking services focused on Industry 4.0 adoption and integration outcomes in coordination with state programs and institutions. The staff would focus their efforts on working proactively to develop synergies between the existing companies that comprise the cluster—relationships that, for the most part, do not currently exist.

Dedicated staff that is seeking to build a manufacturing ecosystem should focus on:

- Fostering relationships and synergies amongst cluster members through networking events (see Action 9).
- Identifying common needs through dialogue with companies and then focusing on shaping ways to provide more common services to the industry cluster, such as addressing technical assistance for modernization, access to markets, business service gaps, and Industry 4.0 adoption and integration in coordination with state programs and institutions.
- Aggregating and then addressing an industry cluster's education, training, and workforce needs to impact curriculum, program development, and experiential learning with K-12 and higher-education institutions (see Strategy 2).
- Providing "regional supply chain" services to work with purchasing departments within cluster companies to identify manufacturing or service inputs that are currently provided by providers external to the community that could actually be fulfilled by local suppliers.

Action 9: Expand Value-Added Networking across Region's Advanced Manufacturing Sector

Networking between industry representatives, R&D leaders, educational providers, intermediary organizations, and the public sector has been a staple of economic development for many regions. Whether formalized through collaborative institutes, industry cluster networks/councils, or more ad hoc informal efforts, there should be little doubt that regular contact and dialog between industry, academia, and the public sectors can be the spark that leads to broad transformative initiatives.

While a few regions have been able to develop these value-added networks seemingly serendipitously, most regions spend considerable energy and effort in fostering value-added networks and connectivity among members of its academic, private, and public sectors. While numerous models exist, critical elements include:

- **Relevant:** the networks should have an individual leading the effort with direct industry experience, subject-matter expertise, and economic development knowledge.
- **Targeted:** the networks should focus on solving specific problems facing the industry cluster in the Evansville Region.
- **Exclusive:** membership must be limited to respective companies that comprise the cluster. To ensure the network adds value, it cannot simply become a service provider networking function.

Through the dedicated staff described in Action 8, the Evansville Region should work to organize manufacturing peer networking groups in partnership with other regional organizations, such as the Tri-State Manufacturing Alliance, focused on regular sharing of Industry 4.0 use cases, site tours, and discussions of regional challenges.

Action 10: Enhance Regional Connectivity and Pursue Broader Resources

Leveraging the resources already noted, such as Conexus, IEDC, and the MRG program, the Evansville Region should seek to enhance connectivity with manufacturing ecosystems in Kentucky and with rural Southern Indiana to improve broader regional competitiveness for signature funding opportunities (such as EDA, READI, and Lilly Endowment funding). Many of the issues outlined in this Strategic Roadmap are similar to those facing the manufacturing industry in surrounding communities. By working together, a more holistic ecosystem of support can be developed to address common problems/issues.

Organizing for Success

For this Strategic Manufacturing Roadmap to be successful, a unified regional economic development initiative must be formed. This will require the buy-in and organization of key champions and stakeholders from across the private sector manufacturing cluster, the educational system continuum, and local economic development leaders who can spearhead and lead the various components of strategy implementation.

One option in forming a unified regional economic development initiative would be to expand the Tri-State Manufacturing Alliance's (TSMA) activities and staff it with adequate personnel to implement the ten actions outlined in the Roadmap. This could be undertaken under the auspices of the Evansville Regional Economic Partnership (E-REP) as one of its key programs/initiatives. If it is determined that TSMA, as part of E-REP is not the suitable organization to implement the Roadmap, then a separate entity that can unite the manufacturing cluster from across the region will need to be formed. This will, however, cause significant overlap and duplication of efforts, as well as possibly cause confusion in the marketplace, and should be avoided if possible.

Regardless of the ultimate initiative formed to implement the strategy, the plan will need to be socialized with the manufacturing private sector leaders, key academic stakeholders, and informed thought leaders of the region. An education campaign will be required to increase the region's knowledge and understanding of the manufacturing industry cluster, the role the cluster plays in the Evansville Region's economic future, the opportunities it provides for the region's citizens and their children, and the role innovation will play in transforming the cluster as it adopts Industry 4.0 technologies. It will be particularly important to brief local officials so that they understand the impact investments can have on their constituents.

A CALL TO ACTION

Manufacturing plays a critical role in driving the Evansville Region's economic growth and prosperity.

Manufacturing-related industries make up a disproportionate share of overall regional employment and economic activity, accounting for 21 percent of total private sector employment in the region versus 6 percent nationally and 41 percent of total economic activity (GRP) in the region versus 8 percent nationally, led by several highly specialized sectors and key anchor companies.

The region has also proven resilient to broader macroeconomic trends over time. Growth in manufacturing jobs has continued even against the backdrop of pandemic-related disruptions and declines in the region's overall private-sector employment. Overall, manufacturing employment levels grew by 7.7 percent from 2017-2021, far outpacing regional private sector growth and national growth. This is due in part to the significant diversification of the manufacturing industry in the region comparable to other regions of similar size.

However, manufacturers in the Evansville Region are facing significant disruptive changes in the coming years:

- Adoption of digital technologies and systems known as **Industry 4.0 is driving massive changes to traditional manufacturing operations and skill sets.**
    - Once fully deployed, new technologies can drive major impacts on Key Performance Indicators such as overall throughput, equipment effectiveness, unit cost reduction, and lead time reduction, with potential impacts estimated from 25-60 percent improvement over baseline.
- At the same time, **manufacturing industries everywhere face cost competitiveness, supply chain resiliency, and demographic dynamics that have disruptive potential for businesses worldwide.**
    - Aging workforce demographics, knowledge drain from experienced workers leaving the industry, tight labor markets, disruptions to production operations and supply chains, high materials costs, and many other factors are prompting manufacturers to rethink how they do business.

These challenges point to significant risks for the region's manufacturing cluster in coming years that threaten its legacy of successful growth. To help position the Evansville Region's manufacturing industries for ongoing success, a cluster-based strategic manufacturing roadmap is necessary to focus programmatic efforts on providing the guidance, resources, and organizational capacity to help industry "bridge the gap" to large-scale implementation of Industry 4.0 technologies and frameworks.

Given the outsized importance manufacturing industries play in driving both employment and overall economic activity for the region, focusing cluster-based initiatives and activities around manufacturing is likely to yield significant economic impacts. Conversely, the costs of not successfully navigating the transition to digital manufacturing environments have the potential to be extremely damaging to the region's economic outlook.

If the Evansville Region is to succeed in maintaining the economic competitiveness of its manufacturing industry base in the face of these disruptive challenges, thereby helping ensure the economic prosperity of its citizens, it must be prepared to respond to these trends by:

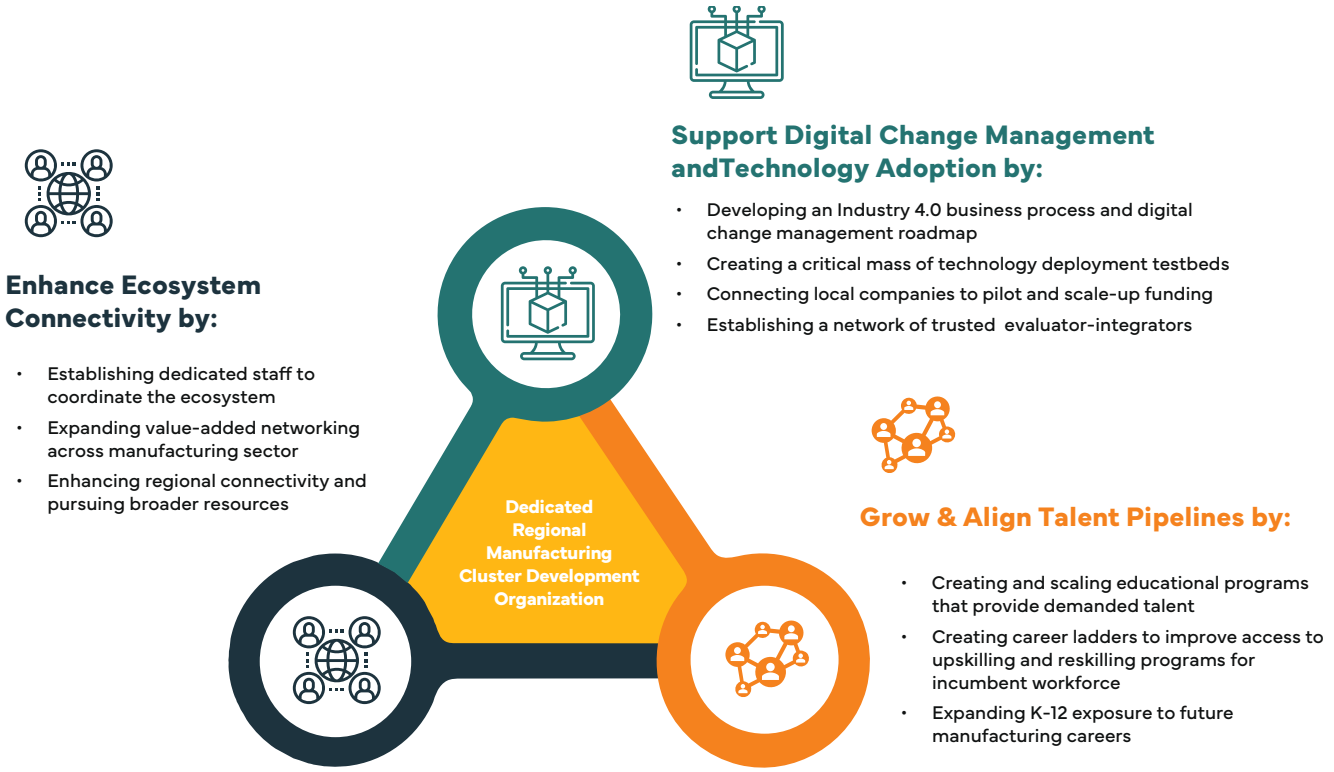
- **Supporting digital change management and technology adoption,**
- **Growing and aligning talent pipelines, and**
- **Enhancing ecosystem connectivity.**

By focusing on these three thematic areas, the Evansville Region will help ensure the region's future economic vitality. Anticipated economic and societal impacts that will be realized through the successful implementation of this Strategic Roadmap include:

- Better-paying jobs with higher growth potential
- Ability to weather future economic challenges, and
- Inspired future generations who reach their full potential.

Generating these outcomes does not happen on its own but rather through a series of intentional, strategic, and proactive decisions. The Strategic Roadmap is driven by public-private partnerships that capitalize on the Evansville Region's strengths while ensuring that future programmatic investments are focused on building the ecosystem that will help ensure the robustness of the region's manufacturing cluster for years to come (Figure 17).

Figure 17: A Strategic Roadmap to Support the Evansville Region's Manufacturing Cluster



Source: TEConomy Partners, LLC.

The strategies and actions have been developed with the intent of helping the region's manufacturers accelerate their integration of Industry 4.0 by addressing the key challenges they face today: barriers to digital change management and technology adoption, gaps in the supply and alignment of talent, and a need to more aggressively coordinate the region's assets to build a critical mass that can drive broad impacts. By proactively supporting this vital industry sector, the Evansville Region will be proactively working to ensure its long-term economic prosperity. The time is now for decisive action.

APPENDIX A: ECONOMIC QUANTITATIVE ANALYSIS

Analyzing the Economic, Workforce, and Innovation Landscape That Enables the Evansville Region's Manufacturing Sector

Adoption and integration of Industry 4.0 technologies is accelerating across manufacturing industries and will be critical to the future competitiveness of regional industry clusters. Industry 4.0, also known as Smart Manufacturing, refers to the various ways in which technology is driving the ongoing digitization of manufacturing. Adoption of these technologies drives productivity, efficiency, quality, flexibility, and cost reduction improvements that ensure regional manufacturers can compete in a global marketplace.

Defining the Evansville Region's Manufacturing Cluster

The Evansville Region's manufacturing cluster[10] is comprised of nine manufacturing subclusters in which the region has more highly concentrated employment than the nation:

- **Biomedical Manufacturing**, including areas such as biopharmaceuticals, dental laboratories, and ophthalmic goods. Key regional companies include Bristol-Myers Squibb and AstraZeneca.
- **Electric/Electronic Products Manufacturing**, including areas such as motors and generators, lighting, and broadcasting equipment. Key regional companies include Hansen Motor and ERI.
- **Food Processing and Manufacturing**, including areas such as meat processing, canning, and bakeries. Key regional companies include Mead Johnson Nutrition and Lewis Bakeries.
- **Machinery Manufacturing**, including areas such as commercial and industrial machinery, farm machinery, and printing machinery. Key regional companies include Flanders and Koch Finishing Systems.
- **Metal Machining and Finishing Services**, including areas such as machine shops, industrial mold manufacturing, and turbines. Key regional companies include Sunspring America and Service Tool & Plastics.
- **Metals Manufacturing and Fabrication**, including areas such as aluminum refining and production, die-casting, and structural metal manufacturing. Key regional companies include Koch Enterprises and Gibbs Die Casting.
- **Motor Vehicle Manufacturing**, including areas such as light truck and utility vehicle, seating and trim, and automobile manufacturing. Key regional companies include Toyota and United Components.
- **Petroleum & Chemical Products**, including areas such as petroleum refineries, soap and other detergents, and ethyl alcohol manufacturing. Key regional companies include CountryMark and ORG CHEM Group.

10 For a detailed list of industry NAICS codes included in these analyses, see Appendix A-1.

- **Polymers & Plastics Products**, including areas such as plastics materials and resin manufacturing and adhesives. Key regional companies include Berry Global and SABIC.

To provide context for the overall manufacturing industry in the region, high-level analyses also consider two additional definitions of manufacturing:

- **NAICS 31-33 Manufacturing** – the total of all manufacturing as classified by the federal NAICS system.
- **Brookings Advanced Industries** – a subset of manufacturing that focuses on R&D- and STEM-worker intensive industries.

Taken together, the manufacturing cluster comprised 94 percent of the region's total manufacturing employment in 2021. Trends observed among the combined manufacturing subclusters therefore align well with observed trends across the entire manufacturing sector.

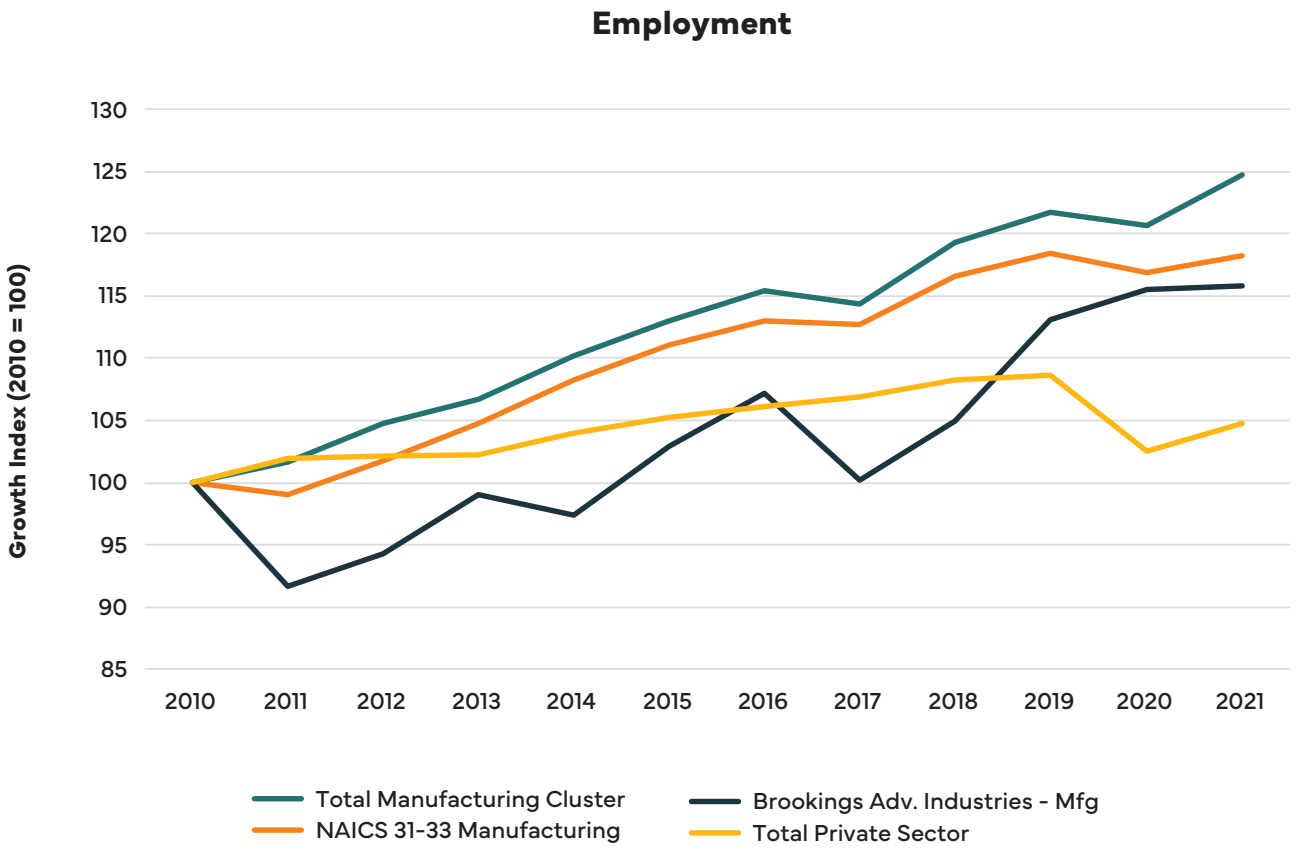
Table A-1: Employment Levels and Change Across Different Definitions of the Manufacturing Sector

Industry Sector	Regional Employment, 2021	Regional Employment Change, 2017-21	U.S. Employment Change, 2017-21
Total Manufacturing Cluster	31,424	7.7%	0.8%
Brookings Advanced Industries – Manufacturing	18,204	15.5%	0.3%
NAICS 31-33 Manufacturing	33,310	4.9%	-0.8%
Total Private Sector	152,359	-2.0%	0.3%

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

A detailed breakdown of regional and national manufacturing performance is shown in Table A-1. While elements of the manufacturing sector included within the Brookings Advanced Industry definition have outperformed the combined manufacturing cluster, the overlap between these definitions is significant: 97 percent of employment included within the Brookings definition is incorporated into the manufacturing cluster, which again suggests that the subclusters adequately capturing the most high-performing and advanced segments within the overall sector.

Figure A-1: Index of Regional Employment Change, 2010-2021



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

The long-term employment trends across each of these industry definitions is shown in Figure 1. The industry segments comprising the manufacturing cluster experienced the strongest growth over the previous decade, resulting in indexed employment levels in 2021 landing substantially higher than those of other definitions of this sector. The trends in Figure 1 again establish that the subclusters included in the industry definition used within this report emphasize the strongest drivers of manufacturing performance.

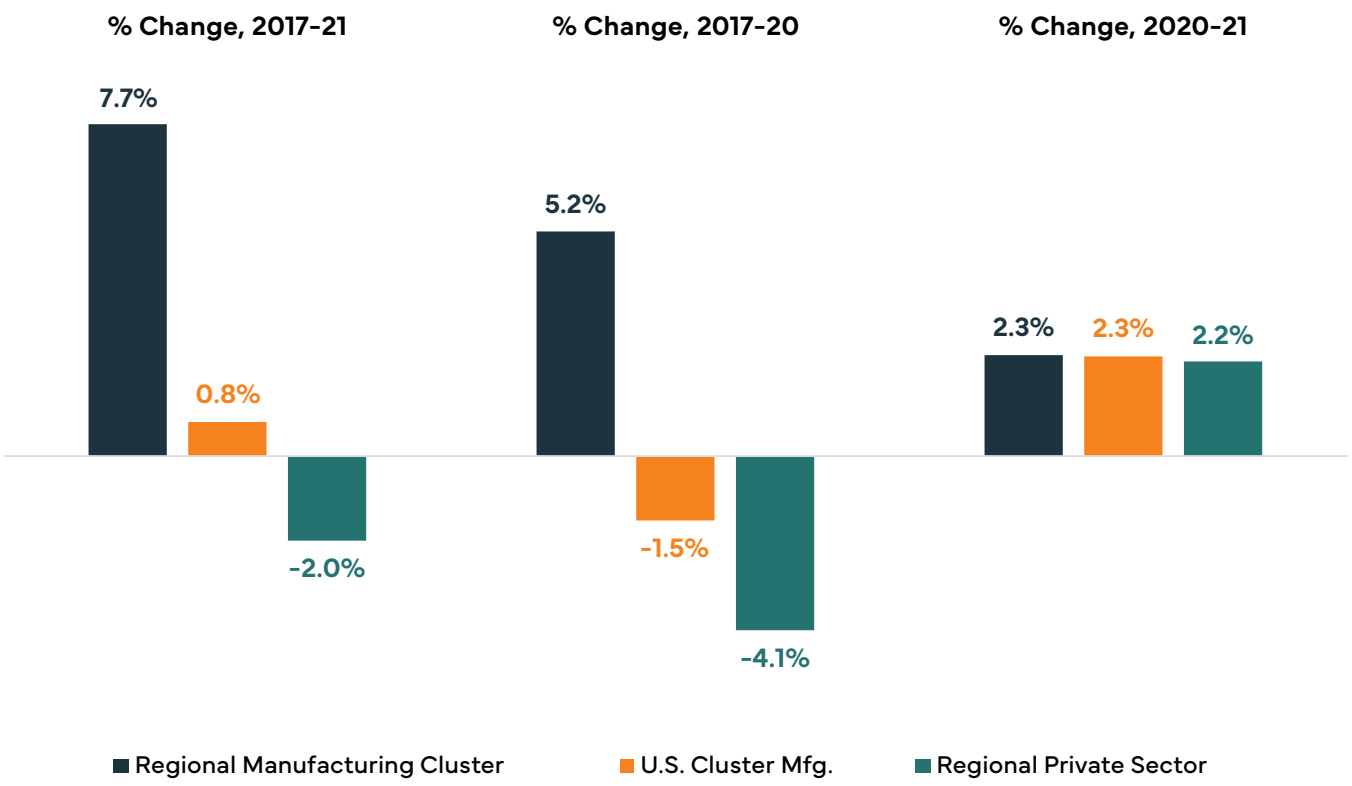
Analyzing the Economic, Workforce, and Innovation Landscape That Enables the Evansville Region's Manufacturing Sector

Regional Industry Performance

The manufacturing cluster in the Evansville Region constituted 33,310 jobs in 2021, an increase of 4.9 percent from 2017. With a Location Quotient (LQ) of 3.63, the region's employment is therefore 3.63 times as concentrated as that of the nation, representing a significant advantage in the relative employment size of the region's manufacturing cluster.

