MACOMB COMMUNITY COLLEGE

REGIONAL INDUSTRY IT SKILL NEEDS ASSESSMENT

FINAL REPORT

October 2024

Presented by the Workforce Intelligence Network (WIN)

EXECUTIVE SUMMARY

The Information Technology (IT) industry is a vast and dynamic field that encompasses the use of computer systems, software, hardware, and networks to manage, process, and exchange information. Macomb Community College commissioned the Regional Industry Information Technology Skill Needs Assessment to explore the current state of the IT industry in Macomb, Oakland, and Wayne Counties in Michigan. Specifically, this assessment seeks to gather data on the current IT workforce job landscape, identify skill gaps and make recommendations to address these gaps effectively. The findings of this study will be critical for informing workforce development and training initiatives, educational programs, and industry collaboration aimed at strengthening the region's IT workforce.

The scope of research included a labor market analysis, skills assessment, stakeholder engagement, best practices review, and future trends analysis. To first validate the existence of skill gaps, a review was conducted of job postings during 2023 for IT positions in the 3-county area. A comparison was made between the frequency of specific skills being sought by employers in their job postings against the availability of those skills in job-seeker resumes.

Employment prospects are also a key consideration for future graduates. In the 3-county area, total employment in the IT sector between 2013-2023 has increased by nearly 4,000 workers. Most of these top jobs require a Bachelor's degree as the entry requirement, according to online employer job postings. However, there are a few opportunities for those with an Associate's degree or some college, no degree. Most notably, Computer User Support Specialists was the third most posted job in IT for the 3-county region and US overall. Most occupations in IT are quite lucrative compared with other occupation groups, although wages are somewhat lower in the 3-county area compared with national benchmarks.

In addition to identifying skill gaps, an analysis was performed to identify rapidly growing skills. There were three distinct skill groupings analyzed, including "specialized", "common" and "software" skills. For this analysis, there are two major considerations: projected growth and current demand. Among those skills that scored high in both measures are Automation, Agile Methodology, and Innovation. A survey of emerging and important skills also revealed answers such as Critical Thinking and Analysis, Reasoning, Problem-Solving, and effective use of Artificial Intelligence.

A survey and focus group were conducted with representatives from various groups within the IT industry, including employers, educators, and workforce development professionals. Findings from these surveys suggest that turnover in IT is quite low and experience levels of the current IT workforce are quite high. This may present challenges for recent graduates to stand out during the hiring process.

When preparing to educate the workforce of tomorrow, consideration was also given to upskilling and reskilling plans for employers. Training for Artificial Intelligence (AI) adoption was a top priority for many respondents. This included incorporating AI into marketing, data analysis, and forecasting.

Learner preferences were another focus of the industry survey. When asking respondents about preferences for learning, over 30 percent indicated a preference for online courses, followed closely by workshops (27.3 percent) and on-the-job training (21.6 percent). These preferences underscore the value of flexibility and accessibility, as well as interactive and hands-on learning.

EXECUTIVE SUMMARY CONTINUED

Specific IT-related credentials were an important highlight of the research, with strong agreement between labor market data and the industry survey. Both data sets suggest a strong employer preference for credentials such as Microsoft Certified Professional, Amazon Web Services (AWS) Certified Solutions Architect, and Cisco Certified Network Associate.

One survey item stood out from others, with 29.5 percent of respondents answering "lack of qualified candidates or limited talent availability" when asked about significant challenges in talent acquisition. A follow-up to this question was explored during the focus group, where participants were asked what a "qualified" candidate means to them. Surprisingly, educational credentials such as degrees or certifications were not a primary consideration for employers. When asked about specific skills required for success in IT, respondents indicated communication, problem-solving, project and time management, and curiosity. Few technical skills were mentioned, such as programming, cloud computing, and database management. Regarding employer perspective of recent IT graduates' career readiness, there is consensus that specialized skills are increasingly important. This further supports the observation that careers in IT are highly diverse and can vary from one employer to another.

To address several problems outlined in the research, a few key recommendations are offered. First, portfolios showcasing contributions to projects are becoming more important, allowing hiring agents to assess a candidate's abilities. The focus group also suggested that short-term training, mock interviews, and resume preparation would be valuable.