Compared to the U.S. overall, the Evansville Region's manufacturing clusters have performed well in employment growth, as shown in Figure 2. The region's manufacturing cluster grew by 7.7 percent between 2017 and 2021 compared to 0.8 percent nationally. Regional manufacturing also far outpaced total regional private sector employment declines of 2.0 percent, establishing that manufacturing is a major driver of overall economic progress despite economy-wide net job loss.

Figure A-2: Employment Trends in the Manufacturing Cluster vs. Private Sector



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

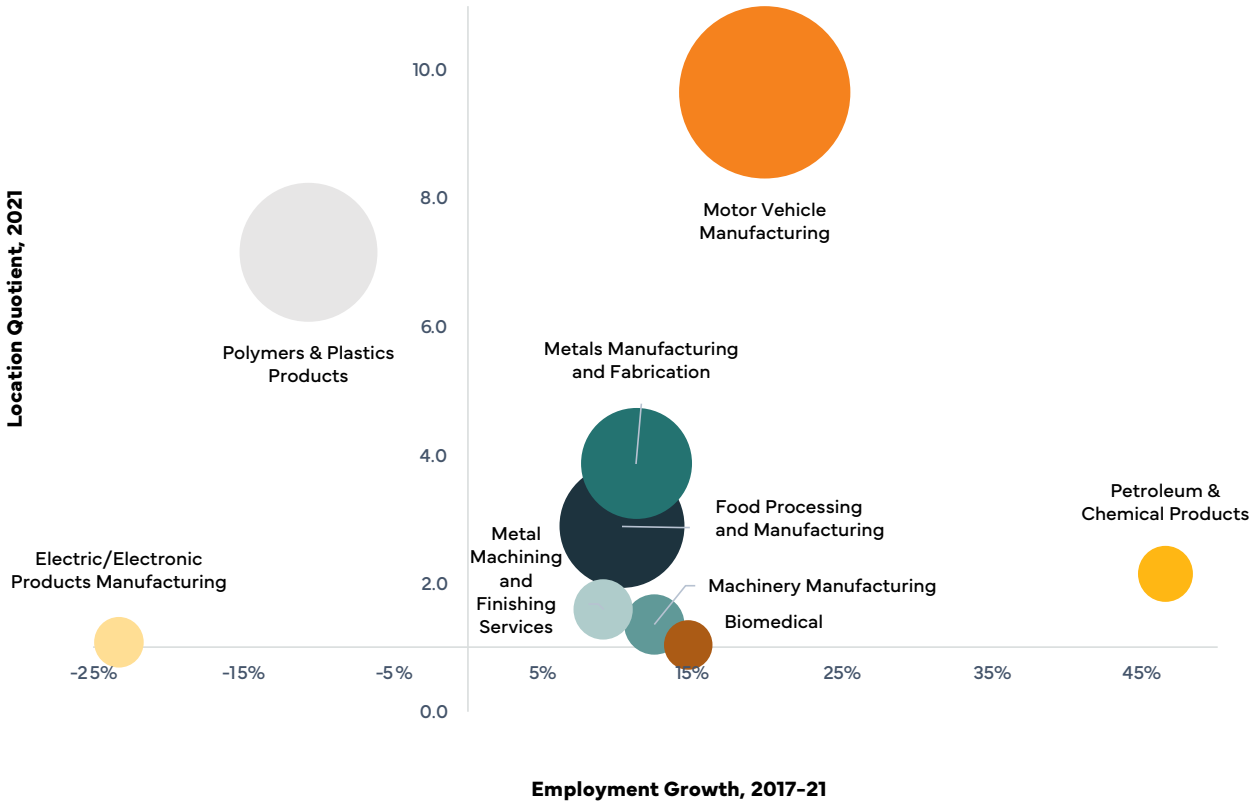
Growth trends in Figure 2 also demonstrate that manufacturing employment was more resilient than other sectors during the pandemic downturn, with positive growth within the region compared to both total

regional employment and national manufacturing employment. Additionally, the region's manufacturing employment base grew at a similar rate to that of total employment from 2020 into 2021.

Figure A-3: The Evansville Region's Manufacturing Cluster – Employment, Concentration, and Growth

The Bureau of Labor Statistics defines Location Quotient as a key measure of specialization : Location quotients (LQs) compare the concentration of an industry within a specific area to the concentration of that industry nationwide. If an LQ is equal to 1, then the industry has the same share of its area employment as the nation. An LQ greater than 1 indicates an industry with a greater share (a concentration) of local area employment than is found in the nation. For example, Las Vegas has an LQ greater than 1 in the Leisure and Hospitality industry because this industry makes up a larger share of the Las Vegas employment total than it does for the nation as a whole.

*TEConomy considers location quotients with values greater than 1.2 to be highly specialized, representing industries with unique regional concentrations



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

The Evansville Region has experienced strong performance among most manufacturing subclusters, with six subclusters that are both highly specialized and growing, as illustrated in Figure 3. Just two subclusters (Polymers & Plastics Products and Electric/Electronic Products Manufacturing) have experienced employment declines over the 2017-21 period. A complete breakdown of subcluster performance is shown in Table 2.

In addition to high levels of specialization across most subsectors, regional employment growth also exceeded that of the nation in most cases. Motor Vehicle Manufacturing, the most highly specialized subcluster, grew by 19.8 percent over the 2017 to 2021 period, which is more than 2.5 times the national growth rate in this subcluster. A total of seven subclusters grew faster than their national counterparts, with the overall manufacturing cluster growing nearly 10 times as quickly as the nation.

Table A-2: Manufacturing Subcluster Employment Performance

Industry Subcluster	Regional Employment, 2021	Regional LQ, 2021	Regional Employment Change, 2017-2021	U.S. Employment Change, 2017-21
Motor Vehicle Manufacturing	10,108	9.65	19.8%	7.5%
Polymers & Plastics Products	6,545	7.16	-10.6%	-1.0%
Food Processing and Manufacturing	5,301	2.89	10.3%	5.4%
Metals Manufacturing and Fabrication	4,267	3.87	11.3%	2.2%
Machinery Manufacturing	1,252	1.36	12.5%	-7.9%
Metal Machining and Finishing Services	1,229	1.59	9.0%	-2.4%
Petroleum & Chemical Products	1,044	2.15	46.5%	-0.7%
Electric/Electronic Products Manufacturing	854	1.08	-23.2%	0.8%
Biomedical	825	1.04	14.7%	0.3%
Total Manufacturing Cluster	31,424	3.63	7.7%	0.8%
Total Private Sector	152,359	1.00	-2.0%	0.3%

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

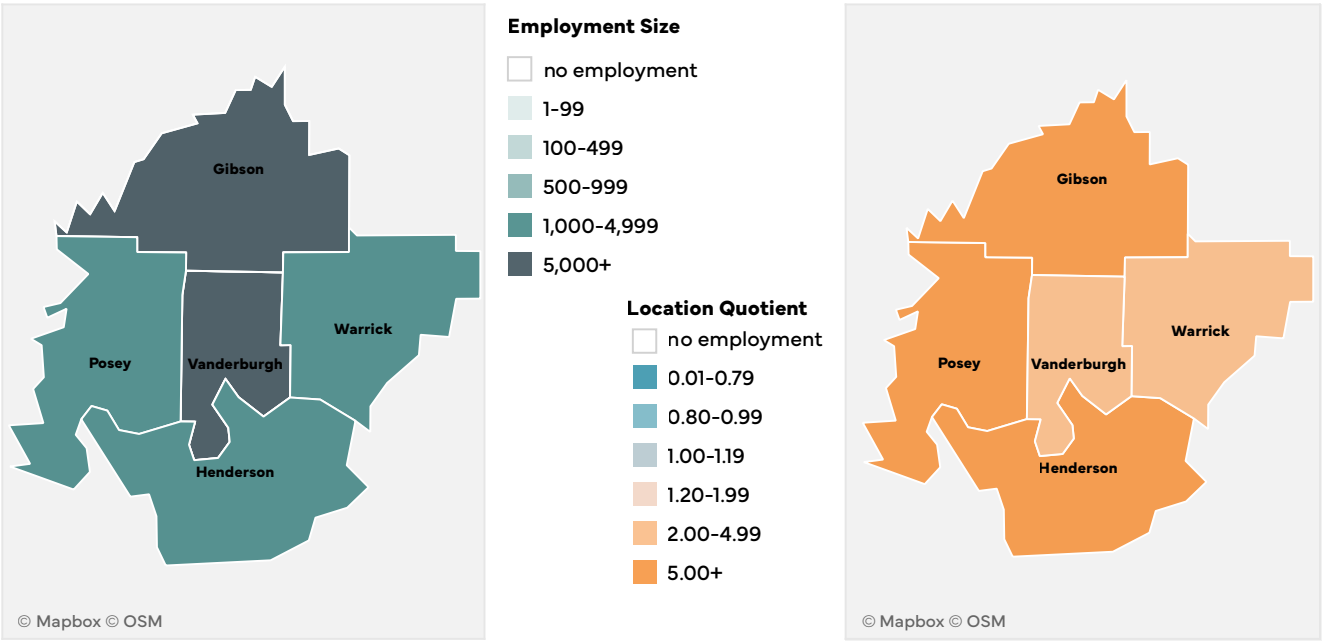
Geographic Distribution of Regional Manufacturing Employment

Manufacturing cluster employment is distributed well across the region's five counties, with each of them supporting more than 2,000 manufacturing jobs and LQs higher than 2.00. Subcluster employment trends by county are shown in Table 3. In addition to total manufacturing specialization being strong across the counties, each county has four or more subclusters with high specialization:

- Gibson County – specialized in four subclusters
- Henderson County – specialized in seven subclusters
- Posey County – specialized in six subclusters
- Vanderburgh County – specialized in five subclusters
- Warrick County – specialized in seven subclusters

High specialization and substantial employment values across the region emphasize the importance of each county in overall regional manufacturing performance. Each county's unique mix of subcluster employment contributes to the region's overall advantage in manufacturing and provides a strong industrial basis for advancing Industry 4.0 processes region-wide.

Figure A-4: Cluster Employment Size and Location Quotient by County, 2021[11]



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

11 A series of maps by industry subcluster can be found in Appendix C.

Table A-3: Manufacturing Subcluster Employment Size and Concentration by County

Industry Subcluster	Gibson County		Henderson County		Posey County		Vanderburgh County		Warrick County	
	Empl., 2021	LQ	Empl., 2021	LQ	Empl., 2021	LQ	Empl., 2021	LQ	Empl., 2021	LQ
Biomedical Manufacturing	-	-	3	0.04	-	-	806	1.63	15	0.20
Electric/Electronic Products Manufacturing	341	3.38	-	-	-	-	332	0.67	180	2.42
Food Processing and Manufacturing	220	0.94	1,656	8.69	203	2.27	2,821	2.46	400	2.32
Machinery Manufacturing	74	0.63	285	2.96	117	2.60	465	0.80	311	3.58
Metal Machining and Finishing Services	156	1.58	302	3.76	92	2.43	579	1.20	99	1.37
Metals Manufacturing and Fabrication	51	0.36	1,716	14.95	525	9.73	940	1.36	1,035	9.98
Motor Vehicle Manufacturing	9,306	69.62	380	3.49	-	-	297	0.45	125	1.27
Petroleum & Chemical Products	30	0.48	141	2.78	790	33.30	63	0.21	20	0.43
Polymers & Plastics Products	191	1.64	379	3.99	900	20.15	4,916	8.60	159	1.85
Total Manufacturing Cluster	10,371	9.38	4,862	5.40	2,627	6.21	11,219	2.07	2,345	2.88
Total Private Sector	19,451	1.00	15,846	1.00	7,446	1.00	95,290	1.00	14,325	1.00

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Gross Regional Product, Productivity, and Wages

Regional manufacturing cluster gross regional product (GRP) in 2021 totaled $9.082 billion. 40.8 percent of GRP compared to 7.9 percent nationally. As noted with employment, the manufacturing cluster has outperformed total manufacturing in growth. A comparison of GRP across the different industry definitions is shown in Table 4.

Table A-4: Gross Regional Product Levels and Change Across Different Definitions of the Manufacturing Sector

Industry Sector	Regional GRP, 2021 (in Billions)	Regional GRP Change, 2017-21	U.S. GRP Change, 2017-21
Total Manufacturing Cluster	$9.082	2.7%	14.5%
Brookings Advanced Industries – Manufacturing	$7.292	8.6%	11.7%
NAICS 31-33 Manufacturing	$9.277	1.9%	12.9%
Total Private Sector	$22.272	9.6%	20.5%

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Subcluster GRP is shown in Table 5. Unlike with employment, subcluster GRP growth has been less consistent. Four of the region's subclusters have experienced slower GRP growth than the national equivalent, with total manufacturing cluster GRP growth of 2.7 percent compared to national growth of 14.5 percent. Regional manufacturing GRP growth also lagged total private sector growth of 9.6%. Despite the region's manufacturing employment growing faster than both regional total employment and national manufacturing employment, GRP has not experienced similarly strong growth.

Table A-5: Manufacturing Subcluster Performance in GRP Metrics

Industry Subcluster	Regional GRP, 2021 (Billions)	Regional Change, 2017-21	U.S. Change, 2017-21	Regional Productivity, 2021
Motor Vehicle Manufacturing	$4.951	0.9%	0.5%	$489,791
Polymers & Plastics Products	$1.215	-21.3%	12.8%	$185,582
Food Processing and Manufacturing	$0.867	1.0%	28.4%	$163,606
Petroleum & Chemical Products	$0.735	59.8%	8.9%	$704,316
Metals Manufacturing and Fabrication	$0.651	35.0%	18.6%	$152,498
Biomedical Manufacturing	$0.257	17.6%	18.0%	$311,227
Machinery Manufacturing	$0.147	40.3%	16.5%	$117,078
Electric/Electronic Products Manufacturing	$0.134	-19.4%	19.4%	$157,217
Metal Machining and Finishing Services	$0.126	23.6%	4.6%	$102,408
Total Manufacturing Cluster	$9.082	2.7%	14.5%	$289,021
Total Private Sector	$22.272	9.6%	20.5%	$146,182

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

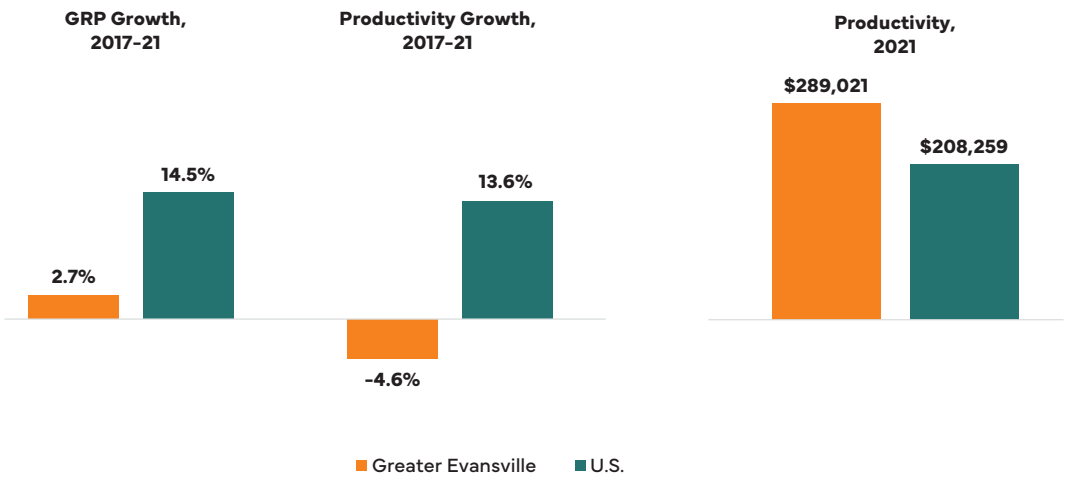
Another key metric in assessing the performance of the region's manufacturing cluster is productivity. Productivity is defined as GRP per employee, measuring the relative value of goods and services produced in a region after accounting for employment size. Across the manufacturing cluster, productivity in the Evansville Region is higher than the national level. This is primarily driven by four subclusters:

- Motor Vehicle Manufacturing (where regional productivity is 2.9x that of the nation)
- Polymers & Plastics Products (1.1x)
- Food Processing and Manufacturing (1.1x)
- Metals Manufacturing and Fabrication (1.1x)

Not only is employment in these subclusters highly specialized, but a relative advantage in productivity highlights the importance of these segments to the economic vitality of the region.

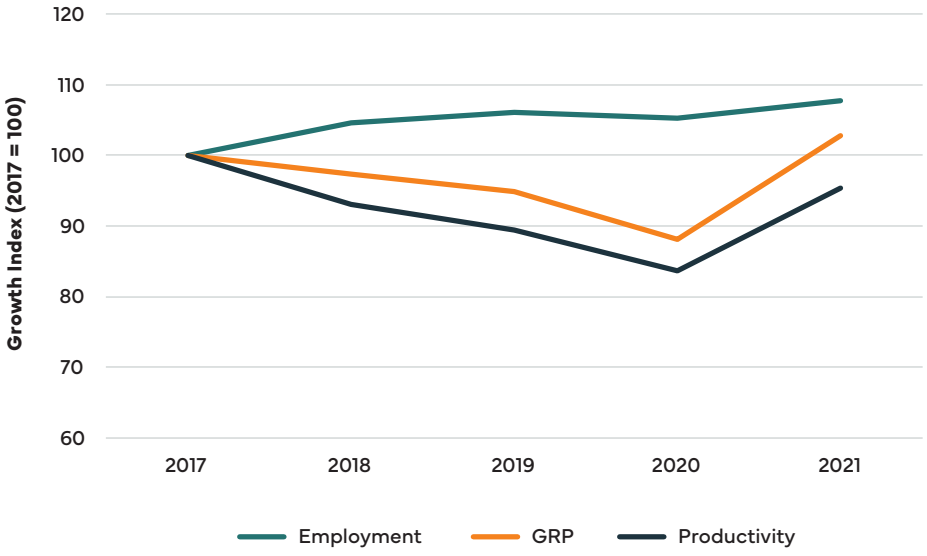
Despite having higher productivity levels in 2021, the Evansville Region has experienced poorer growth in GRP. Regional GRP within the manufacturing cluster grew by just 2.7 percent between 2017 and 2021, whereas national GRP grew by 14.5 percent over the same period, as shown in Figure 5. Additionally, the region's productivity advantage has eroded somewhat, with regional productivity declining while national productivity increased.

Figure A-5: Manufacturing Cluster GRP Growth and Productivity for the Region and the U.S.



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-6: Indexed Growth in Employment, GRP, and Productivity, 2017-21



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Because productivity is defined as a function of both employment and GRP, changes in productivity may result from shifts in either of those factors. By plotting indexed growth in Figure 6, the relationship between these three factors becomes clearer. Employment growth from 2017 to 2021 was steady compared to GRP growth, which bottomed out into the pandemic before bouncing back in 2021. Productivity follows the same trend as GRP, suggesting increases in employment were not adequate to offset the decline in value

added. Regional productivity decline within a context of national productivity growth suggests that the region's competitiveness in manufacturing has diminished.

And finally, with an average manufacturing cluster wage of $69,034 in 2021, the Evansville Region lags the nation ($76,095) by a small margin. However, this gap is smaller than that between the regions in terms of average private sector wage.

Within the Evansville Region, average wages are higher than national levels in three subclusters:

- Metals Manufacturing and Fabrication
- Motor Vehicle Manufacturing
- Food Processing and Manufacturing

Despite manufacturing wages falling below that of the national average, manufacturing jobs in within the region still provide a significant wage boost compared to the average of employees across all sectors.

Table A-6: Average Wages by Manufacturing Subcluster, 2021

Subcluster	Evansville	U.S.
Biomedical Manufacturing	$92,750	$107,928
Petroleum & Chemical Products	$86,981	$97,888
Metals Manufacturing and Fabrication	$79,577	$67,052
Motor Vehicle Manufacturing	$71,247	$67,874
Total Manufacturing Cluster	$69,034	$76,095
Machinery Manufacturing	$66,658	$72,591
Electric/Electronic Products Manufacturing	$64,778	$135,019
Polymers & Plastics Products	$62,762	$65,861
Food Processing and Manufacturing	$60,356	$53,273
Metal Machining and Finishing Services	$59,267	$63,970
Total Private Sector	$52,698	$68,027

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Workforce

Vital to the success of deployment of Industry 4.0 processes across the manufacturing sector is the availability of a sizable workforce with skills in relevant technology areas. The ability for companies to take full advantage of the benefits of Industry 4.0 is based in large part on the quantity of both new workers with recent education or training in key areas as well as "upskilling" of groups who are already in the workforce. As demand for certain technical skills increases across other industries, the manufacturing sector faces the dual challenges of stiff competition and limited supply of skilled labor. An analysis of recent occupational trends is therefore critical to the development and retention of a workforce suited to the transition into Industry 4.0 practices.

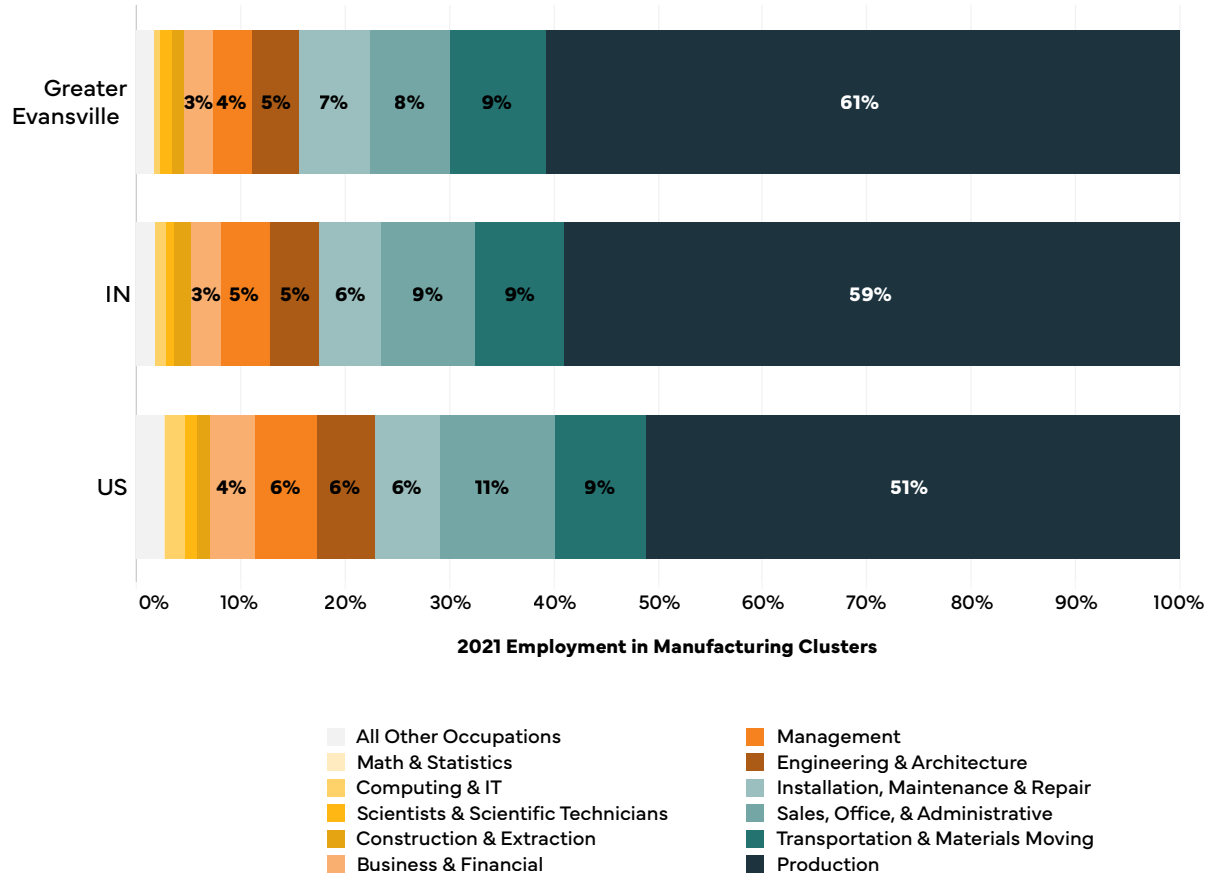
Occupational Workforce Assessment

Digitalization of manufacturing processes and operations ultimately requires a skilled workforce to implement and oversee adoption of new technologies. Using data published by the Bureau of Labor Statistics (sourced with some adjustments through Lightcast), it is possible to examine the "staffing patterns" within manufacturing industries, or the occupations that make up the mix of roles workers play within the industry. This analysis includes a variety of different occupational role types, ranging from traditional production jobs (technicians, assemblers, fabricators, operators, etc.) to technical roles (engineers, scientists) to administrative and other business support functions (clerks, managers, financial professionals, etc.).

These data can be used to examine several components of workforce composition, including the following:

- Determining the occupational makeup of key manufacturing industries within the region relative to the state and the nation, which aids in highlighting any key differences
- Identifying specialized types of labor that are driving regional manufacturing clusters
- Examining the extent to which occupations closely aligned with Industry 4.0 skills deployment are present within manufacturing clusters
- Highlighting "real-time" demand from regional employers through the lens of job postings activity from manufacturing companies in key Industry 4.0-related positions.

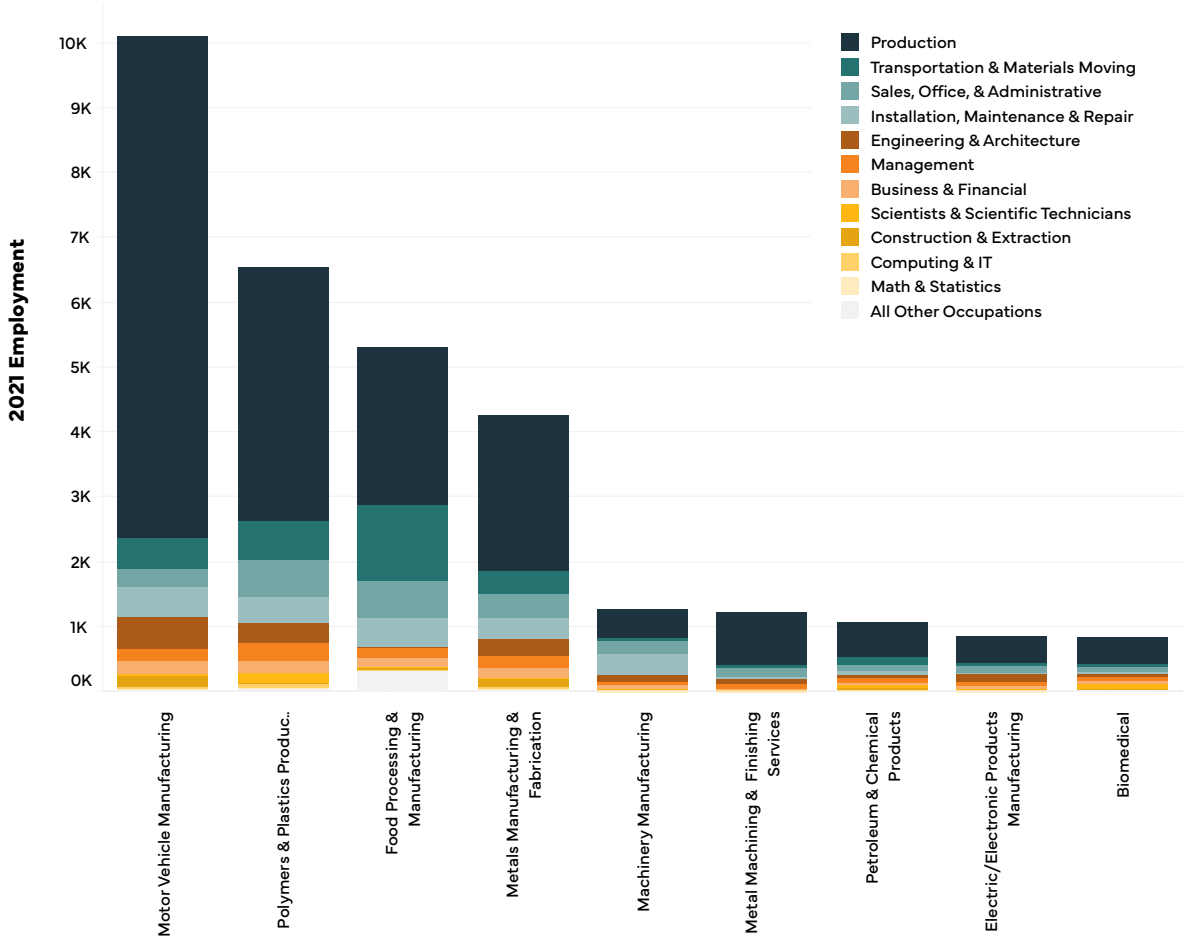
Figure A-7: Distribution of Manufacturing Cluster Employment Across Occupational Categories, 2021



Source: TEConomy's analysis of staffing patterns data from Lightcast (Datarun 2023.1)

Manufacturing cluster workforce composition by occupational category is shown in Figure 7. The region's key manufacturing clusters are driven by a production-intensive workforce that typically encompasses jobs requiring an Associate's degree or lower. The region's occupational composition mirrors that of the state, which emphasizes the nature of Indiana as a production-intensive workforce.

Figure A-8: Occupational Workforce Profile of the Region's Manufacturing Cluster Industries, 2021



Source: TEConomy's analysis of staffing patterns data from Lightcast (Datarun 2023.1)

Regional production workforce is heavily concentrated in motor vehicle, polymers/plastics, and metals manufacturing, as shown in Figure 8. The skilled engineering workforce is fairly distributed across clusters outside of food processing and manufacturing, which holds a significant proportion of the region's logistics and transportation-related workforce.

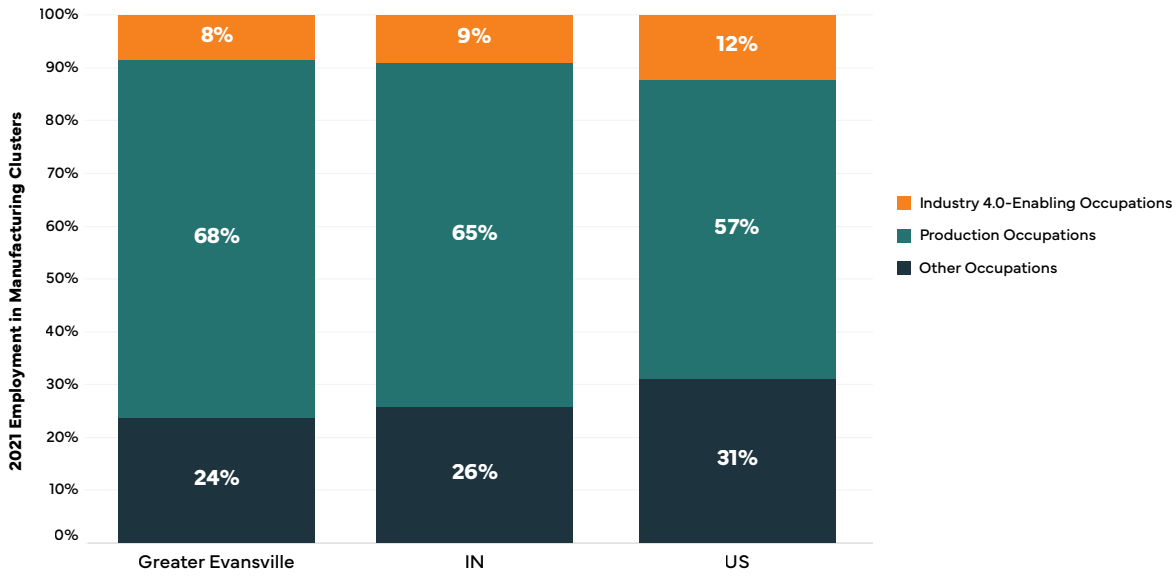
Table A-7: Example Occupations Within the Regional Manufacturing Cluster

Industry 4.0-Enabling Occupational Segments	Example Occupations in Segment
Business Analytics	Management Analysts, Market Research Analysts
Computer Hardware & Networking	Information Security Analysts, Network and Computer Systems Administrators
Computer Software	Software Developers, Applications, Computer Programmers
Digital Systems	Computer Systems Analysts, Database Administrators
Engineering Technicians	Aerospace Engineering and Operations Technicians, Industrial Engineering Technicians
Engineers	Mechanical Engineers, Industrial Engineers
Modeling & Data Science	Statisticians, Mathematicians
Operations & Logistics	Logisticians, Operations Research Analysts
Scientific Technicians	Chemical Technicians, Ag and Food Science Technicians
Scientists	Chemists, Materials Scientists

Manufacturing job types can be further categorized into Production-related occupations that serve traditional labor-intensive manufacturing operations versus Industry 4.0-enabling occupations that support digitization and automation of manufacturing. Examples of these occupational classifications, developed by BLS, are shown in Table 7.

The skilled technical occupations represented in Industry 4.0-enabling segments will be critical to helping companies remain competitive in the future, while recognizing that Production workforces will still play a key role and may transition to new occupational segments over time. Staffing patterns data can therefore be leveraged to observe the profile of these occupational categories within the manufacturing industry by outlining the current state of Industry 4.0 skills deployment in the region.

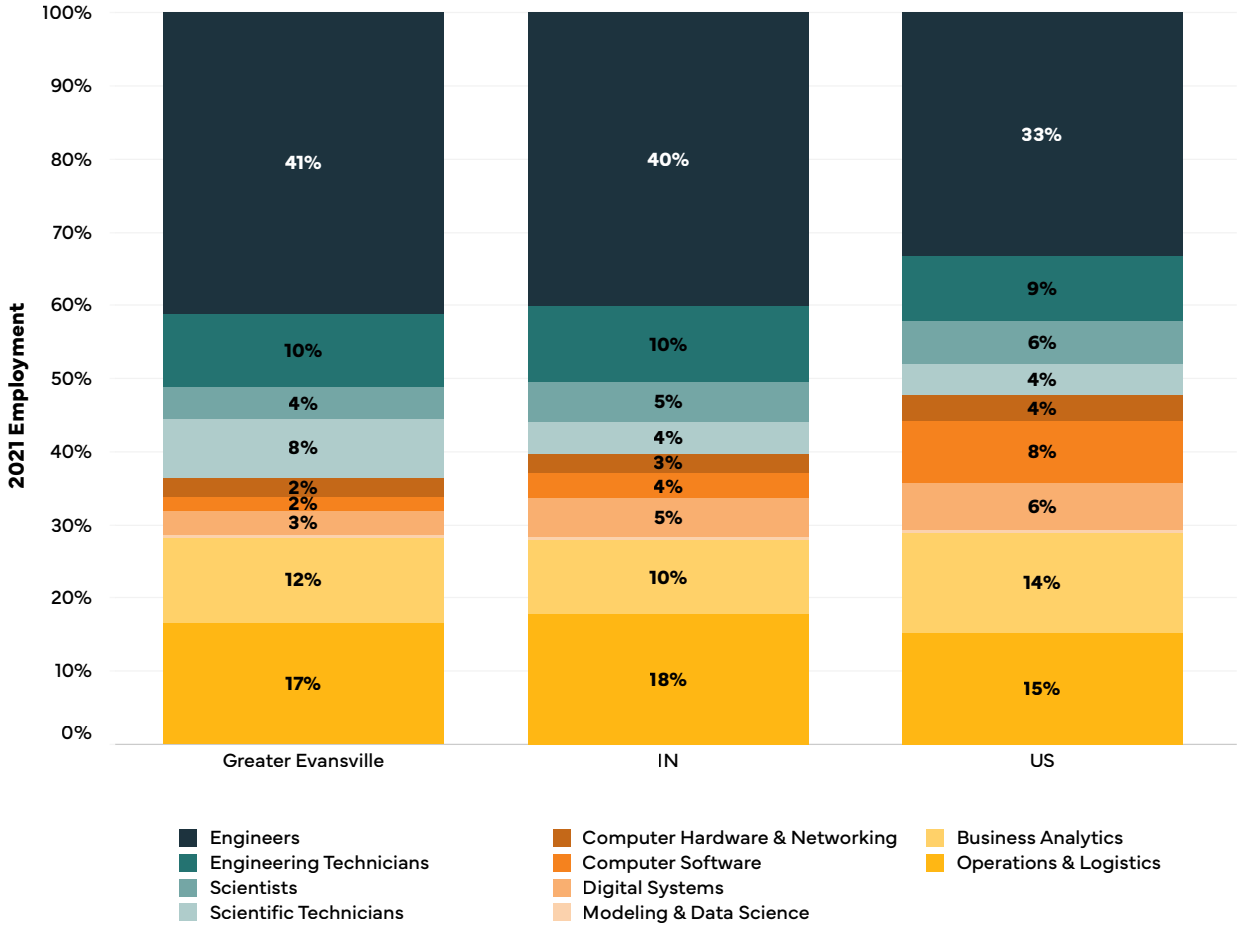
Figure A-9: Industry 4.0-Enabling and Production Occupations



Source: TEConomy's analysis of staffing patterns data from Lightcast (Datarun 2023.1)

As shown in Figure 9, Industry 4.0-enabling occupations make up a smaller portion of overall manufacturing employment relative to the nation. Nearly 63 percent of these Industry 4.0-enabling workforce jobs are located in two counties, Vanderburgh and Gibson. The Evansville Region's share of employment in Industry 4.0-enabling occupations has declined since 2017, falling from 9 percent of total manufacturing cluster employment to 8 percent in 2021, while the state and national shares remained the same.

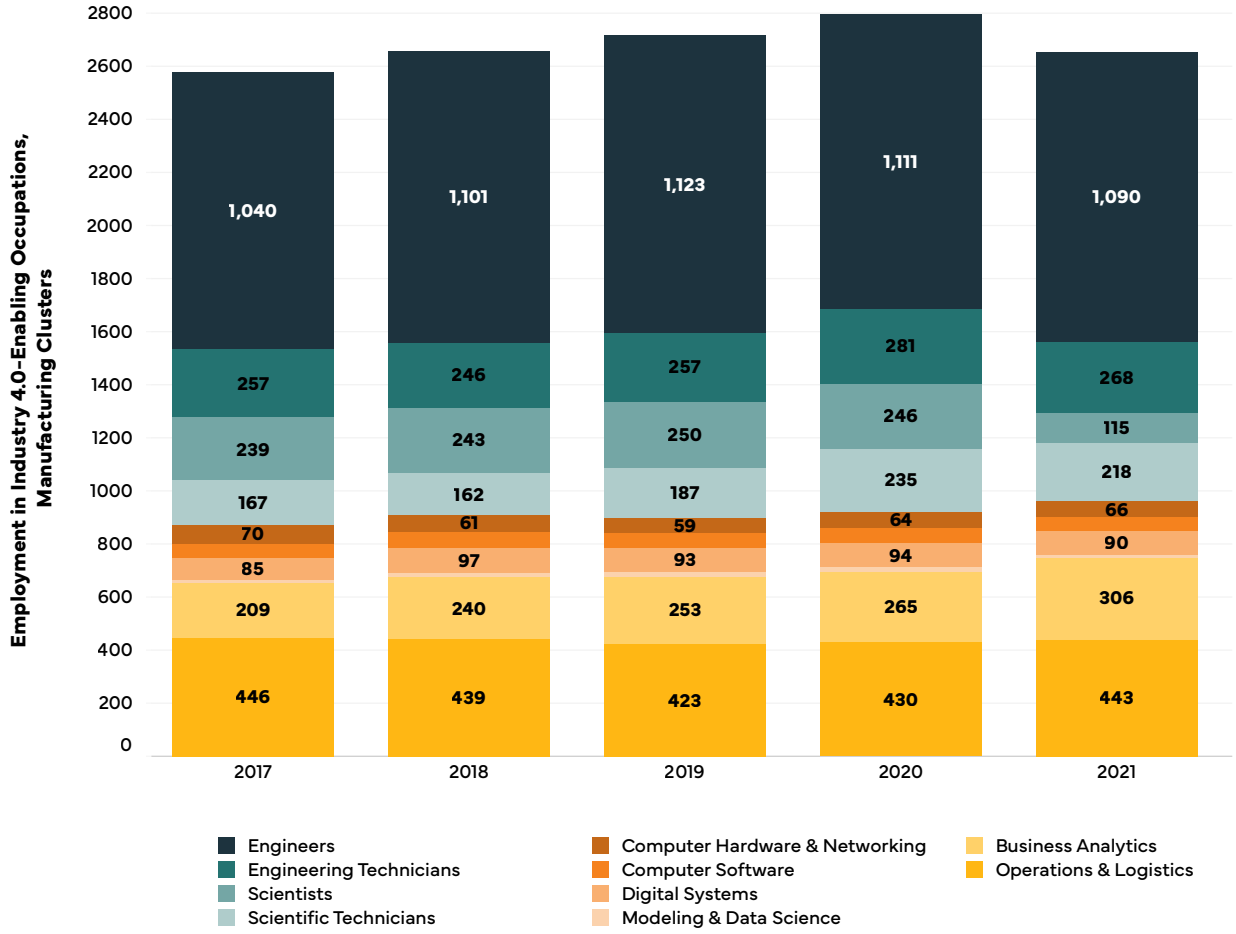
Figure A-10: Detailed Industry 4.0-Enabling Occupational Employment



Source: TEConomy's analysis of staffing patterns data from Lightcast (Datarun 2023.1)

Engineering workforce makes up the bulk of Industry 4.0-enabling workers within the region's manufacturing clusters, as shown in Figure 10. Within the region, significant segments in business analytics and operations and logistics also exist. There is also a notable share of scientific technicians in the region's Industry 4.0-enabling workforce – double the concentration of the state and nation. However, decline in the scientist segment in 2021 led to an overall reduction in total Industry 4.0-enabling jobs in the region, as shown in Figure 11.

Figure A-11: Trends in the Region's Industry 4.0-Enabling Workforce



Source: TEConomy's analysis of staffing patterns data from Lightcast (Datarun 2023.1)

Insights from Job Postings

In addition to analyzing the occupational mix of key manufacturing industries, further insights into the demand for Industry 4.0-enabling talent can be gleaned from industry job postings. Aggregated job postings data from Lightcast aggregates cross-listed job postings across numerous company-specific and broader job search websites to identify unique job positions and descriptive data outlining the characteristics of the advertised positions.

Job postings activity among regional manufacturers covering the period from 2020 through 2022 were analyzed to establish patterns in Industry 4.0-enabling position hiring and associated skill sets of importance. Lightcast reports a total of 12,493 job postings across the region's manufacturing cluster, 22 percent of which were written for Industry 4.0-enabling occupations. Detailed posting counts by industry subcluster are shown in Table 8, with comprehensive lists of hiring companies, in-demand occupations, and desired skills in Figure 12.

Table A-8: Unique Job Postings in Regional Manufacturing, 2020-2022

Industry Subcluster	Number of Unique Postings, 2020-2022	Percentage of Postings for Industry 4.0-enabling Roles
All Manufacturing Industries	12,493	22%
Polymers & Plastics Products	3,160	23%
Food Processing & Manufacturing	1,265	10%
Metals Manufacturing & Fabrication	1,161	23%
Petroleum & Chemical Products	954	29%
Motor Vehicle Manufacturing	836	18%
Biomedical	584	29%
Electric/Electronic Products Manufacturing	542	35%
Machinery Manufacturing	535	18%
Metal Machining & Finishing Services	445	23%

Source: TEConomy's analysis of job postings data from Lightcast (Datarun 2023.1)

Figure A-12: Industry 4.0-Enabling Workforce Hiring: Leading Companies, Occupational Roles, & Skill Sets Across Regional Job Postings, 2020-2022

Who's Hiring?

Includes companies with 3+ average unique monthly postings over period in descending order by volume

- Berry Global
- Alcoa
- Reckitt Benckiser
- Koch Enterprises
- AstraZeneca
- Toyota Motors
- GAF Materials Corporation
- Applied Materials
- SABIC
- Kaiser Aluminum
- Gibbs Die Casting Corporation
- Ameriqual Foods
- SrgGlobal
- Green Plains
- Nuclear Fuel Services
- Red Spot Paint & Varnish Company

For What Roles?

Includes roles with 5+ average unique monthly postings over period in descending order by volume

- Industrial Engineering
- Technologists and Technicians
- Industrial Engineers
- Mechanical Engineers
- Logisticians
- Industrial Production Managers
- Transportation, Storage, and Distribution Managers
- Electrical and Electronic Engineering Technologists and Technicians
- Software Developers
- Electrical Engineers
- Chemical Engineers
- Computer Occupations, All Other
- Life, Physical, and Social Science Technicians, All Other
- Financial and Investment Analysts
- Computer Network Architects

Seeking Which Skills?