The research also included a review of best practices within the IT industry. By integrating training programs with curricula, industry leaders and educational institutions can collaboratively foster a talent pipeline. This should be a coordinated effort where all stakeholders are engaged in continuous dialogue to equip the workforce with the necessary skills for an evolving IT industry. A framework of key actions from each of the following stakeholder groups is proposed to bridge these gaps: Employers, Employees/Job Seekers/Students, Education Providers, Policymakers, and Researchers.

Specific training methods are also proposed, with four themes emerging as best practices. First, hands-on learning has been shown to improve student comprehension and reduce failure rates. The second theme is industry collaboration. Programs like the Google IT certificate and the College Work Experience Program at the University of Central Florida, in collaboration with Lockheed Martin, provide students with practical skills and work experience. Theme number three suggests that apprenticeships and mentorships hold tremendous value. The fourth theme pertained to specific protocols, such as cohort-based learning, boot camps, web-based learning, and problem-based learning. Prospective regional partnerships offering some of these protocols were also identified, including Code for Good, Girls Who Code, and others.

The final component to this research included forecasting future trends and emerging technologies. Based on the literature review and industry survey, a short list of trends were identified, including Artificial Intelligence, Encryption and Cyber Security, Cloud computing, and Immersive Reality technologies (AR & VR).

REGIONAL INDUSTRY IT SKILL NEEDS ASSESSMENT
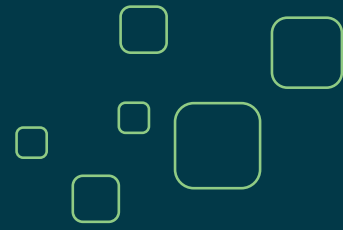
PHASE 1

Phase one is comprised of two parts:
1. Identifying IT Occupations and
2. Labor Market Analysis.

Part one consists of several components: listing and validation of the IT Occupations, keyword analysis and occupation grouping. Including an outline of middle-skill jobs based on commonly accepted criteria for this classification.

Part two utilizes the existing IT group that has been highlighted in the WIN Labor Market reports for several years.

This group is made up of 16 individual occupations, each of which was previously identified by WIN and subsequently validated as being representative of the industry overall.

PHASE 1: IDENTIFYING IT OCCUPATIONS
O*NET OCCUPATIONS

Top IT Occupations & SOC Codes
2023–2033

SOC	Occupation
15-1221	Computer and Information Research Scientists
11-3021	Computer and Information Systems Managers
15-1241	Computer Network Architects
15-1231	Computer Network Support Specialists
15-1299	Computer Occupations, All Other
15-1251	Computer Programmers
15-1211	Computer Systems Analysts
15-1232	Computer User Support Specialists
15-1242	Database Administrators
15-1243	Database Architects
15-1212	Information Security Analysts
15-1244	Network and Computer Systems Administrators
15-1252	Software Developers
15-1253	Software Quality Assurance Analysts and Testers
15-1255	Web and Digital Interface Designers
15-1254	Web Developers

Occupations and Industries

WIN conducted a cross-reference of these 16 occupations against those identified on the Bureau of Labor Statistics (BLS.gov) website for Computer and Information Technology Occupations. All occupations listed on BLS.gov are captured by the WIN Information Technology grouping. Below is a full list from BLS:

- Computer and Information Research Scientists
- Computer Network Architects
- Computer Programmers
- Computer Support Specialists
- Computer Systems Analysts
- Database Administrators and Architects
- Information Security Analysts
- Network and Computer Systems Administrators
- Software Developers, Quality Assurance Analysts, and Testers
- Web Developers and Digital Designers
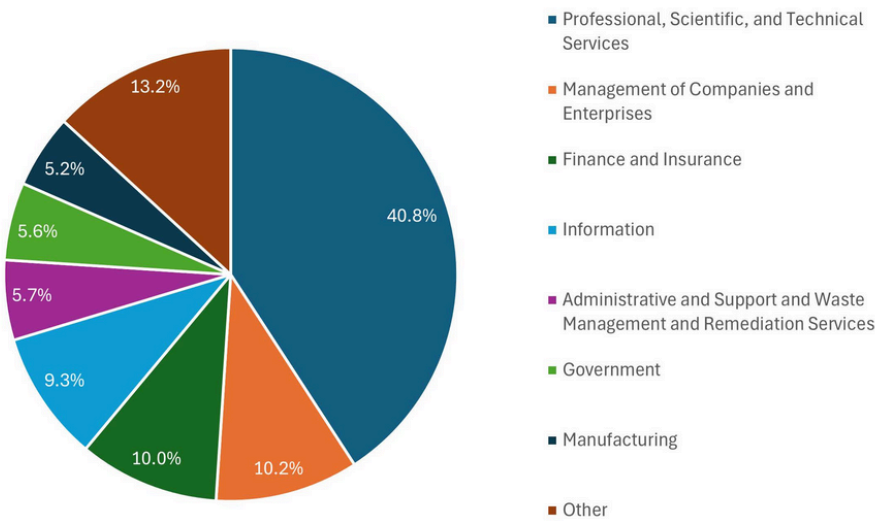
Emerging In-Demand Occupations
2023-2033