Within Industry 4.0-enabling roles over period in descending order by frequency of mentions

- Project Management
- Auditing
- Automation
- Supply Chain
- Programmable Logic Controllers
- Process Improvement
- New Product Development
- Continuous Improvement Process
- Good Manufacturing Practices
- Computer Science
- Lean Manufacturing
- Data Analysis
- Mechanical Engineering
- Environment Health And Safety
- Root Cause Analysis
- SAP Applications
- Finance
- Electrical Engineering
- Tooling
- AutoCAD

Source: TEConomy's analysis of job postings data from Lightcast (Datarun 2023.1)

Manufacturing-Related Degrees and Certificate Programs

Fostering an expanding Industry 4.0-enabling workforce requires a steady supply of postsecondary graduates with the skills and education to meet the needs of employers across varied industries. The symbiotic relationship between education and employment opportunities requires a degree of coordination between industry and education institutions as well as flexibility in adjusting to future changes in the occupational landscape. An evaluation of recent postsecondary award trends provides the backdrop for which future workforce needs can be addressed.

As discussed in the previous section, Industry 4.0-enabling occupations require training in a variety of STEM skills. These analyses focus on a key set of academic fields that prepare graduates for Industry 4.0-enabling jobs:

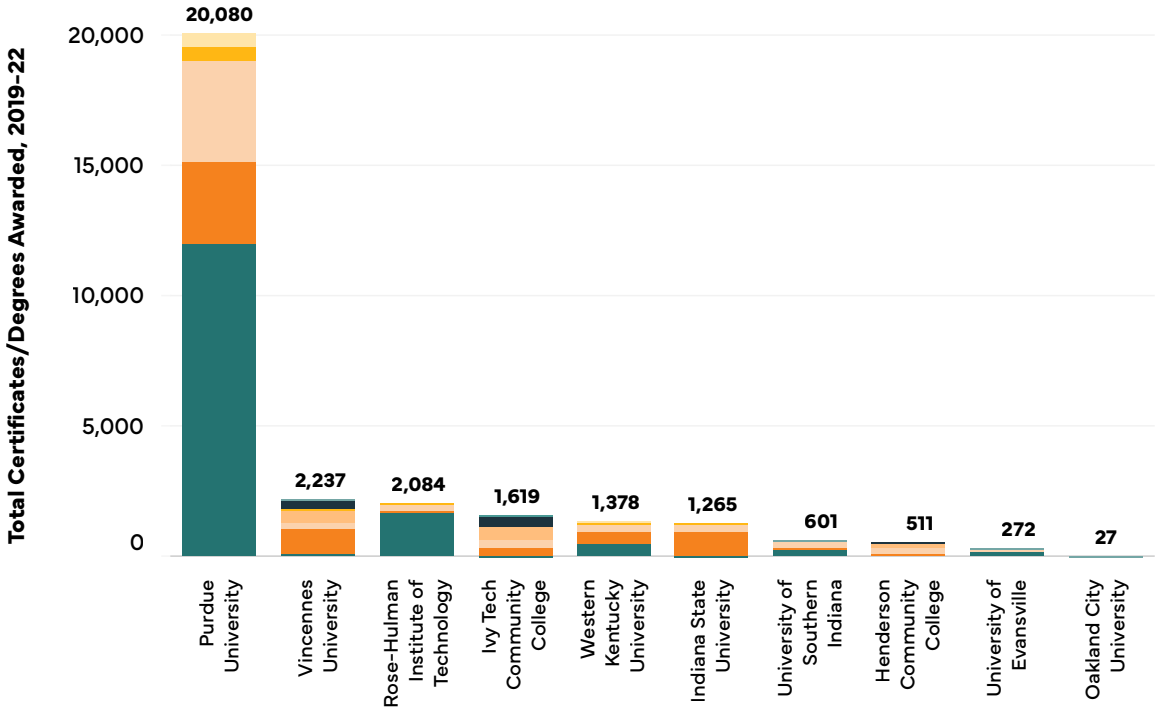
- Agbiosciences (machinery and food/ag product processing only)
- Computing & IT
- Engineering
- Engineering Technicians
- Installation, Maintenance, and Repair
- Operations & Business Support
- Scientists (manufacturing-related fields only)
- Scientific Technicians (manufacturing-related fields only)
- Skilled Production (e.g., machine shop technology, welding)

This section examines the supply of graduates from institutions that provide the backbone of the region's skilled workforce. The following institutions were identified by the Taskforce as providing talent to the Evansville Region:

- Henderson Community College
- Indiana State University
- Ivy Tech Community College
- Oakland City University
- Purdue University
- Rose-Hulman Institute of Technology
- University of Evansville
- University of Southern Indiana
- Vincennes University
- Western Kentucky University

A breakdown of total graduates from each institution over the 2019 to 2022 period is shown in Figure 13. Approximately one-third of graduates come from institutions located within the region, with Purdue University included as an important

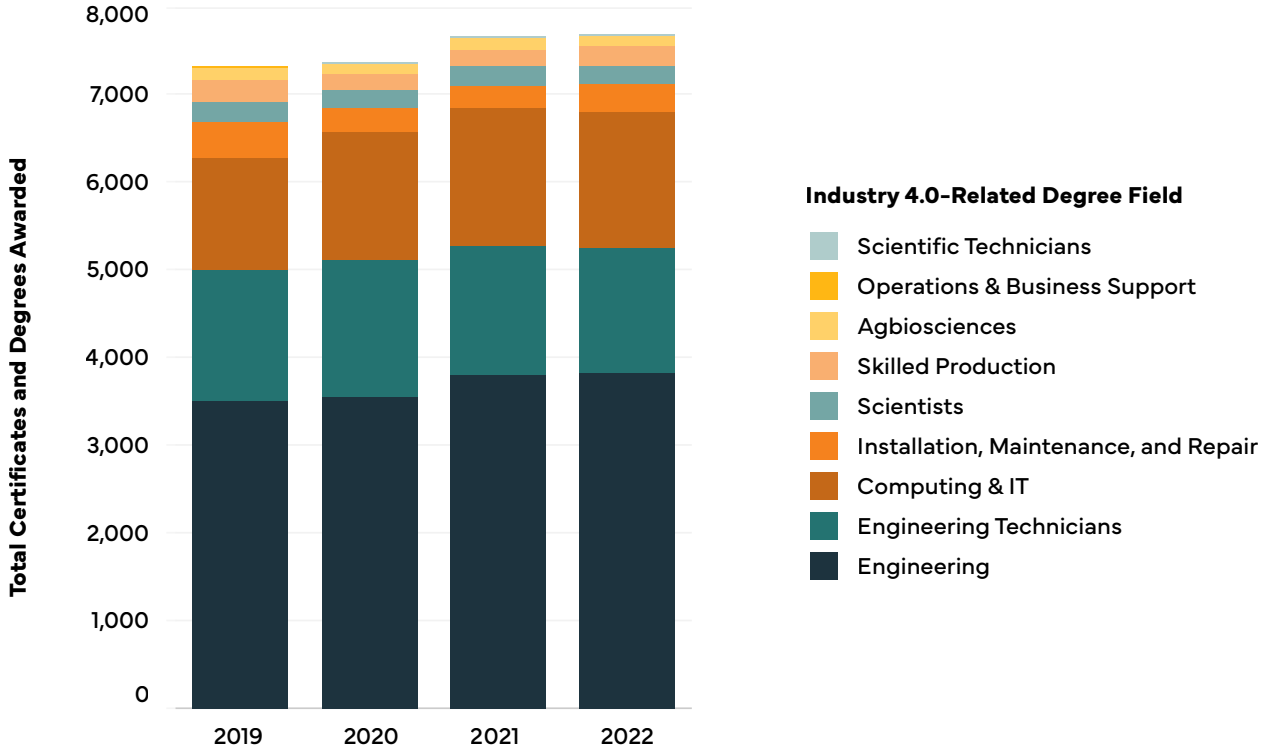
Figure A-13: Industry 4.0-Related Certificates and Degrees by Institution, 2019-22



Source: TEConomy's analysis of Integrated Postsecondary Education Data System (IPEDS), NCES; with additional data provided by Ivy Tech Community College

Trends in total Industry 4.0-related degrees are shown in Figure 14. Regional institutions produced 7,696 graduates in 2022. This represents increase of 5.1 percent from 2019 compared to 3.8 percent nationally.

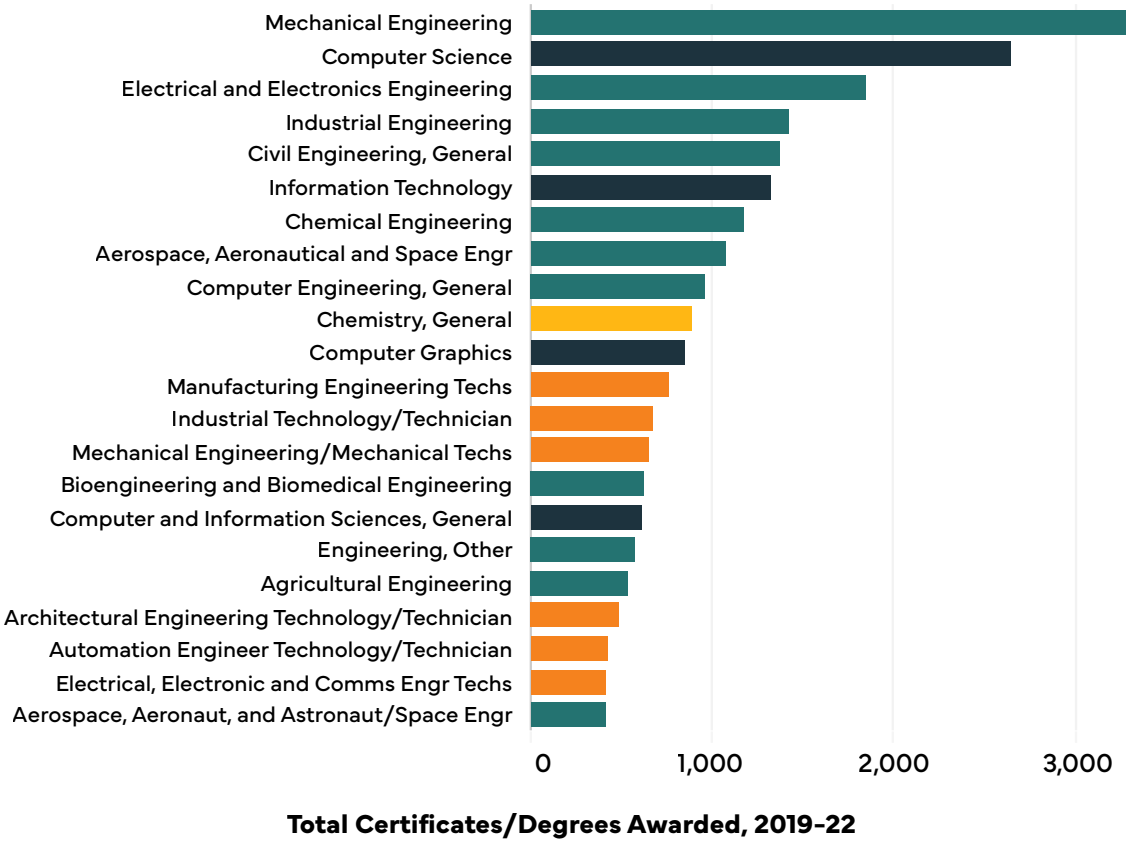
Figure A-14: Industry 4.0-Related Certificates and Degrees Awarded, 2019-22



Source: TEConomy's analysis of Integrated Postsecondary Education Data System (IPEDS), NCES; with additional data provided by Ivy Tech Community College

Between 2019 and 2022, nearly 90 percent of the region's graduates in Industry 4.0-related fields received awards in the following three areas: Engineering (48.8 percent), Computing & IT (19.9 percent), and Engineering Technicians (19.4 percent). A detailed list of leading fields is shown in Figure 15.

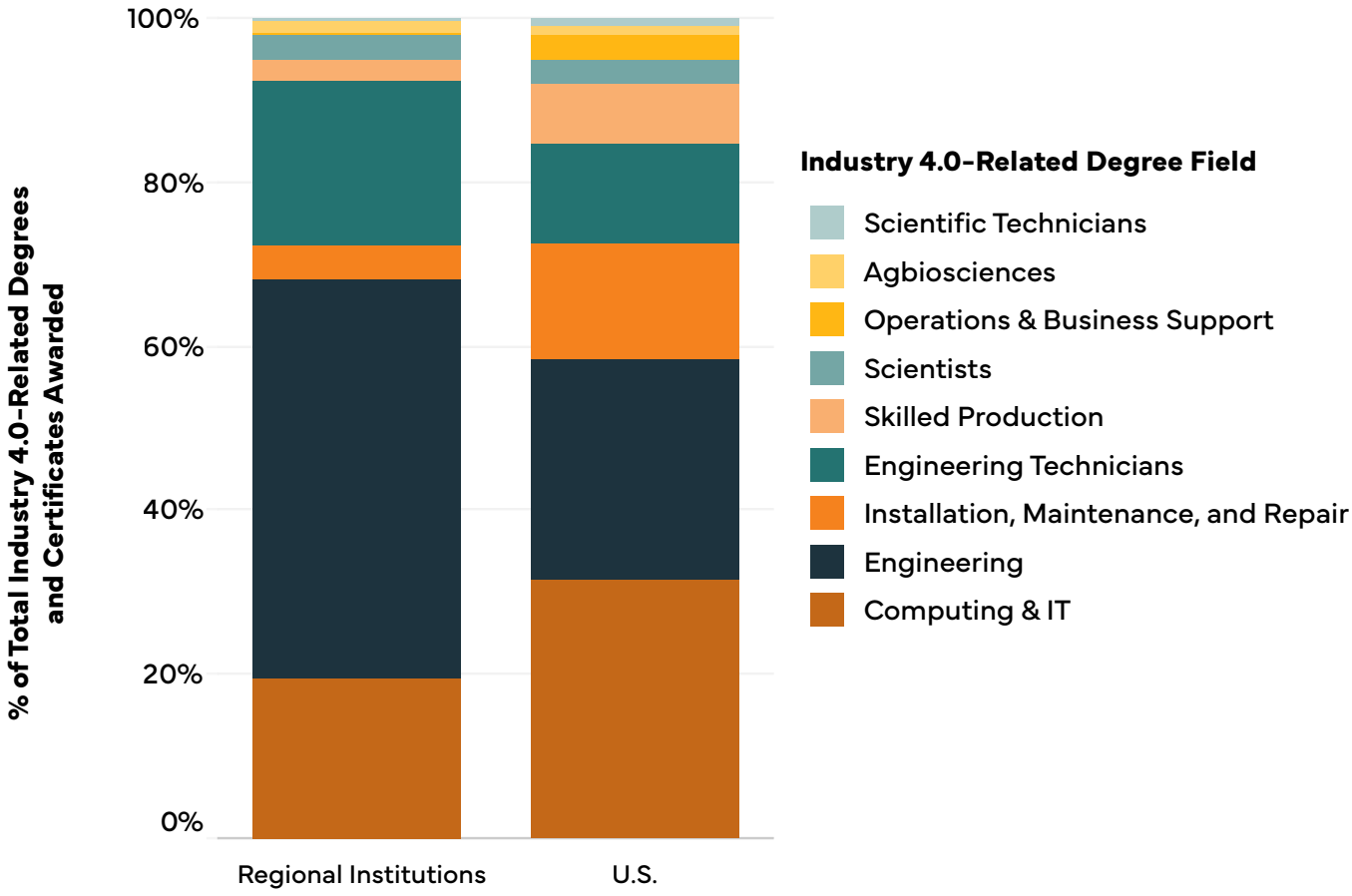
Figure A-15: Certificates and Degrees Awarded to Leading Fields, 2019-22



Source: TEConomy's analysis of Integrated Postsecondary Education Data System (IPEDS), NCES; with additional data provided by Ivy Tech Community College

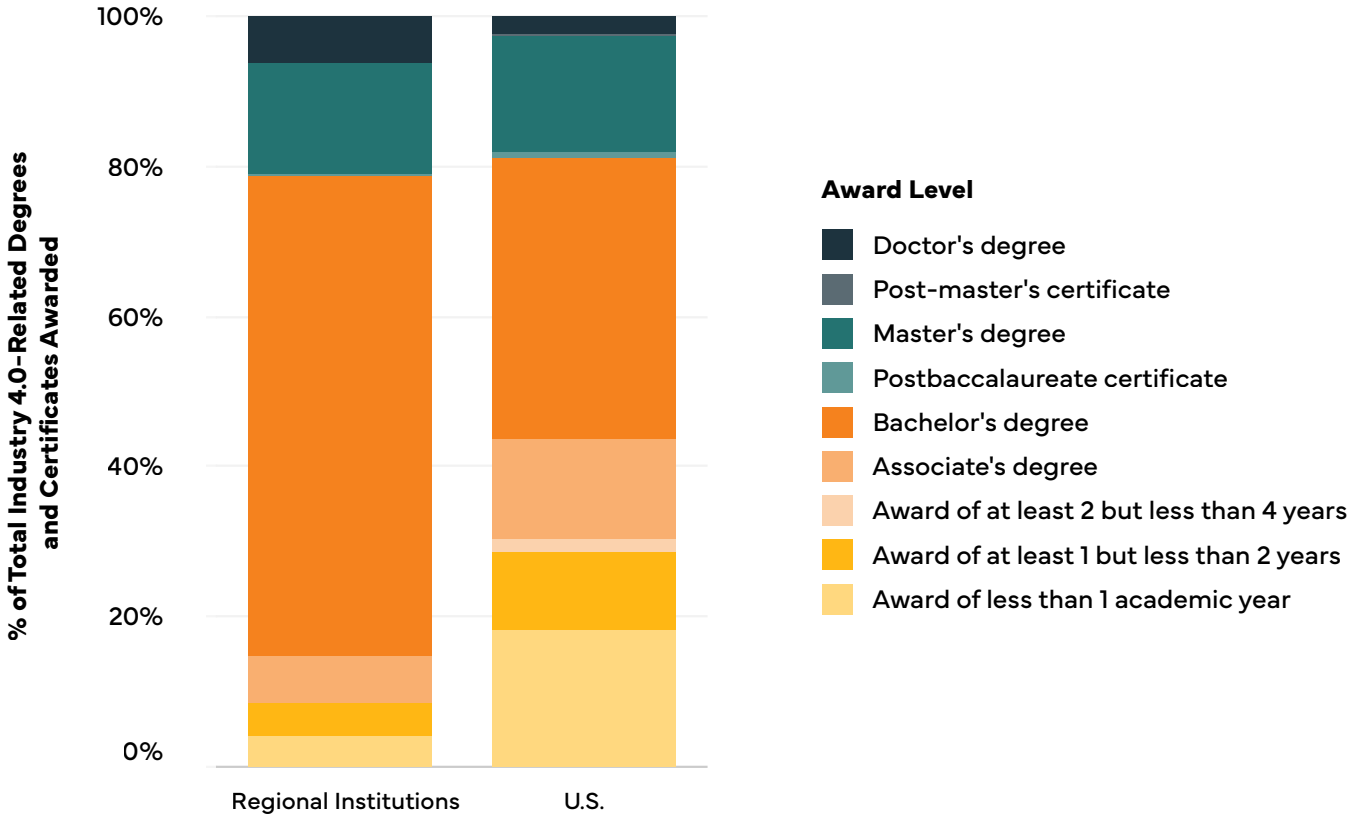
The mix of regional graduates across key fields demonstrates a different mix of program areas relative to the composition of all U.S. institutions. Compared to the national average, the region's institutions hold a comparative advantage in awards within Engineering and Engineering Technicians; but lower proportions of graduates in Computing & IT and Installation, Maintenance, and Repair. Additionally, the region's institutions are awarding a much larger proportion of Bachelor's degrees than the national average, as shown in Figure 17.

Figure A-16: Composition of Industry 4.0-Related Certificates and Degrees Awarded by Field, 2019-22



Source: TEConomy's analysis of Integrated Postsecondary Education Data System (IPEDS), NCES; with additional data provided by Ivy Tech Community College

Figure A-17: Composition of Industry 4.0-Related Certificates and Degrees Awarded by Award Level, 2019-22



Source: TEConomy's analysis of Integrated Postsecondary Education Data System (IPEDS), NCES; with additional data provided by Ivy Tech Community College

Innovation Scan

The last component of this review of the Evansville Region's manufacturing cluster performance is a summary of innovation activities related to Industry 4.0 technologies. Assessing the regional drivers of technological innovation and adoption provides insights into the strength of the region's foundation in these key areas. Future growth of and utilization in Industry 4.0 technologies is dependent on the concerted effort of corporate and institutional actors to foster a supportive and resourced environment.

Innovation Centers

Critical to the advancement of both innovation and skilled labor is an academic commitment to research and teaching in key Industry 4.0-related fields. A comprehensive listing of academic programs and institutional centers is detailed in Table 9. Identified in this table are programs across eleven regional institutions, including initiatives in STEM outreach, corporate partnerships, student internships, and advanced manufacturing practices. Institutional support for Industry 4.0 advancement is essential to the development of a vibrant ecosystem in which these practices and technologies can flourish.