SOC	Description	2023 Jobs	2033 Jobs	2023 - 2033 % Change	Annual Openings	Median Hourly Earnings	Typical Entry Level Education
15-1252	Software Developers	22,842	24,718	8.2%	1,453	$50.45	Bachelor's degree
11-3021	Computer and Information Systems Managers	7,328	7,755	5.8%	527	$67.25	Bachelor's degree
15-1212	Information Security Analysts	1,794	2,082	16.1%	144	$49.47	Bachelor's degree
15-1299	Computer Occupations, All Other	3,854	4,030	4.6%	265	$46.48	Bachelor's degree
15-1221	Computer and Information Research Scientists	146	172	18.0%	13	$64.37	Master's degree
15-1211	Computer Systems Analysts	9,060	9,074	0.2%	546	$51.77	Bachelor's degree
15-1253	Software Quality Assurance Analysts and Testers	1,405	1,534	9.2%	103	$41.23	Bachelor's degree
15-1254	Web Developers	565	633	12.1%	44	$41.49	Bachelor's degree
15-1255	Web and Digital Interface Designers	562	648	15.2%	51	$38.67	Bachelor's degree
15-1242	Database Administrators	688	720	4.6%	44	$45.73	Bachelor's degree
15-1231	Computer Network Support Specialists	1,067	1,109	3.9%	77	$31.12	Associate's degree
15-1243	Database Architects	529	538	1.6%	32	$46.68	Bachelor's degree

PHASE 1: IDENTIFYING IT OCCUPATIONS
MIDDLE SKILL JOBS ANALYSIS

WIN conducted a thorough examination of the industry affiliations for each occupation analyzed, finding a specific industry connected to every job listing. By analyzing the industry distribution among all 16 IT occupations, WIN pinpointed the industries that are most actively seeking IT professionals. This analysis encompassed both the broader categories of 2-Digit industries and the more detailed 4-Digit industries, each offering unique insights into industry composition.

2-Digit Industry Composition 2023-2024

- Professional, Scientific, and Technical Services
- Management of Companies and Enterprises
- Finance and Insurance
- Information
- Administrative and Support and Waste Management and Remediation Services
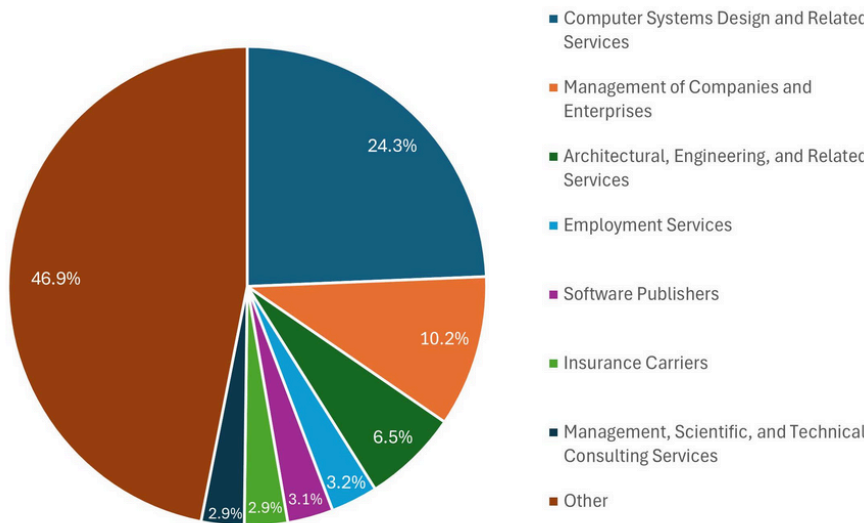- Government
- Manufacturing
- Other

Aggregated Industry Composition (2-Digit)

The highest proportion of job postings for Information Technology workers was found in the Professional, Scientific, and Technical Services Industry, with 40.8 percent of the job postings. Management of Companies and Enterprises was a distant second with 10.2 percent. Rounding out the top three was the Finance and Insurance industry, with 10.0 percent.

Aggregated Industry Composition (4-Digit)

The highest proportion of job postings for Information Technology workers was found in the Computer Systems Design and Related Services Industry, with 24.3 percent of the job postings. Management of Companies and Enterprises was second with 10.2 percent, followed closely by Architectural, Engineering, and Related Services with 6.5 percent.

4-Digit Industry Composition 2023-2024

- Computer Systems Design and Related Services
- Management of Companies and Enterprises
- Architectural, Engineering, and Related Services
- Employment Services
- Software Publishers
- Insurance Carriers
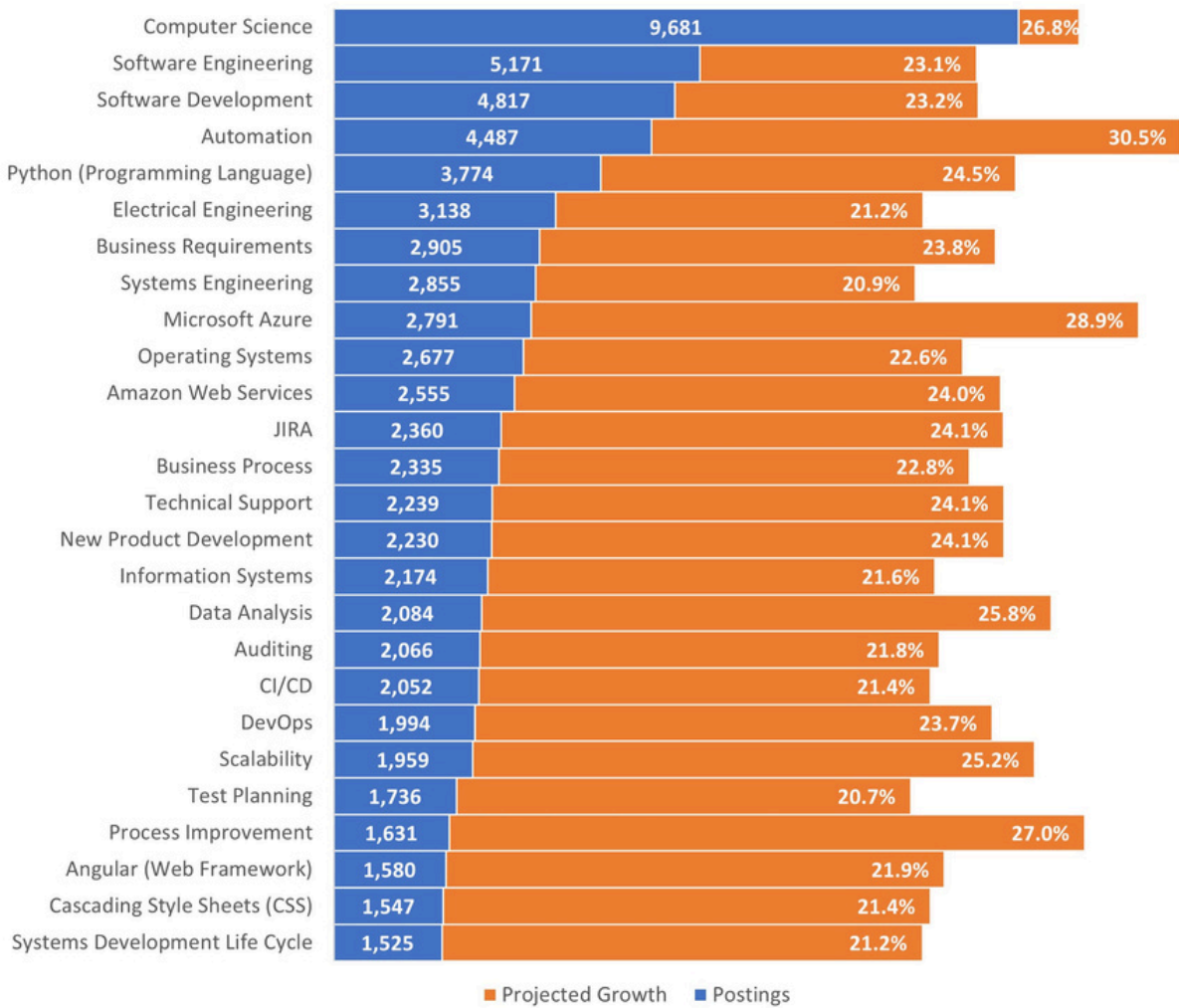- Management, Scientific, and Technical Consulting Services
- Other