Table A-9: Scan of the Evansville Region Academic Support Programs

University Name	Industry 4.0 Related R&D and Outreach	Industry 4.0 Related Student Development Programs	Industry 4.0 Related Majors and Academic Programs	Potentially Related Majors and Academic Programs
University of Southern Indiana (USI)	Center for Applied Research Corporate Partnerships and Customized Training	Applied Engineering Center Southwest Indiana STEM (SwISTEM)	Engineering Mechatronics Manufacturing Engineering Technology	Pott College of Science, Engineering, and Education Romain College of Business
Vincennes University	Vincennes University's Gibson County Center for Advanced Manufacturing and Logistics in Fort Branch At Vincennes University Jasper, The Center for Technology, Innovation and Manufacturing (CTIM) Career Advancement Partnership (CAP) Program	Advanced Manufacturing Technology program The Center for Technology, Innovation and Manufacturing (CTIM) Career Advancement Partnership (CAP) Program The Advanced Internship in Manufacturing (AIM) program	BS in Advanced Manufacturing The Advanced Manufacturing Automation Technology Program The Advanced Manufacturing Industrial Maintenance Program	A number of College of Technology programs as well as Information Technology Department Programs
Rose-Hulman Institute of Technology	Rose-Hulman Ventures Corporate Partnership Program	Branam & Kremer Innovation Centers Co-Op Programs Summer STEM Camps	Minor in Internet of Things Multidisciplinary Minor in Robotics Second Major in Data Science Minor in Manufacturing Engineering	Programs including biomathematics, computer science, engineering design, software engineering, and others
IU Bloomington	Institute for Digital Enterprise (IDE) The Center for Excellence in Manufacturing Fibers and Additive Manufacturing Enabled Systems Laboratory	New program in AI and ML for energy analytics	B.S. in Intelligent Systems Engineering Accelerated M.S. in Intelligent Systems Engineering M.S. in Intelligent Systems Engineering Ph.D. in Intelligent Systems Engineering	BS in Computer Science, Data Science, and Informatics Certificates in key areas such as information, intelligence studies, data science, and more
Purdue University	Purdue Manufacturing Extension Partnership (MEP)	Purdue Polytechnic Smart Learning Factory Intelligent Process Manufacturing Laboratory	Industrial and Systems Engineering major Bachelors in Smart Manufacturing Industrial Informatics Dual Master of Science Degree	Programs in a range of engineering fields, such as: Biomedical, Chemical, Civil, Computer, Electrical, and others

University Name	Industry 4.0 Related R&D and Outreach	Industry 4.0 Related Student Development Programs	Industry 4.0 Related Majors and Academic Programs	Potentially Related Majors and Academic Programs
Western Kentucky University	The Metals Innovation Initiative (MI2) Advantage Kentucky Alliance (AKA)	WKU's Manufacturing Mentoring Internship Program	Manufacturing Engineering Technology (MET) Program	School of Engineering and Applied Sciences includes: Architectural Science, Civil Engineering, Computer Information Technology, etc. Gordon Ford College of Business's Department of Analytics and Information Systems
Indiana State University		John T. Myers Technology Center	Bailey College of Technology and Engineering's Department of Electronics and Computer Engineering Technology (ECET) B.S. in Automation and Control Engineering Program	The Department of Applied Engineering and Technology Management (AETM)
University of Evansville		Cooperative Education Programs	ChangeLab – a multidisciplinary course to develop innovative solutions toward positive change across different domains	School of Engineering and Computer Science
Ivy Tech (Evansville, Princeton, and Tipp City)		Advanced Manufacturing Next Level Jobs Programs IT & Business Next Level Jobs Program	Advanced Automation and Robotics Technology Process Operations Technician Program	Degrees within the School of Advanced Manufacturing, Engineering & Applied Sciences
Oakland City University				Computer Science (BS)
Henderson Community College				Industrial Maintenance Technology Program Computer and Information Technologies Program

Venture Capital Investment and Federal SBIR/STTR Awards

To complete the scan of the region's manufacturing-related innovation activity, key funding sources for startup and emerging, high-growth potential manufacturers were examined, including awards from the federal Small Business Innovation Research Program (SBIR) and venture capital investments in manufacturing.

Between 2017 and 2022, manufacturing and Industry 4.0-related companies in the Evansville Region received four venture capital investments totaling $2.40 million. This represents just 18 percent of the region's total venture capital investment of $13 million over the same period. A list of companies and their investments is presented in Table 10.

Table A-10: Manufacturing and Industry 4.0-Related Venture Capital Investment in Regional Companies

Company	City	Description	Total Deals	Total Investment
Audubon Metals	Henderson	metal processing	1	Undisclosed (later stage)
Quarion Technology	Evansville	warehouse safety system	1	$0.65 M
ZeroCarb LYFE	Evansville	food production	2	$1.75 M

Source: PitchBook Data.

SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer) is a Federal Program that provides non-dilutive capital to encourage domestic small businesses to engage R&D with the potential for commercialization. Federal SBIR/STTR awards therefore provide companies with key funds to advance development of innovative products.

Compared to venture capital investments, regional SBIR/STTR activity was more limited, with one company receiving two awards totaling $1.23 million between 2017 and 2022. Details are presented in Table 11.

Table A-11: Manufacturing and Industry 4.0-Related Federal SBIR/STTR Awards to Regional Companies

Company	City	Description	Total Awards	Total Amount Awarded
Anu (formerly GroPod/Heliponix)	Evansville	agtech hardware development	2	$1.23 M

Source: SBIR.gov.

Considering both venture capital investment and federal SBIR awards, the region is underperforming in terms of companies' access to external funding. Expanding access to programs supporting commercialization would aid in the process of scaling companies and assist in increasing employment opportunities in this sector. Widespread adoption of Industry 4.0 will require the fostering of regional companies with cutting-edge product development. Increasing access to external funding, in the form of venture capital and SBIR, will facilitate regional goals in growing the utilization of Industry 4.0 technologies.

APPENDIX A-1

Industry NAICS Definitions

Table A-12: Manufacturing Cluster NAICS Definitions by Subcluster

NAICS	Description
Biomedical Manufacturing	
325411	Medicinal and Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
Electric/Electronic Products Manufacturing	
334111	Electronic Computer Manufacturing
334210	Telephone Apparatus Manufacturing
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing
334290	Other Communications Equipment Manufacturing
334310	Audio and Video Equipment Manufacturing
334419	Other Electronic Component Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
334516	Analytical Laboratory Instrument Manufacturing
334519	Other Measuring and Controlling Device Manufacturing
334614	Software and Other Prerecorded Compact Disc, Tape, and Record Reproducing
335110	Electric Lamp Bulb and Part Manufacturing
335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing
335311	Power, Distribution, and Specialty Transformer Manufacturing
335312	Motor and Generator Manufacturing
335313	Switchgear and Switchboard Apparatus Manufacturing
335314	Relay and Industrial Control Manufacturing
335931	Current-Carrying Wiring Device Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing
Food Processing and Manufacturing	
311111	Dog and Cat Food Manufacturing
311119	Other Animal Food Manufacturing
311211	Flour Milling
311212	Rice Milling

NAICS	Description
311224	Soybean and Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311352	Confectionery Manufacturing from Purchased Chocolate
311422	Specialty Canning
311513	Cheese Manufacturing
311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing
311520	Ice Cream and Frozen Dessert Manufacturing
311611	Animal (except Poultry) Slaughtering
311612	Meat Processed from Carcasses
311613	Rendering and Meat Byproduct Processing
311615	Poultry Processing
311710	Seafood Product Preparation and Packaging
311811	Retail Bakeries
311812	Commercial Bakeries
311824	Dry Pasta, Dough, and Flour Mixes Manufacturing from Purchased Flour
311920	Coffee and Tea Manufacturing
311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing
311942	Spice and Extract Manufacturing
311991	Perishable Prepared Food Manufacturing
311999	All Other Miscellaneous Food Manufacturing
312111	Soft Drink Manufacturing
312113	Ice Manufacturing
312120	Breweries
312130	Wineries
312140	Distilleries
Machinery Manufacturing	
333111	Farm Machinery and Equipment Manufacturing
333120	Construction Machinery Manufacturing
333131	Mining Machinery and Equipment Manufacturing
333244	Printing Machinery and Equipment Manufacturing
333249	Other Industrial Machinery Manufacturing
333318	Other Commercial and Service Industry Machinery Manufacturing
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
333517	Machine Tool Manufacturing
333519	Rolling Mill and Other Metalworking Machinery Manufacturing
333914	Measuring, Dispensing, and Other Pumping Equipment Manufacturing
333922	Conveyor and Conveying Equipment Manufacturing
333992	Welding and Soldering Equipment Manufacturing
333999	All Other Miscellaneous General Purpose Machinery Manufacturing
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance

NAICS	Description
Metal Machining and Finishing Services	
332710	Machine Shops
332721	Precision Turned Product Manufacturing
332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing
333511	Industrial Mold Manufacturing
333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing
333515	Cutting Tool and Machine Tool Accessory Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
333995	Fluid Power Cylinder and Actuator Manufacturing
333996	Fluid Power Pump and Motor Manufacturing
Metals Manufacturing and Fabrication	
331110	Iron and Steel Mills and Ferroalloy Manufacturing
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel
331222	Steel Wire Drawing
331313	Alumina Refining and Primary Aluminum Production
331314	Secondary Smelting and Alloying of Aluminum
331318	Other Aluminum Rolling, Drawing, and Extruding
331420	Copper Rolling, Drawing, Extruding, and Alloying
331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding
331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)
331511	Iron Foundries
331523	Nonferrous Metal Die-Casting Foundries
331524	Aluminum Foundries (except Die-Casting)
331529	Other Nonferrous Metal Foundries (except Die-Casting)
332111	Iron and Steel Forging
332114	Custom Roll Forming
332119	Metal Crown, Closure, and Other Metal Stamping (except Automotive)
332312	Fabricated Structural Metal Manufacturing
332313	Plate Work Manufacturing
332321	Metal Window and Door Manufacturing
332322	Sheet Metal Work Manufacturing
332323	Ornamental and Architectural Metal Work Manufacturing
332420	Metal Tank (Heavy Gauge) Manufacturing
332439	Other Metal Container Manufacturing
332618	Other Fabricated Wire Product Manufacturing
332996	Fabricated Pipe and Pipe Fitting Manufacturing
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
Motor Vehicle Manufacturing	
327215	Glass Product Manufacturing Made of Purchased Glass
336111	Automobile Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing

NAICS	Description
336211	Motor Vehicle Body Manufacturing
336212	Truck Trailer Manufacturing
336214	Travel Trailer and Camper Manufacturing
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336390	Other Motor Vehicle Parts Manufacturing
Petroleum & Chemical Products	
324110	Petroleum Refineries
324121	Asphalt Paving Mixture and Block Manufacturing
324122	Asphalt Shingle and Coating Materials Manufacturing
324191	Petroleum Lubricating Oil and Grease Manufacturing
324199	All Other Petroleum and Coal Products Manufacturing
325130	Synthetic Dye and Pigment Manufacturing
325180	Other Basic Inorganic Chemical Manufacturing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing
325611	Soap and Other Detergent Manufacturing
325612	Polish and Other Sanitation Good Manufacturing
325613	Surface Active Agent Manufacturing
325620	Toilet Preparation Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
Polymers & Plastics Products	
325211	Plastics Material and Resin Manufacturing
325510	Paint and Coating Manufacturing
325520	Adhesive Manufacturing
325991	Custom Compounding of Purchased Resins
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing
326121	Unlaminated Plastics Profile Shape Manufacturing
326122	Plastics Pipe and Pipe Fitting Manufacturing
326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing
326140	Polystyrene Foam Product Manufacturing
326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing
326160	Plastics Bottle Manufacturing
326199	All Other Plastics Product Manufacturing
326212	Tire Retreading
326220	Rubber and Plastics Hoses and Belting Manufacturing
326291	Rubber Product Manufacturing for Mechanical Use
326299	All Other Rubber Product Manufacturing

Figure A-18: Gibson County Manufacturing Cluster Summary

Industry Subcluster	Employment, 2021	LQ, 2021	County Growth, 2017-21	Regional Growth, 2017-21	GRP, 2021 (Millions)
Motor Vehicle Manufacturing	9,306	69.62	29.5%	19.8%	$4,866
Electric/Electronic Products Manufacturing	341	3.38	-14.6%	-23.2%	$34
Food Processing and Manufacturing	220	0.94	77.6%	10.3%	$19
Polymers & Plastics Products	191	1.64	-16.5%	-10.6%	$20
Metal Machining and Finishing Services	156	1.58	9.1%	9.0%	$12
Machinery Manufacturing	74	0.63	-0.9%	12.5%	$7
Metals Manufacturing and Fabrication	51	0.36	59.4%	11.3%	$4
Petroleum & Chemical Products	30	0.48	-	46.5%	$29
Total Manufacturing Cluster	10,371	9.38	26.6%	7.7%	$4,990
Total Private Sector	19,451	1.00	3.0%	-2.0%	$6,212

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-19: Henderson County Manufacturing Cluster Summary

Subcluster	Employment, 2021	LQ, 2021	County Employment Change, 2017-21	Regional Employment Change, 2017-21	GRP, 2021 (Millions)
Metals Manufacturing and Fabrication	1,716	14.95	-7.1%	11.3%	$260
Food Processing and Manufacturing	1,656	8.69	-8.5%	10.3%	$171
Motor Vehicle Manufacturing	380	3.49	-20.1%	19.8%	$40
Polymers & Plastics Products	379	3.99	-15.4%	-10.6%	$52
Metal Machining and Finishing Services	302	3.76	2.5%	9.0%	$22
Machinery Manufacturing	285	2.96	-5.4%	12.5%	$24

Subcluster	Employment, 2021	LQ, 2021	County Employment Change, 2017-21	Regional Employment Change, 2017-21	GRP, 2021 (Millions)
Petroleum & Chemical Products	141	2.78	11.1%	46.5%	$25
Biomedical Manufacturing	3	0.04	-	14.7%	$1
Total Manufacturing Cluster	4,862	5.40	-8.3%	7.7%	$596
Total Private Sector	15,846	1.00	-7.0%	-2.0%	$1,785

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-20: Posey County Manufacturing Cluster Summary

Subcluster	Employment, 2021	LQ, 2021	County Employment Change, 2017-21	Regional Employment Change, 2017-21	GRP, 2021 (Millions)
Polymers & Plastics Products	900	20.15	-24.6%	-10.6%	$484
Petroleum & Chemical Products	790	33.30	45.4%	46.5%	$651
Metals Manufacturing and Fabrication	525	9.73	75.5%	11.3%	$84
Food Processing and Manufacturing	203	2.27	7.3%	10.3%	$61
Machinery Manufacturing	117	2.60	-7.9%	12.5%	$14
Metal Machining and Finishing Services	92	2.43	-1.3%	9.0%	$10
Total Manufacturing Cluster	2,627	6.21	7.4%	7.7%	$1,305
Total Private Sector	7,446	1.00	4.0%	-2.0%	$1,962

Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-21: Vanderburgh County Manufacturing Cluster Summary

Subcluster	Employment, 2021	LQ, 2021	County Employment Change, 2017-21	Regional Employment Change, 2017-21	GRP, 2021 (Millions)
Polymers & Plastics Products	4,916	8.60	-5.0%	-10.6%	$640
Food Processing and Manufacturing	2,821	2.46	14.3%	10.3%	$566
Metals Manufacturing and Fabrication	940	1.36	8.7%	11.3%	$93
Biomedical Manufacturing	806	1.63	19.8%	14.7%	$254
Metal Machining and Finishing Services	579	1.20	9.6%	9.0%	$71
Machinery Manufacturing	465	0.80	-1.8%	12.5%	$58
Electric/ Electronic Products Manufacturing	332	0.67	3.4%	-23.2%	$46
Motor Vehicle Manufacturing	297	0.45	-59.7%	19.8%	$35
Petroleum & Chemical Products	63	0.21	49.8%	46.5%	$22
Total Manufacturing Cluster	11,219	2.07	-0.6%	7.7%	$1,786
Total Private Sector	95,290	1.00	-3.2%	-2.0%	$10,493

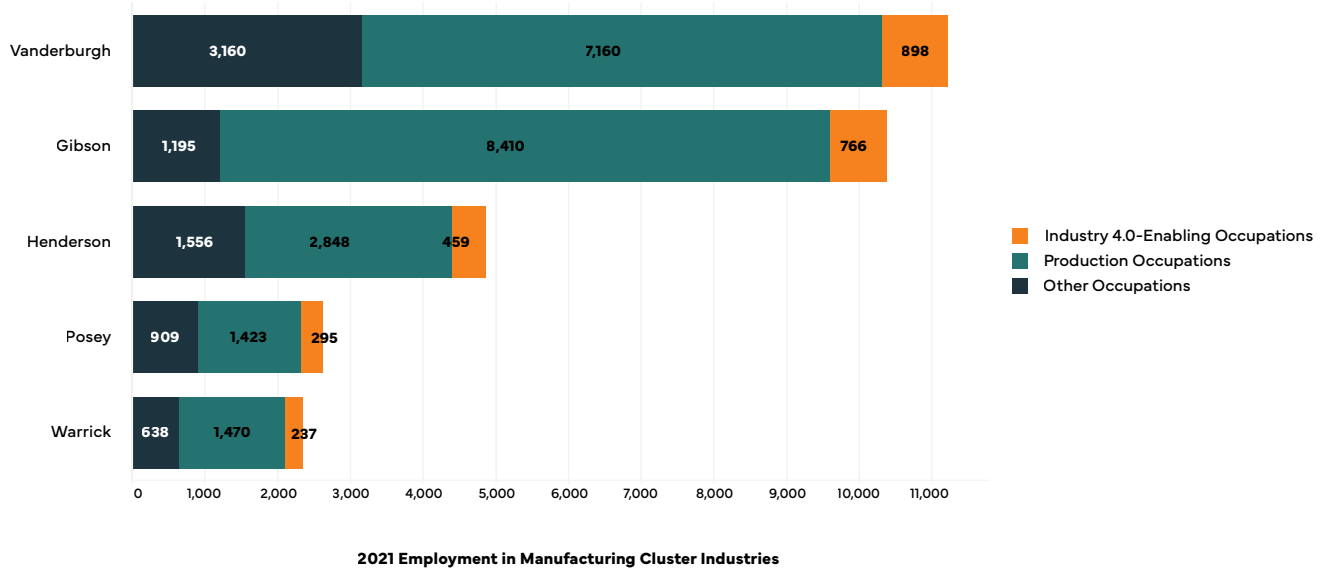
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-22: Warrick County Manufacturing Cluster Summary

Subcluster	Employment, 2021	LQ, 2021	County Employment Change, 2017-21	Regional Employment Change, 2017-21	GRP, 2021 (Millions)
Metals Manufacturing and Fabrication	1,035	9.98	30.8%	11.3%	$209
Food Processing and Manufacturing	400	2.32	86.1%	10.3%	$50
Machinery Manufacturing	311	3.58	127.1%	12.5%	$43
Electric/ Electronic Products Manufacturing	180	2.42	-53.9%	-23.2%	$54
Polymers & Plastics Products	159	1.85	-42.0%	-10.6%	$19
Motor Vehicle Manufacturing	125	1.27	217.9%	19.8%	$10
Metal Machining and Finishing Services	99	1.37	47.6%	9.0%	$10
Petroleum & Chemical Products	20	0.43	-	46.5%	$8
Biomedical Manufacturing	15	0.20	-67.5%	14.7%	$2
Total Manufacturing Cluster	2,345	2.88	19.6%	7.7%	$405
Total Private Sector	14,325	1.00	3.3%	-2.0%	$1,820

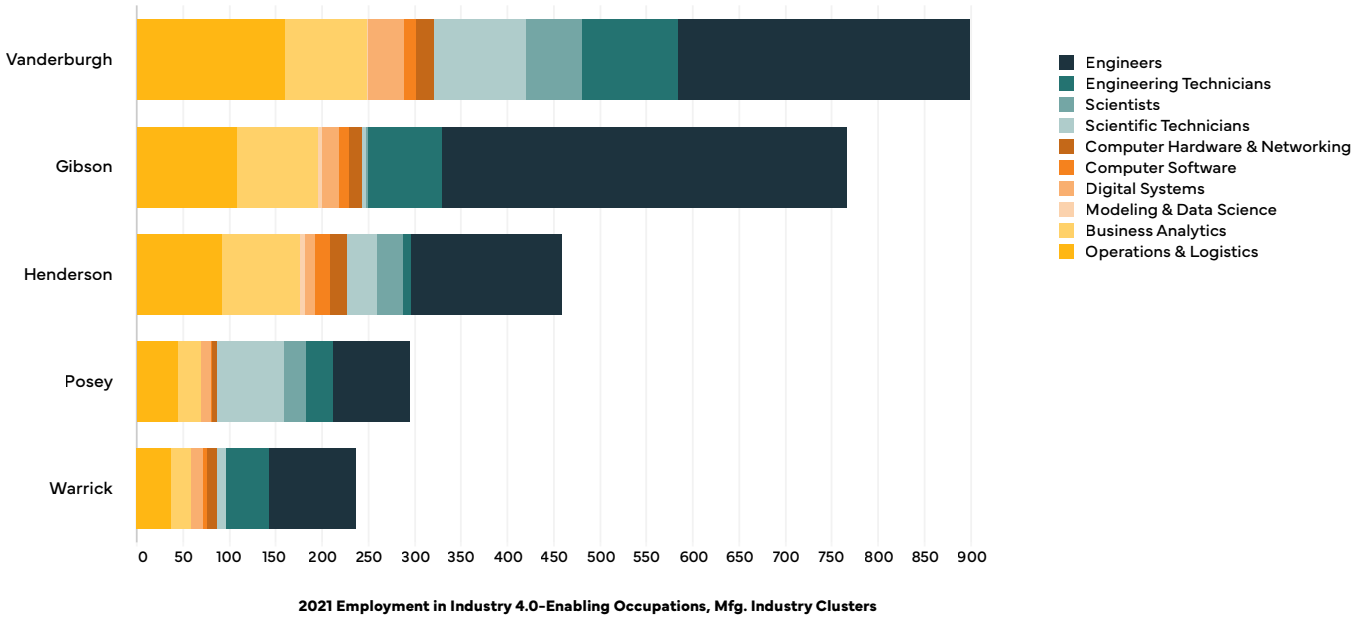
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-23: Industry 4.0-Enabling Occupational Share by County



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

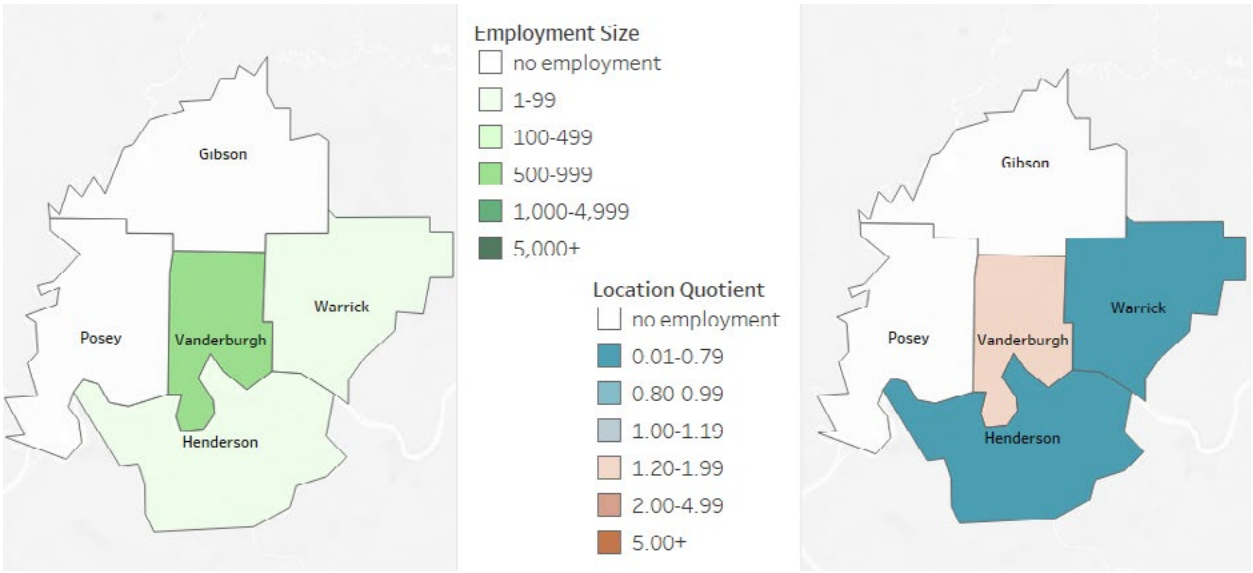
Figure A-24: Detailed Industry 4.0-Enabling Occupational Employment by County