PHASE 1: IDENTIFYING IT OCCUPATIONS
KEYWORD ANALYSIS

Across job postings, there are three distinct skills groupings: software skills, common skills and specialized skills. Specialized skills are those considered necessary for the given occupations in which they appear. Among all 16 occupations in the WIN IT group, there are 26 skills characterized as "rapidly growing" relative to the market. This designation is given on the basis of having greater than 20.0 percent projected skill growth. Given the direct extraction from job postings, these keywords may also serve as a leading indicator of future skills demand.

Rapid Growth Specialized Skills
2023

Skill	Postings	Projected Growth
Computer Science	9,681	26.8%
Software Engineering	5,171	23.1%
Software Development	4,817	23.2%
Automation	4,487	30.5%
Python (Programming Language)	3,774	24.5%
Electrical Engineering	3,138	21.2%
Business Requirements	2,905	23.8%
Systems Engineering	2,855	20.9%
Microsoft Azure	2,791	28.9%
Operating Systems	2,677	22.6%
Amazon Web Services	2,555	24.0%
JIRA	2,360	24.1%
Business Process	2,335	22.8%
Technical Support	2,239	24.1%
New Product Development	2,230	24.1%
Information Systems	2,174	21.6%
Data Analysis	2,084	25.8%
Auditing	2,066	21.8%
CI/CD	2,052	21.4%
DevOps	1,994	23.7%
Scalability	1,959	25.2%
Test Planning	1,736	20.7%
Process Improvement	1,631	27.0%
Angular (Web Framework)	1,580	21.9%
Cascading Style Sheets (CSS)	1,547	21.4%
Systems Development Life Cycle	1,525	21.2%

■ Projected Growth ■ Postings
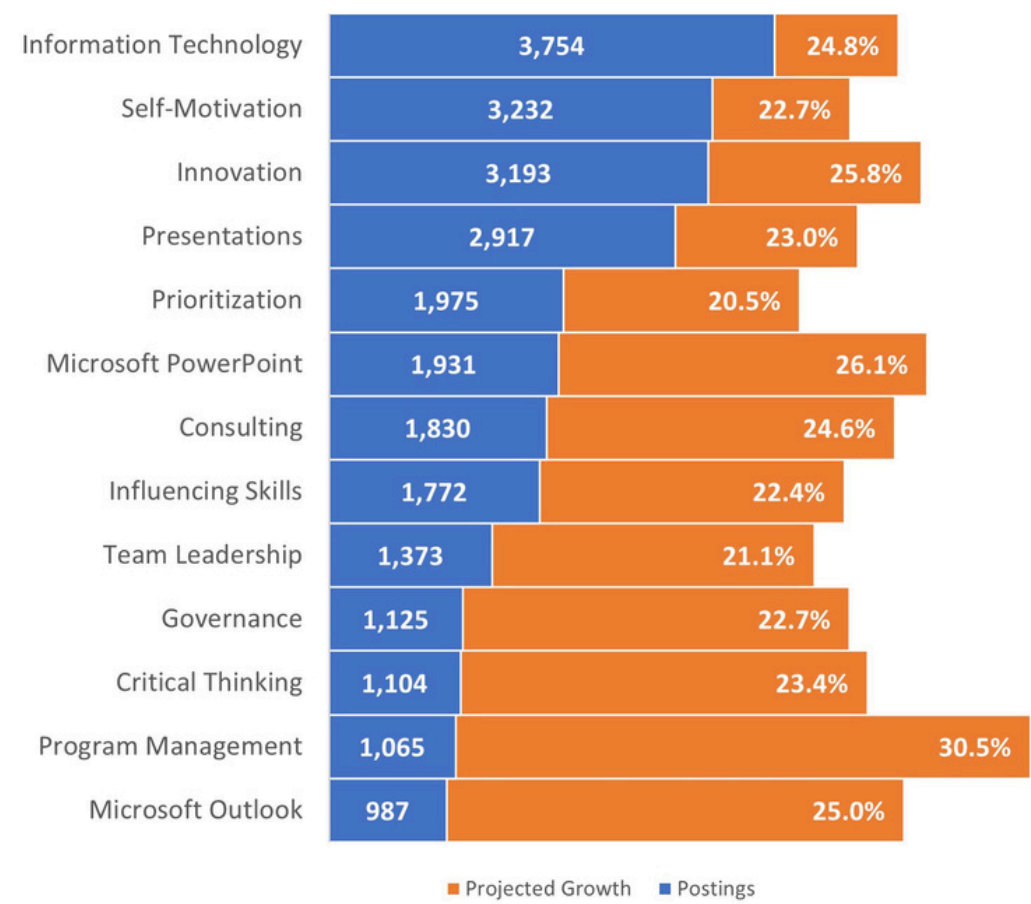
Current and Future Skills Assessment