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

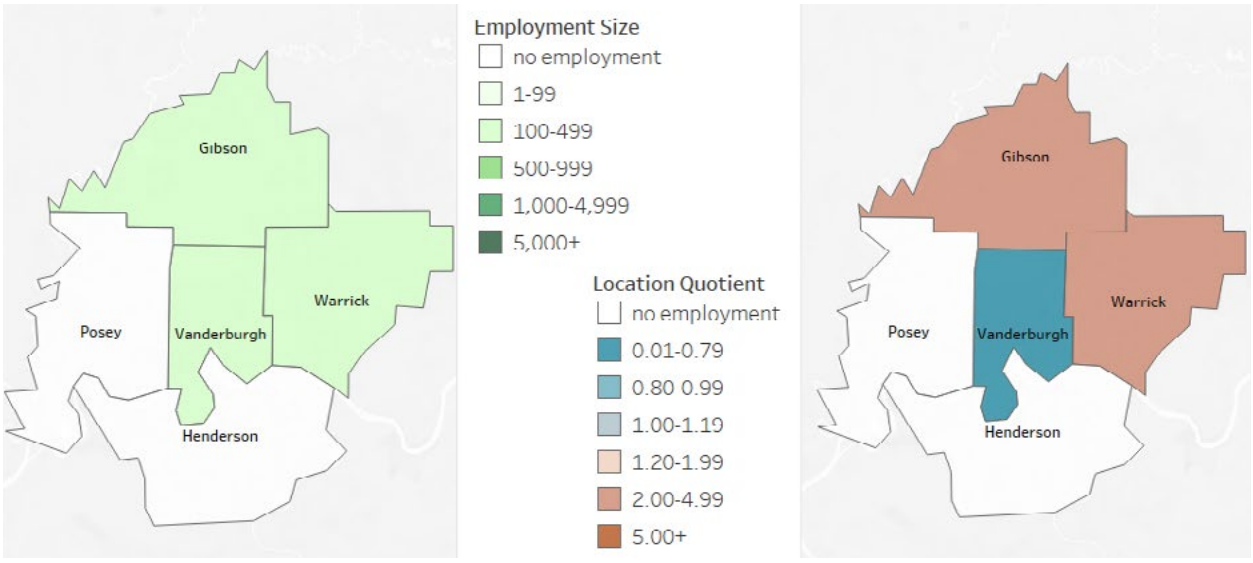
Manufacturing Subcluster Employment Size and Concentration by County

Figure A-25: Biomedical Manufacturing



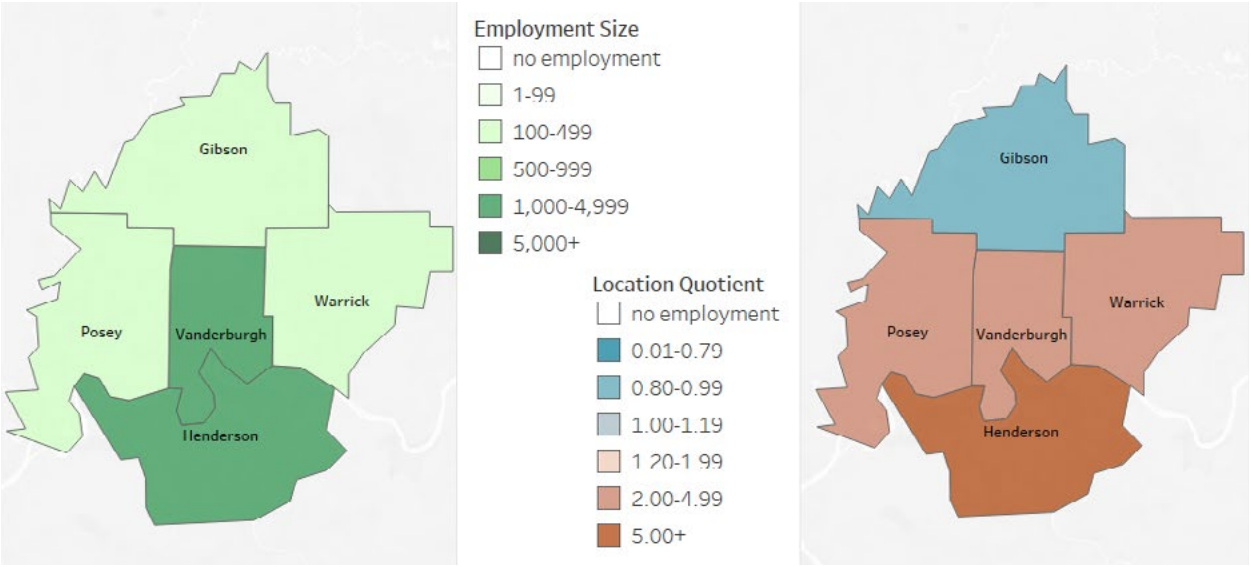
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-26: Electric/Electronic Products Manufacturing



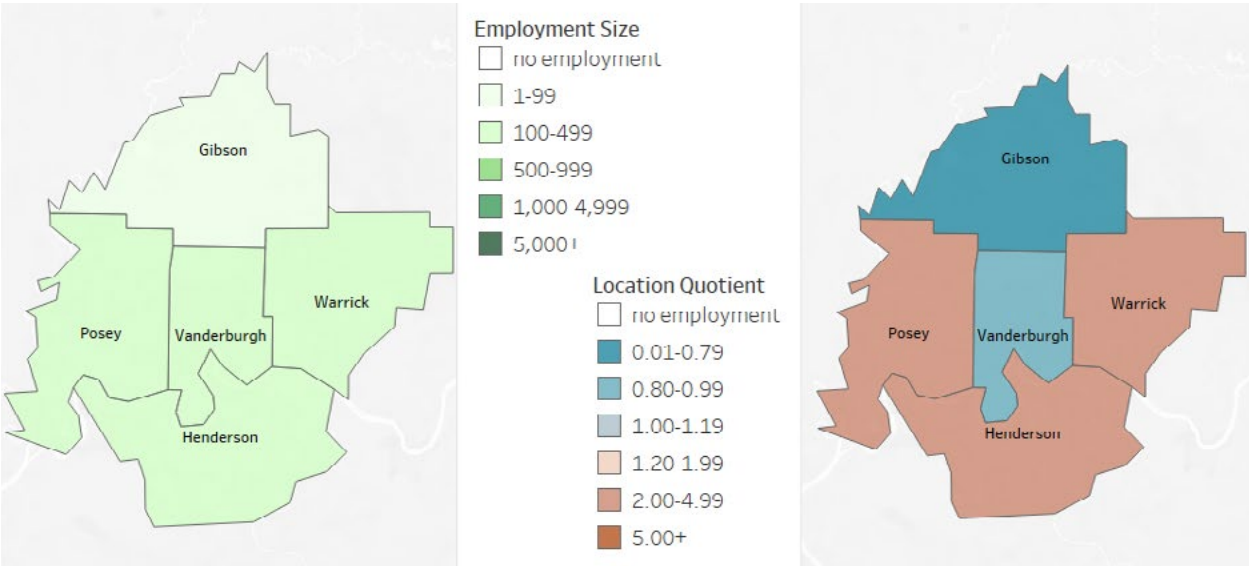
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-27: Food Processing & Manufacturing



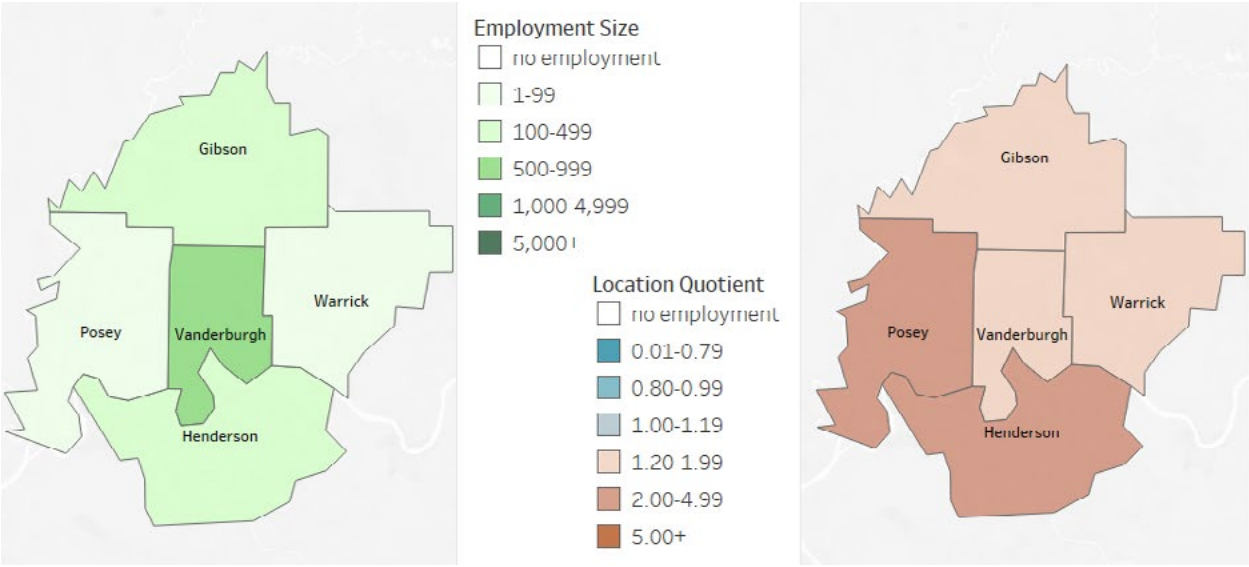
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-28: Machinery Manufacturing



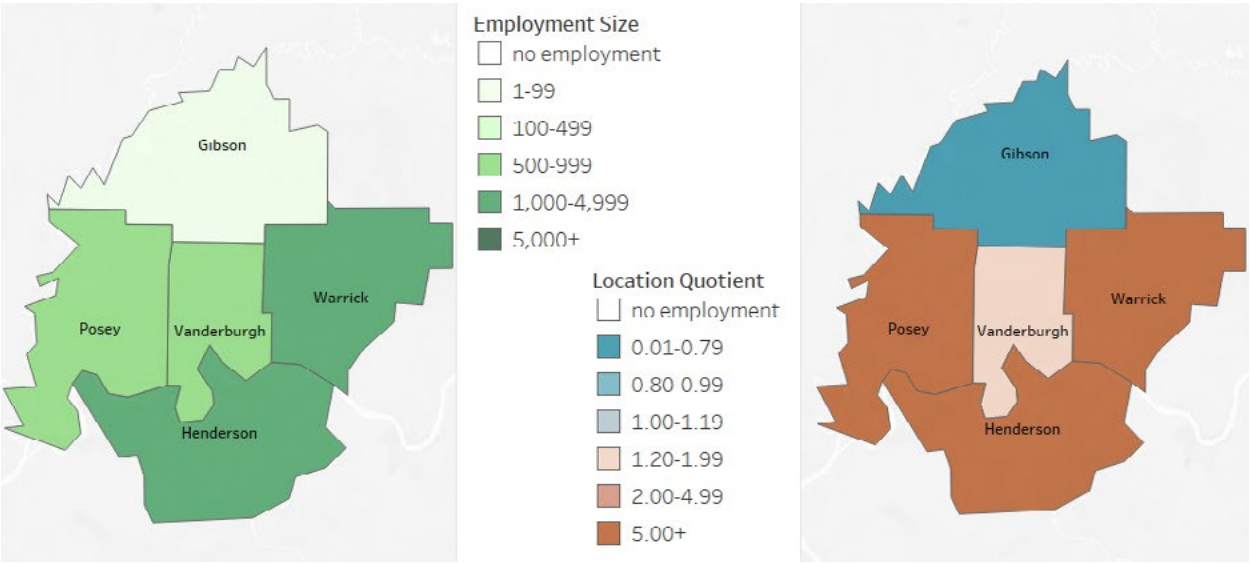
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-29: Metal Machining & Finishing Services



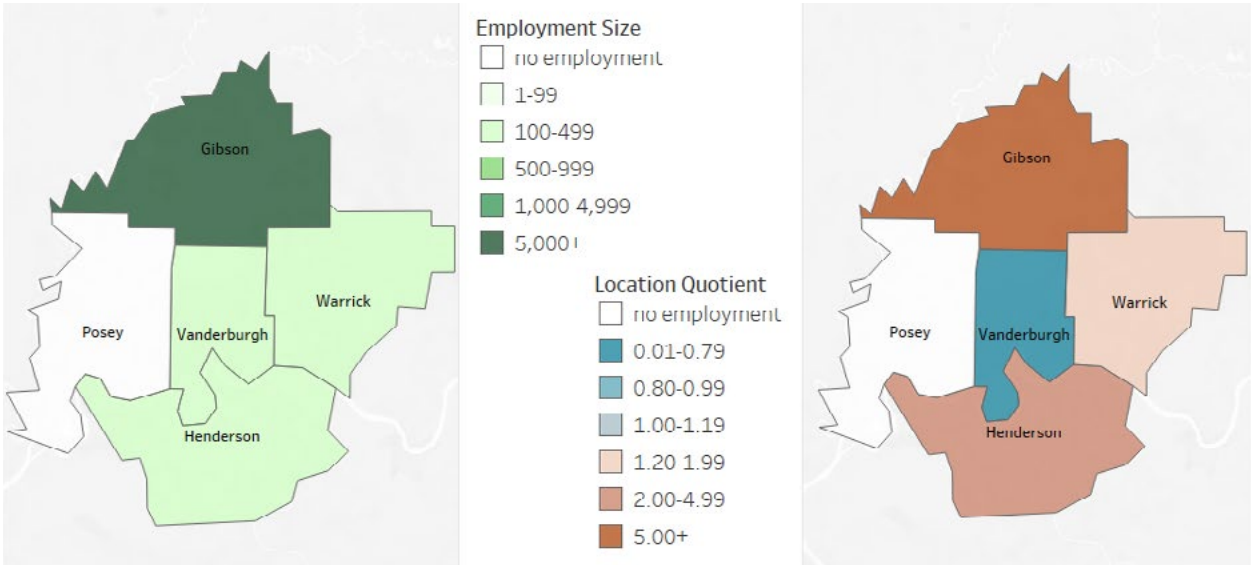
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-30: Metals Manufacturing & Fabrication



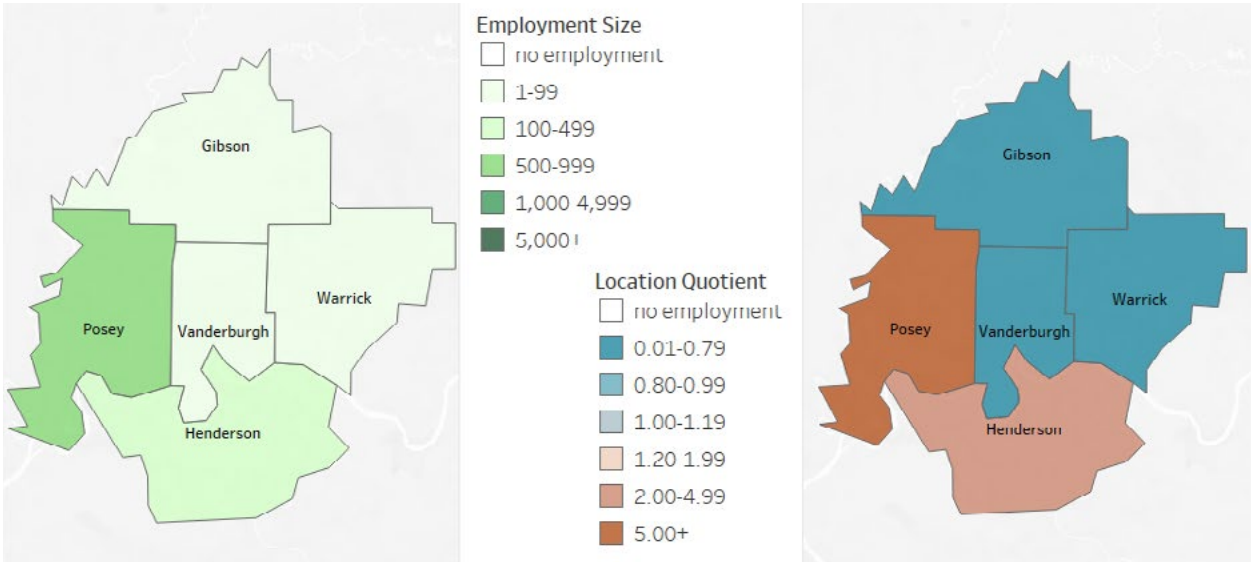
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-31: Motor Vehicle Manufacturing



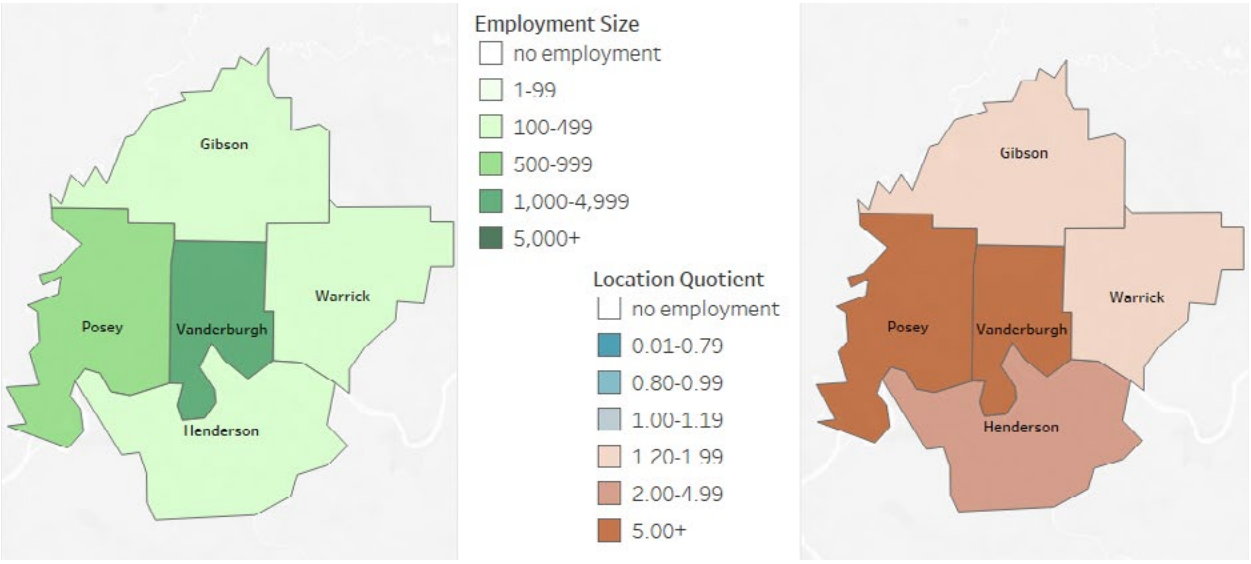
Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-32: Petroleum & Chemical Products



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

Figure A-33: Polymers & Plastics Products



Source: TEConomy's analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2023.1)

APPENDIX B: SURVEY ANALYSIS

Respondent Demographics

This survey encompassed manufacturing companies operating in Evansville, Indiana. Across a variety of industry sectors and company sizes, 67 respondents were recorded in the following survey. A wide range of industry groupings and company sizes are represented in this survey. Companies were divided between 7 industry subclusters, 7 employee-based sizes, and 4 company ages.

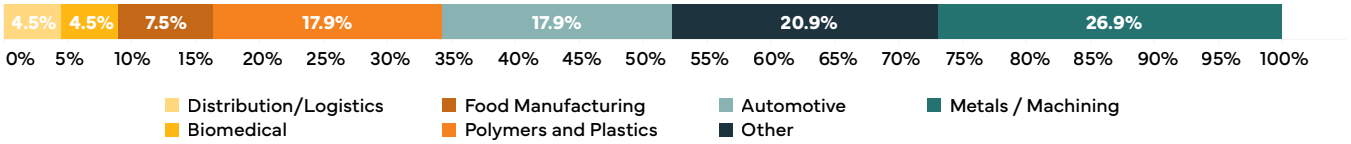
Firstly, respondents were separated by self-selecting into the following manufacturing industry subgroupings:

- Automotive / Motor Vehicle Manufacturing
- Polymers / Plastic Products
- Petroleum and Other Non-Polymer Chemical Products
- Food/Beverage Processing and Manufacturing
- Metals Production / Metals Fabrication
- Metal Machining and Finishing Services
- Machinery and Equipment Manufacturing
- Biomedical / Pharmaceuticals / Medical Devices
- Distribution / Warehousing / Logistics
- Other Manufacturing

Respondents were offered the distinction between Metals Production / Metals Fabrication, Metal Machining & Finishing Services, and Machinery & Equipment Manufacturing, but were ultimately combined into one category: Metals / Machining. Additionally, the Petroleum & Other Non-Polymer Chemical Products selection was combined with the Other Manufacturing and Other selections. (See Figure 1)

The two largest subgroupings that responded to this survey were the Metals / Machining grouping and the Automotive grouping, totaling 48% of all respondents at 32 distinct companies. Additionally, the biomedical sector is unique in that respondents were made up of only one company, which may skew sector-related conclusions. Despite this, a statistically acceptable representation of available manufacturing industries in Evansville is present.

Figure B-1: Survey Respondents by Industry Subcluster



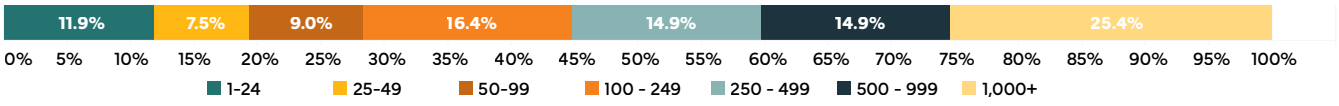
Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Secondly, respondents were distinguished by company size, which was evaluated using the number of full-time employees on payroll as of December 31, 2022. In following analysis and visualizations, the following response combinations were made:

- Companies with 1-24 employees and 25-49 employees are categorized as "Small Companies."
- Companies with 50-99 employees, 100-249 employees, and 250-499 employees are categorized as "Medium Companies."
- Companies with 500-999 employees and 1,000+ employees are categorized as "Large Companies."

Respondents are more evenly split by number of employees, with the largest companies making up the largest portion of the surveyed (See Figure 2). As a result of the compression of sizes into 3 distinct buckets, large companies make up more than 40% of the respondent base at 27 respondent companies. To reduce the biases inherent in such proportions, certain questions are also broken down by company size (notably, Table 1). Regardless, a wide variety of company sizes are present in this survey and are able to provide multifaceted perspectives.

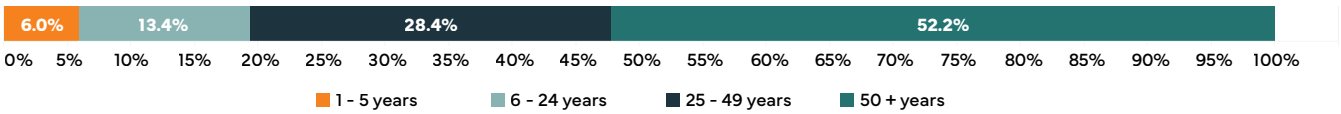
Figure B-2: Survey Respondents by Number of Employees



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Finally, respondents were additionally separated by company age. Defined as the number of years the company has been in business, a strong majority of respondent companies were established before the year 2000, with more than 50% of respondents reporting being in business for more than 50 years (See Figure 3).

Figure B-3: Survey Respondents by Years in Business



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Overall, the average company surveyed is somewhat large, established, and is involved in relatively heavy manufacturing. In attempts to better adapt to technological changes and remain competitive in the face of global manufacturing growth, this survey is focused distinctly on ascertaining the current state of affairs in this regional sector.

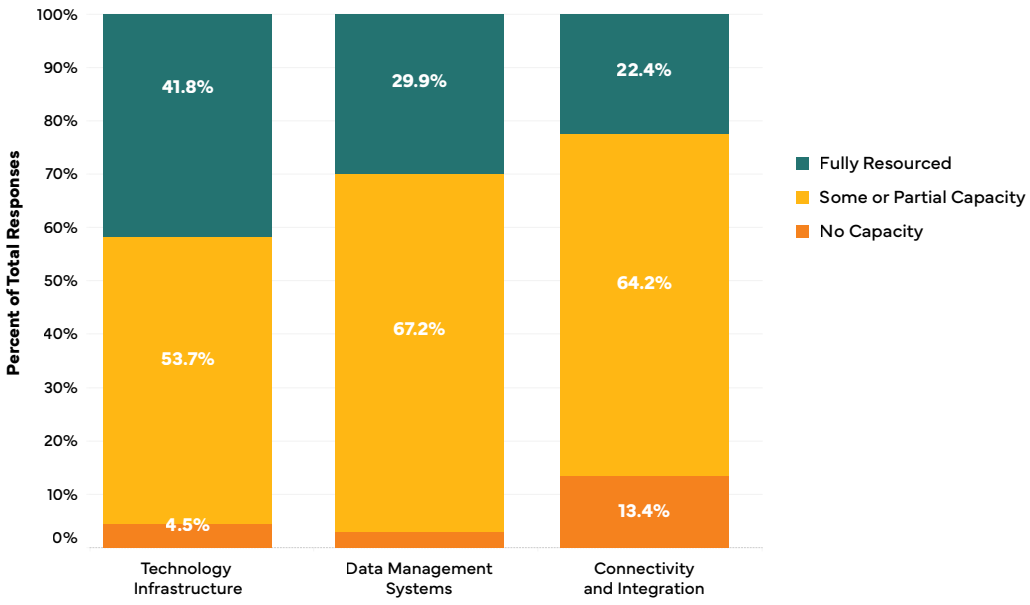
Industry 4.0 Perceptions and Preparedness

Respondents were asked to estimate their company's capacity in the following technological areas:

- Technology Infrastructure
- Data Management Systems
- Connectivity and Integration

Surveyed companies are broadly at least somewhat prepared for the adoption of new technologies, with more than 90% of companies reporting at least a basic level of capacity for Technology Infrastructure and Data Management Systems. Very few companies reported having zero capacity in any of the three categories, but Connectivity and Integration lagged with 13.4% of companies reporting a total lack of capacity. On the other hand, general Technological Infrastructure had 41.8% of respondents reporting a full capacity or a fully resourced ability to implement new technologies (See Figure 4).

Figure B-4: Technology-readiness (physical capacity) by technology

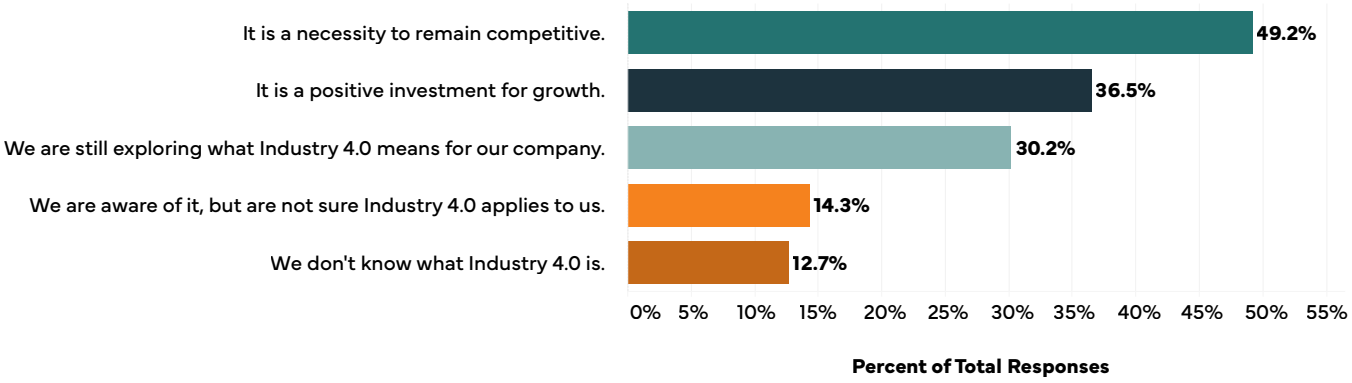


Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

General attitudes concerning Industry 4.0 are very positive (See Figure 5). Half of respondents (49.2%) value 4.0 technologies as a necessity in order to remain competitive, and a further 36.5% of respondents view the technology as a positive investment vehicle. Few companies are either unsure of its efficacy (14.3%) or are unaware of the technology as a whole (12.7%).

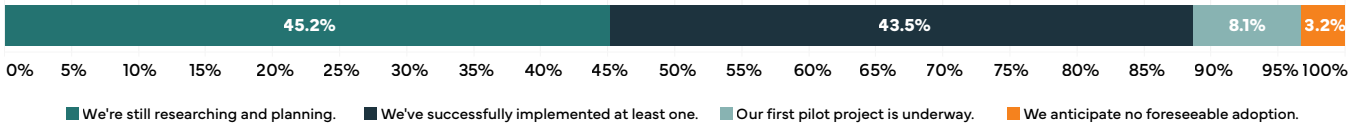
Almost every company is interested in adopting Industry 4.0 technologies, with a large subset (43.5%) of respondents already successfully implementing technologies, and nearly half (45.2%) of respondents actively exploring and research implementation plans. An additional 8% of respondents are even currently undergoing a pilot project for implementation (See Figure 6).

Figure B-5: How Industry 4.0 is Perceived Within Companies



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Figure B-6: Level of Interest in Adopting 4.0 Technologies



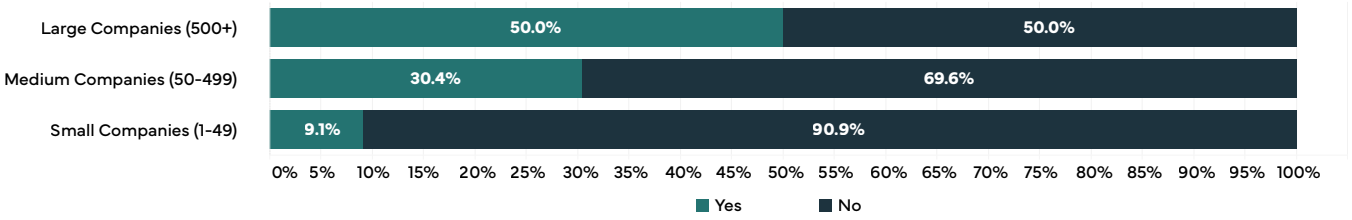
Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Few companies have a dedicated budget for adopting and implementing 4.0 technologies. Only 35% (21 companies) reported having an explicit budget. Additionally, smaller companies are far more unlikely to have a budget, with more than 90% of small company respondents reporting negatively. Even in large companies, however, dedicated budgets remain rare, with only 50% (13 companies) of large company respondents reporting positively (See Figure 7).

Of those, only 4 companies were able to say with confidence that their 4.0 adoption budget was larger than 1% of total revenue. For reference, the average RnD budget for American tech companies stands at 11.4% of revenue. Notably, a supermajority of responses (71.4%) self-reported being either unsure of their budget

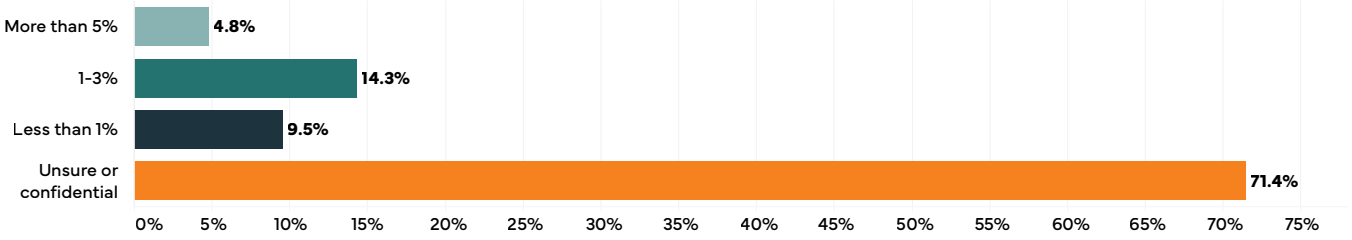
allocation or that the budget itself was confidential (See Figure 8). As a result, the explicit answers that were received remain somewhat statistically unreliable.

Figure B-7: Presence of Dedicated 4.0 Implementation Budget



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

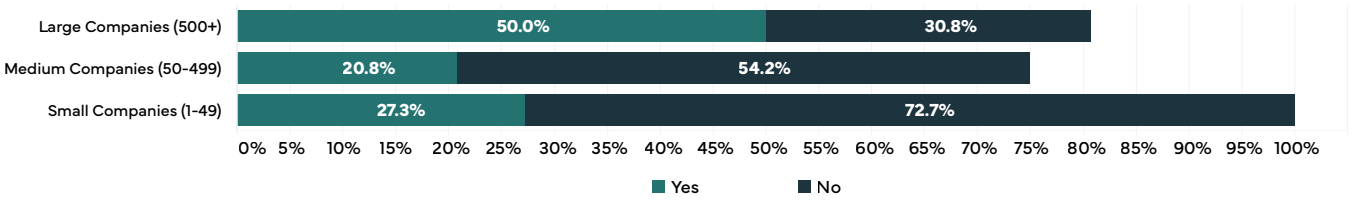
Figure B-8: Percentage of Revenue Allocated to 4.0 Implementation Budget



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Respondents were also asked if, in replacement of or in addition to an implementation budget, there existed a leader or team dedicated to easing the transition to Industry 4.0 technologies (See Figure 9). Leadership remains comparably uncommon to dedicated budgets. Small companies especially do not often have leadership dedicated to 4.0 implementation, but also reported higher numbers of explicit leadership (27.3%) than medium companies (20.8%). Unsure responses were hidden from the following figure for the sake of clarity in meaning.

Figure B-9: Presence of 4.0 Implementation Leader



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

4.0 Implementation

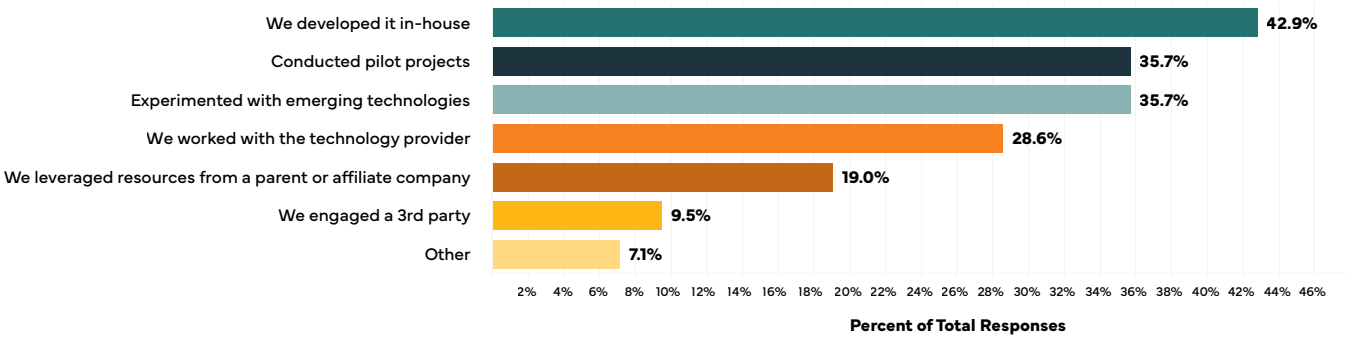
Respondents were asked to discuss both the origin of their company's interest in Industry 4.0 technologies and their current approach to implementation. Respondents reported that companies:

- Developed the technology internally (42.9%)
- Conducted either experiments (35.7%) or pilot projects (35.7%) to ascertain its use
- Worked with an external force, either a technology provider (28.6%) or through a parent or partner company (19%), with fewer reporting usage of an unrelated 3rd party (9.5%)

Note that respondents were allowed to select multiple responses for this question (See Figure 10), so overlapping meaning may have and likely did occur.

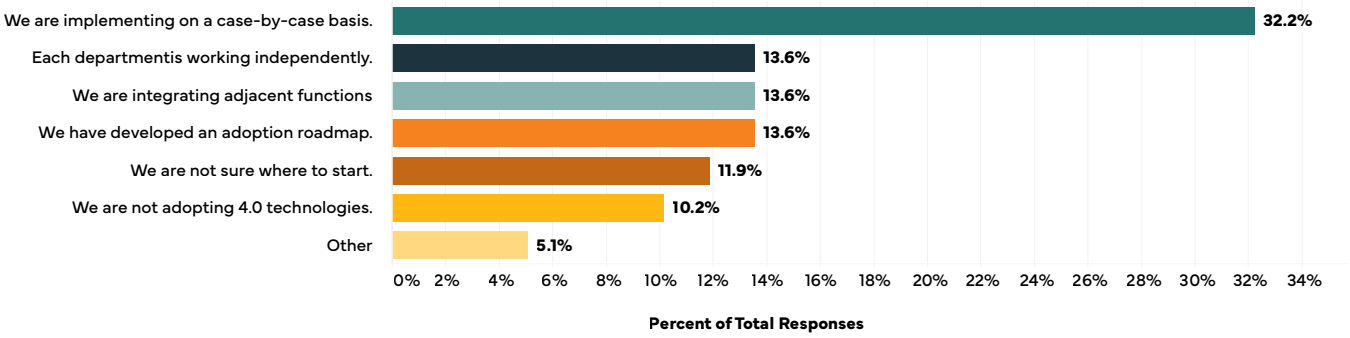
Once an interest in 4.0 technologies was established, respondents were asked about their current implementation plan (See Figure 11). Few companies (13.6%, or 8 companies) reported having a defined strategy and overall plan. Most companies are taking implementation on a case-by-case basis (32.2%) or is allowing departments to research and work on adoption independently (13.6%). It is uncertain whether this freedom is an attempt at optimizing the initial adoption of technologies to departments that would benefit the most, or if leadership is uncertain as to a specific direction of adoption. That being said, only 10% of surveyed respondents had no plans to adopt 4.0 technologies.

Figure B-10: Origin of 4.0 Technology Interest



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Figure B-11: Respondent Approaches to 4.0 Technology Adoption

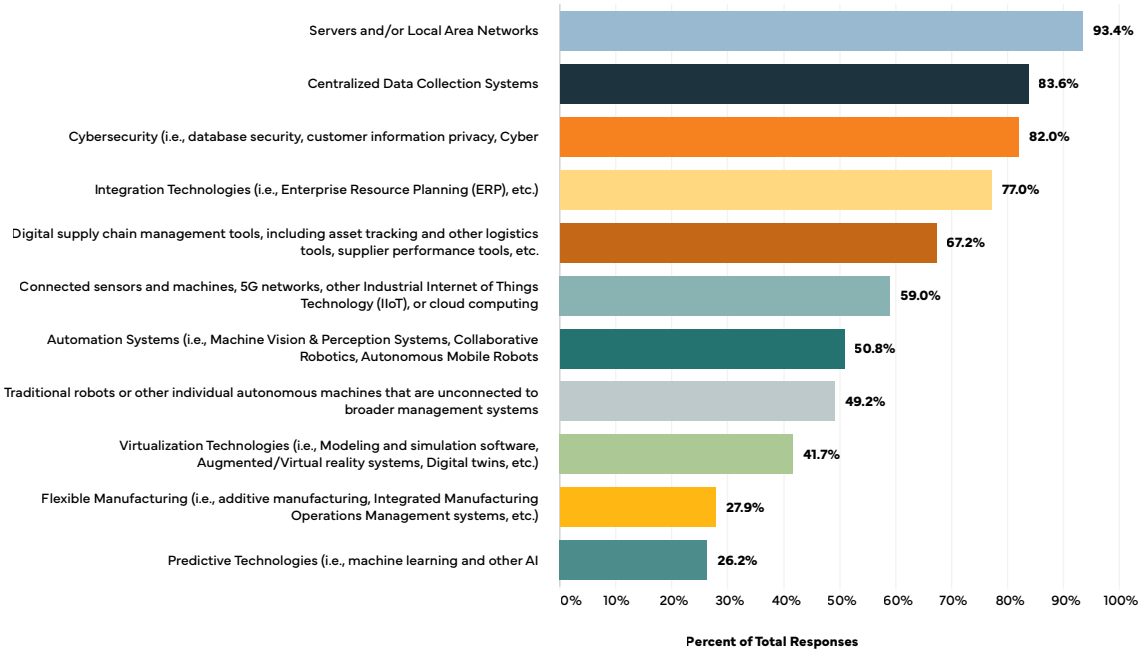


Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Before discussing Industry 4.0 specifically, respondents were asked to describe the level of general technological integration with manufacturing operations by defining which technologies are in use (See Figure 12). In general, most companies have implemented technologies that bring benefits inherently without necessitating a production overhaul:

- Data and cyber infrastructure have been implemented by nearly all companies (more than 80% of companies utilize data servers, networks, data collection systems, and manage cybersecurity)
- Digitalization and digital management are less common, but are still present in the majority of surveyed companies (more than 60% report using digital supply chain management and resource planning tools)
- Preliminary automation is already present in nearly a majority of the surveyed companies (more than 50% report using integrated and automatic sensors, computing, and robotic systems)

Figure B-12: Technologies Previously Implemented into Company Operations



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

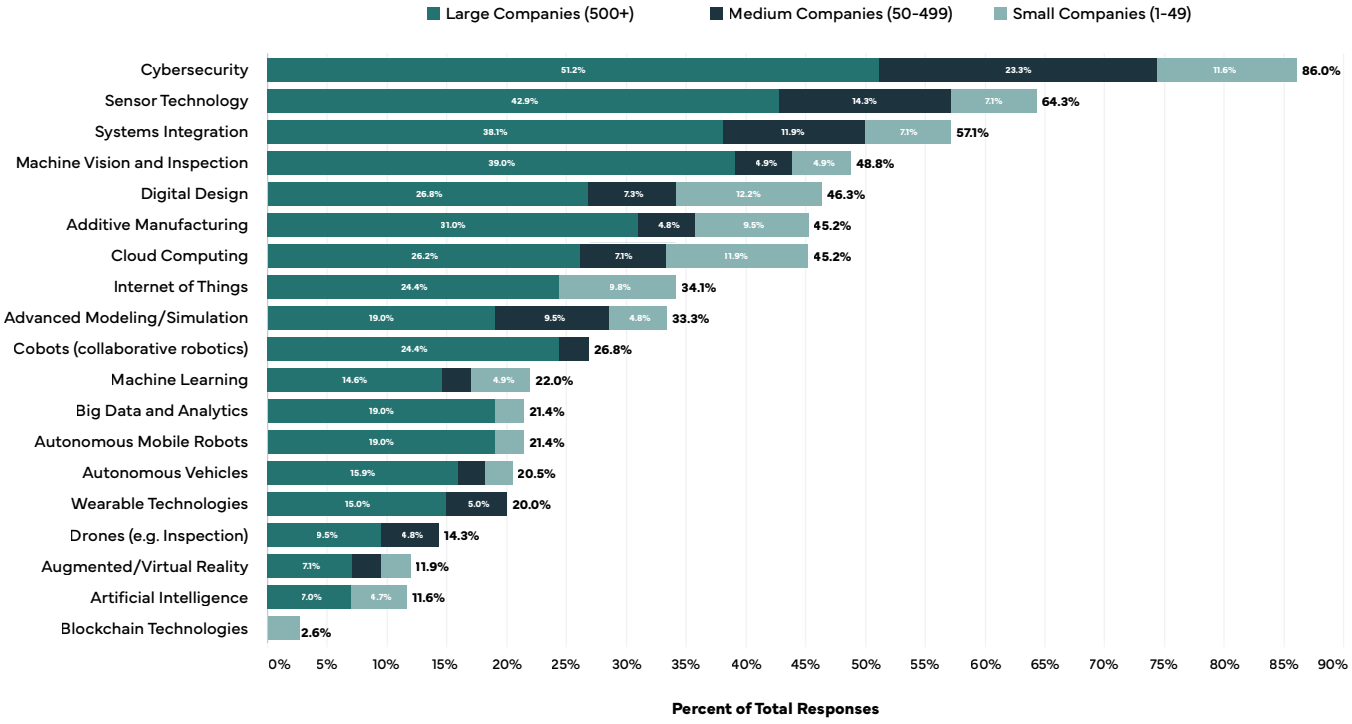
Following general technologies, respondents were asked to describe the level of Industry 4.0 technology implementation (See Figure 13). Notably, certain 4.0 technologies exist as extensions of digital infrastructure that has been developing over the last 3 decades; as a result, most companies have already implemented certain 4.0 technologies into their operations, including:

- Cybersecurity measures (86%)
- Automatic sensors (64.3%)
- General systems integration (57.1%).