The dataset for specialized skills encompassed 50 top skills, with 8 among them approaching the threshold for being characterized as "rapidly growing"—within 2.6 percent of the designation. This is in addition to the existing 26 skills that already carry this label. Notably, only 4 skills are characterized as "stable," and none indicate a decline. This reinforces the notion that numerous IT careers are justifiably classified as "emerging," a topic that is explored further in this report.

PHASE 1: IDENTIFYING IT OCCUPATIONS
KEYWORD ANALYSIS

Across job postings, there are three distinct skills groupings: software skills, common skills and specialized skills. Common skills are those considered less technical in nature, but are still important for success in the occupation. Among all 16 occupations in the WIN IT group, there are 13 skills characterized as "rapidly growing" relative to the market. This designation is given on the basis of having greater than 20.0 percent projected skill growth. Given the direct extraction from job postings, these keywords may also serve as a leading indicator of future skills demand.

Rapid Growth Common Skills
2023

Skill	Postings	Projected Growth
Information Technology	3,754	24.8%
Self-Motivation	3,232	22.7%
Innovation	3,193	25.8%
Presentations	2,917	23.0%
Prioritization	1,975	20.5%
Microsoft PowerPoint	1,931	26.1%
Consulting	1,830	24.6%
Influencing Skills	1,772	22.4%
Team Leadership	1,373	21.1%
Governance	1,125	22.7%
Critical Thinking	1,104	23.4%
Program Management	1,065	30.5%
Microsoft Outlook	987	25.0%