Large companies are more ahead of the curve than medium and small in nearly every technology reported. The gap is especially evident in newer technologies, including:

- Additive manufacturing (31% of positive respondents were large companies vs. a combined small and medium response of 14.3%)
- Big Data (19% vs. 2.4%) and IoT (24.4% vs. 9.8%)
- Machine-based inspection (39% vs. 9.8%)

Figure B-13: Industry 4.0 Technologies Implemented Prior to 2023



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Goals and Barriers

Respondents were asked to define strategic objectives for implementing 4.0 technologies and were give the ability to discriminate between Primary and Secondary objectives (See Figure 14). Results did not vary heavily between industry subgroup nor company size; nearly all companies want to decrease costs (83.7%) and most want to increase product quality (65.1%) and production efficiency (62.8%).

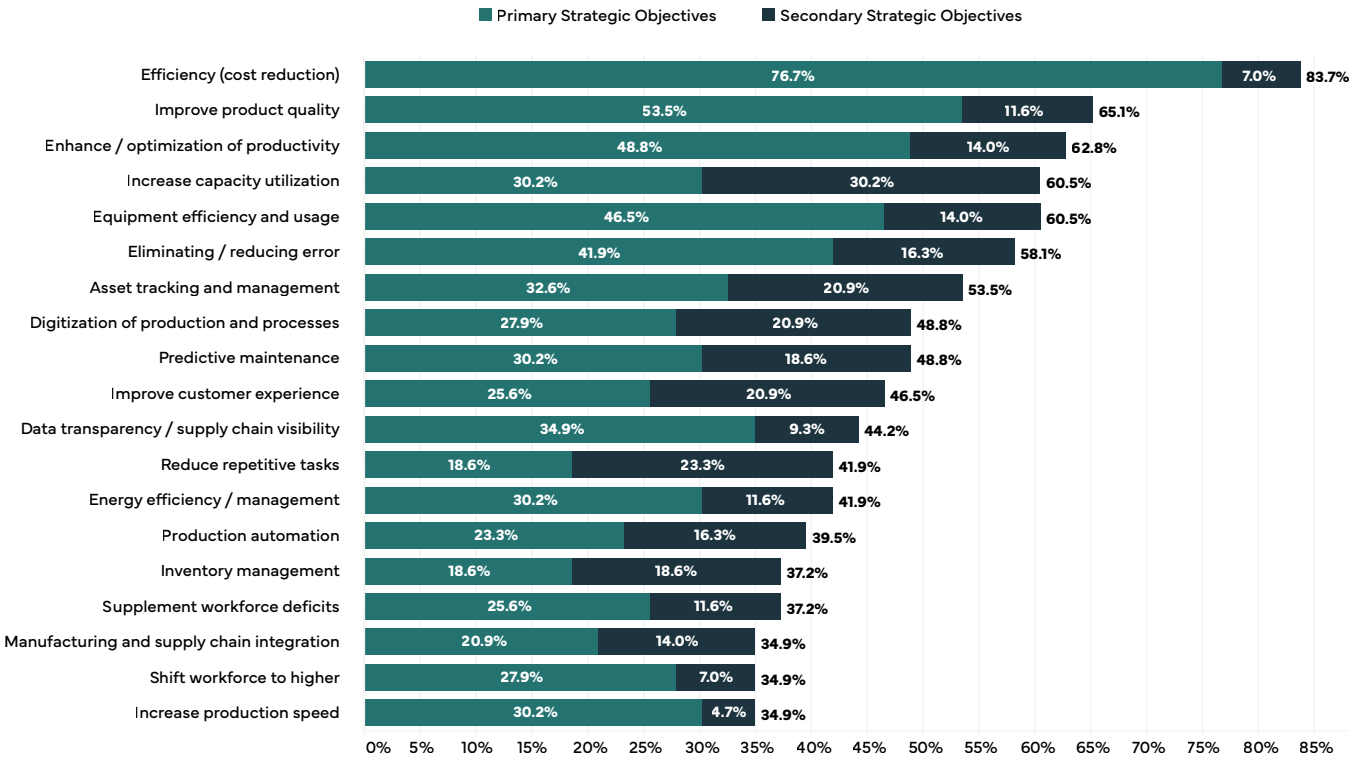
Notably, although most responses provided an approximately similar proportion between "primary" and "secondary" definition (at a bit more than a 2-to-1 ratio), cost reduction retained 76.7% as a primary objective of a total 83.7%. Additionally, the capacity utilization capabilities selection is notable for the inverse; only 50% of respondents (30% of a total 60%) defined the objective as "primary."

Uncommon strategic objectives, not displayed in the following figure, included the following objectives:

- Speed of decision making (23.3%)
- Product customization (21%)
- Add additional shifts (21%)
- Reduce positions (14%)

The unpopular options may be as telling as the reported priorities. Companies do not appear to be seeking to replace workers with new technologies, but rather enhance the production capabilities that are already in place.

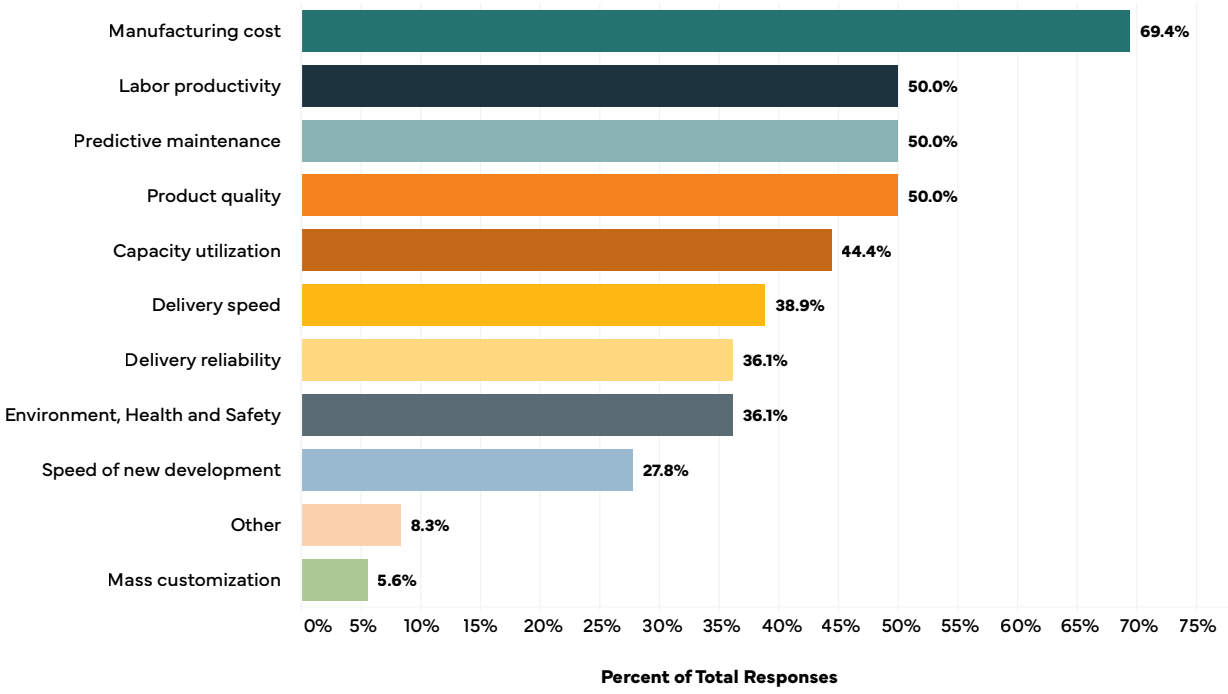
Figure B-14: Strategic Objectives for Adopting Industry 4.0 Technologies



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Respondents who have already begun implementing 4.0 technologies were asked about the perceived gains to operations (See Figure 15). Industry 4.0 technology adoption seems to be having the expected (and desired) effect; a large portion of respondents report a reduction in manufacturing cost (69.4%), and an increase in labor productivity (50%). Because respondents were only asked about gains to operations if they have already adopted one or more 4.0 technologies, the total amount of respondents numbered only 36 for the following figure.

Figure B-15: Gains to Operational Performance Related to 4.0 Technology Adoption



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

When asked about the main barriers to adopting Industry 4.0 technologies, companies primarily cited cost barriers (56.9%) and talent gaps (54.9%). Secondary concerns involved fears of implementation conflicts with legacy systems (47.1%) and internal resistance concerning business priorities (45.1%).

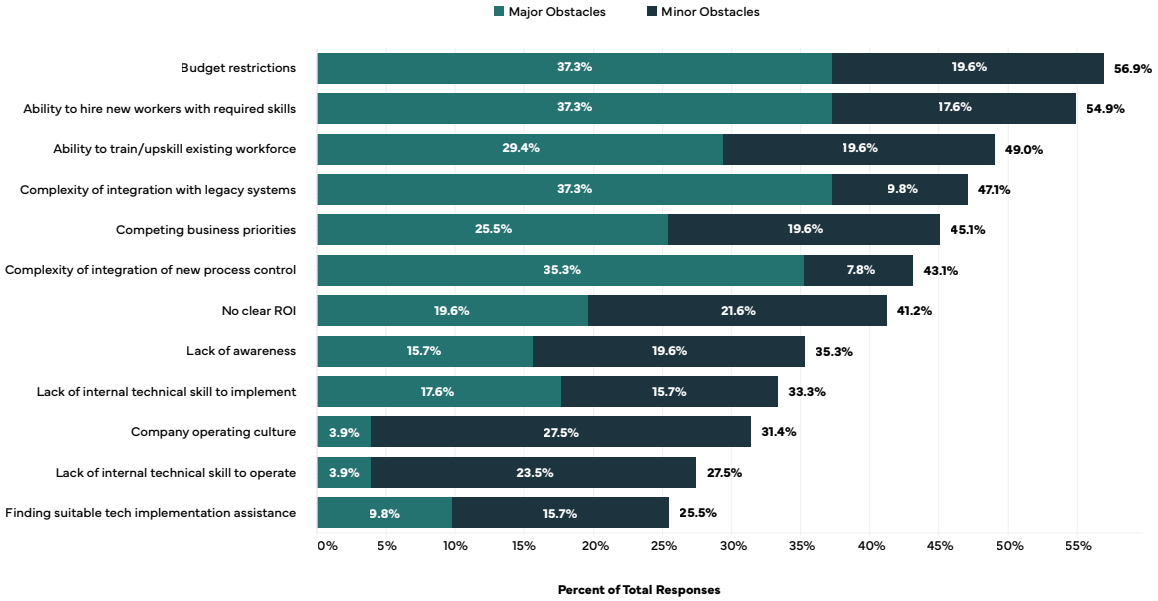
Notable uncommon responses include the following:

- Security concerns (23.5%, more than half of which labeled a "minor" concern)
- No perceived need for technology (19.6%)
- Worker hesitancy (13.7%)

Importantly, although budget restrictions topped respondents' concerns with regard to 4.0 technology implementation at nearly 60%, the barrier is nearly nonexistent in larger companies. The top barriers (if enough responses were available in each strata) for each industry subgrouping, split by company size, has been additionally compiled to showcase the stark difference in priority and concern (See Table 1).

Differences in priorities were defined strongly by company size. Large companies were consistently concerned with talent gaps and either recruiting or upskilling a workforce capable of implementing and engaging the technology. Small and medium-sized companies were consistent in their budgetary constraints. Large and medium companies shared secondary concerns about implementation barriers, such as conflicts with legacy systems.

Figure B-16: Obstacles to 4.0 Technology Adoption and Implementation



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Table B-1: Key Barriers by Industry Subgrouping and Company Size

Subgrouping x Size	Large Companies (500+)	Medium Companies (50-499)	Small Companies (1-49)
Automotive	Workforce Implementation Concerns		
Biomedical	Workforce Implementation Concerns		
Distribution / Logistics	Workforce	Budget No Clear ROI	
Food Manufacturing	Workforce No Clear ROI		Budget Workforce
Metals / Machinery	Workforce Implementation Concerns	Budget	Workforce
Polymers and Plastics	No Clear ROI	Implementation Concerns	Budget
Other		Budget Implementation Concerns	Budget

Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Available Resources

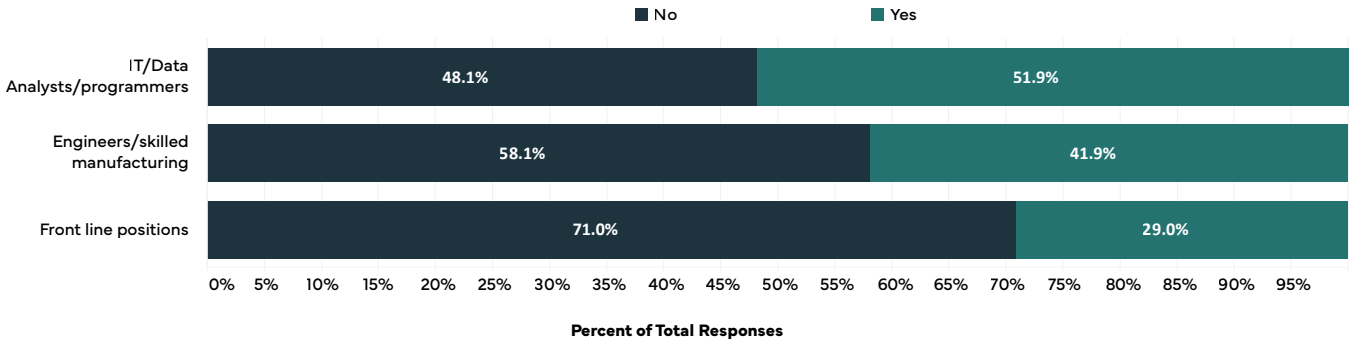
When asked about the types of education programming would be best benefit their workforce, companies responded generally in favor of broad, introductory-level educational classes, with secondary preference for data literacy and general cybersecurity hygiene. [I don't personally think is worth adding the graphic in for, but the transition seems abrupt into talent]

Respondents were asked whether the talent supply within a reachable area fulfilled their needs for a variety of positions, including:

- IT and programming positions
- Engineers and skilled manufacturers
- Front-end workers

All companies, across industry subgrouping and company size, reported significant talent gaps across all positions and all levels of company (see Figure 17). Interestingly, customer-facing talent is currently in shortage more than skilled programmers, though even the most abundant talent pools fulfills only 51.9% of surveyed companies' needs.

Figure B-17: Presence of Sufficient Talent Supply by Position



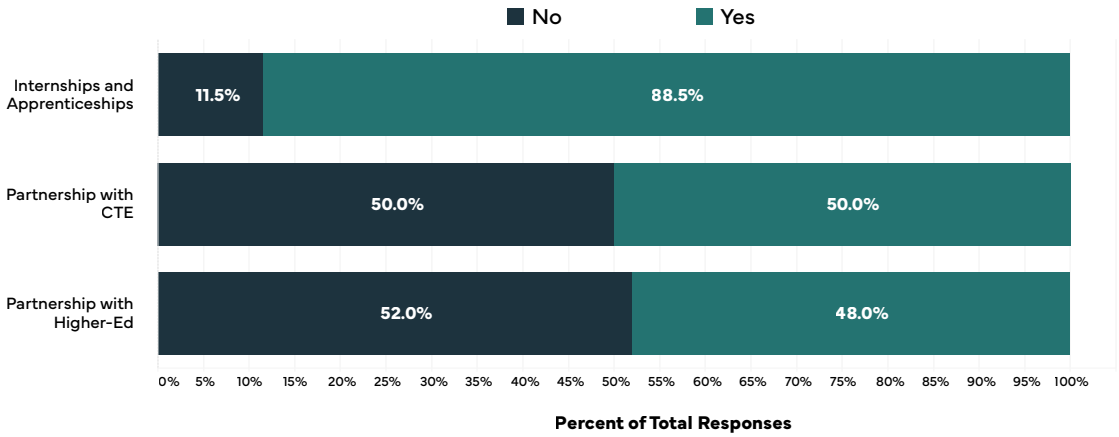
Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Employers do not require specific credentials for positions, for both skilled and unskilled, other than general (or in the case of skilled positions, specialized) experience and a college degree, depending on the position.

In order to fill this talent gap, nearly all companies do work to offer training and apprenticeship opportunities (88.5% of companies responded positively), but only about half work with educational institutions (46.2%) (See Figure 18).

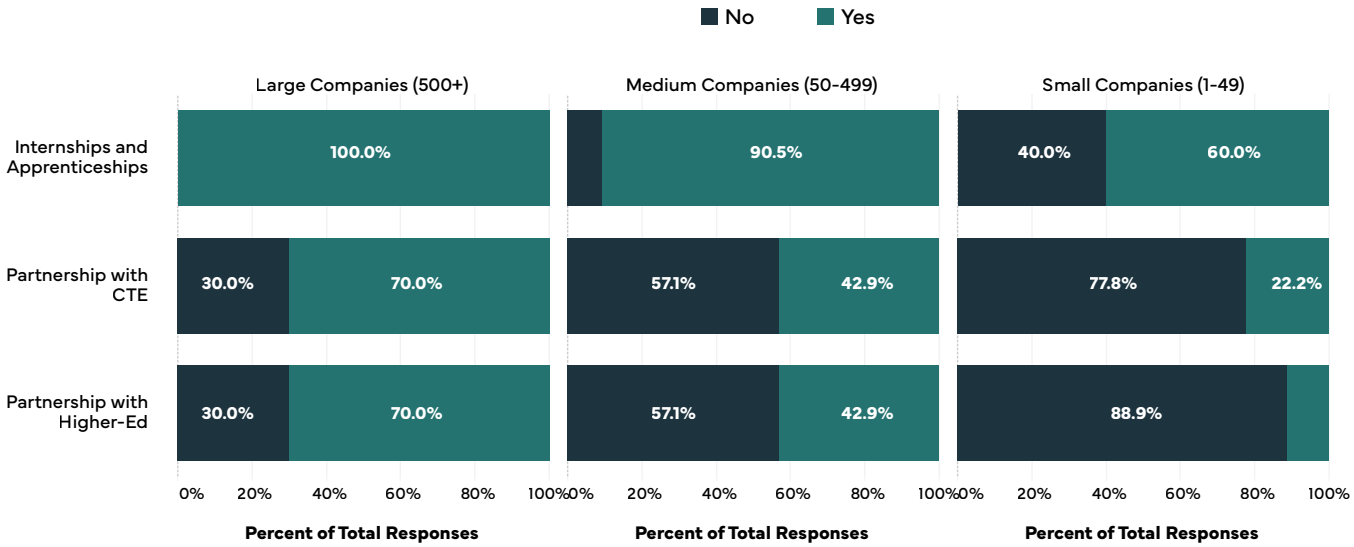
However, large companies make up the majority of partnerships with CTE (70% of large companies) and higher education institutions (70% of large companies). The gap is exacerbated by a nearly complete lack of partnerships on the small company-size (less than 25% work with CTE and less than 10% work with education institutions). Medium companies report more partnerships than small companies, but they remain a minority (See Figure 19).

Figure B-18: Company Efforts to Bridge the Talent Gap Through Training and Partnerships



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Figure B-19: Company Efforts to Bridge the Talent Gap by Company Size



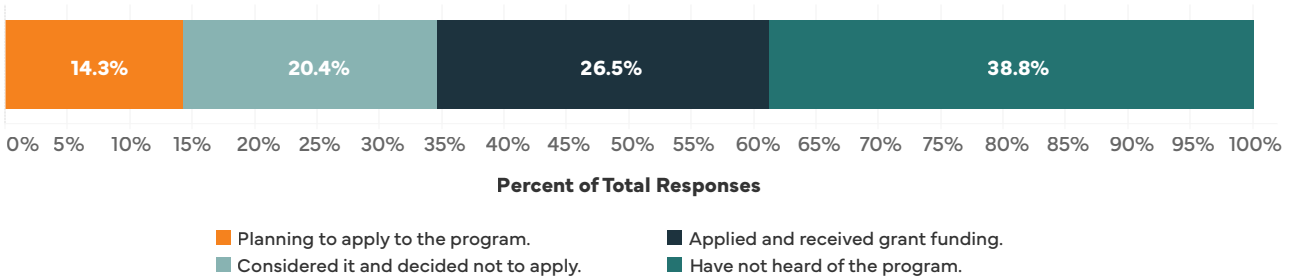
Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

In terms of other resources, respondents were asked about their awareness of and participation in Manufacturing Readiness Grants (See Figure 20) and Purdue MEP Partnerships (See Figure 21).

Most companies do not utilize Manufacturing Readiness Grants, with nearly 40% responding that they had not heard of the program at all. However, of the 26.5% of respondents (13 companies) that have applied and received funding, 91.7% report positive results, including that the grant accelerated the timeline of their project or enabled its existence.

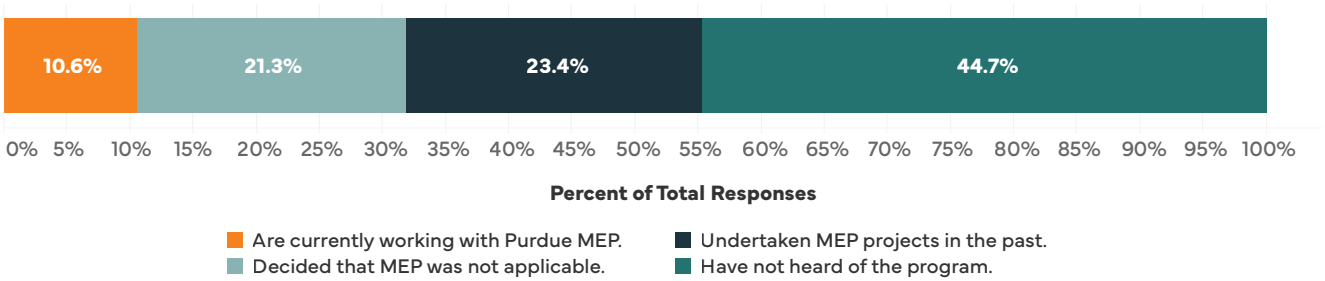
MEP partnerships are similarly unknown, with nearly 45% of respondents unaware of their existence. Additionally, of the 23.4% of respondents (14 companies) that have applied and undertaken MEP projects in the past, 11 of the 14 companies reported that the partnership was unrelated to Industry 4.0 technologies.

Figure B-20: Awareness and Interaction with Manufacturing Readiness Grants



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.

Figure B-21: Awareness and Interaction with Purdue MEP Partnership Programs



Source: TEConomy's analysis of Evansville Region Industry 4.0 survey.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