■ Projected Growth ■ Postings

Current and Future Skills Assessment

The dataset for common skills encompassed 50 top skills, with 8 among them approaching the threshold for being characterized as "rapidly growing"—within 2.8 percent of the cutoff. This is in addition to the existing list of 13 skills, shown above, which already hold the distinction. Furthermore, only 6 skills are characterized as "stable," while 4 skills were listed as "lagging" relative to the market.
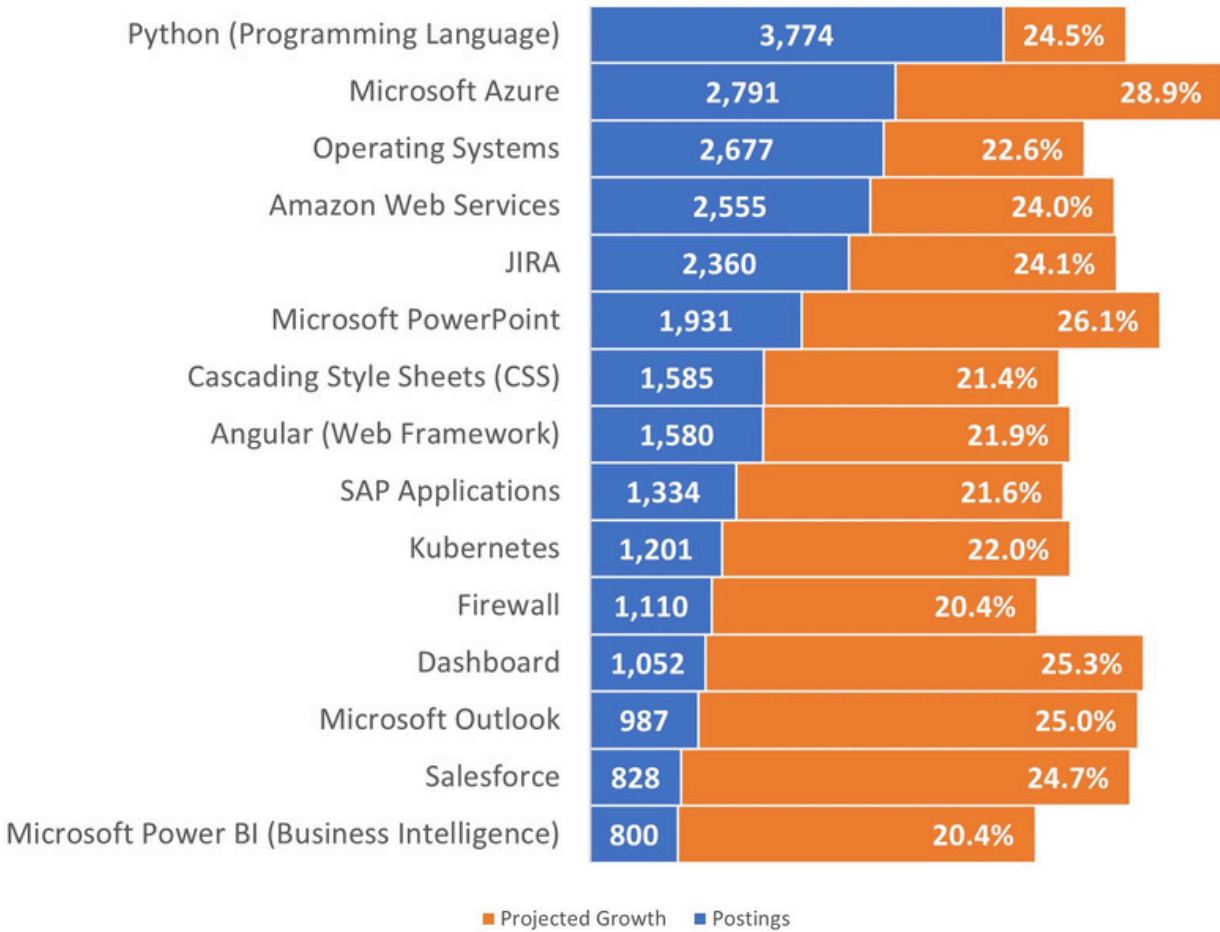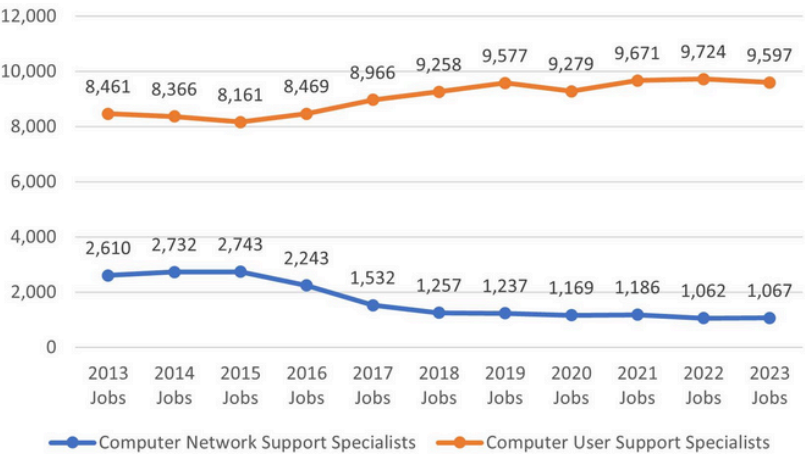
PHASE 1: IDENTIFYING IT OCCUPATIONS
KEYWORD ANALYSIS

Across job postings, there are three distinct skills groupings: software skills, common skills and specialized skills. Software skills are those considered essential to the core tasks of a given occupation. Among all 16 occupations in the WIN Information Technology group, there are 15 skills characterized as "rapidly growing" relative to the market. This designation is given on the basis of having greater than 20.0 percent projected skill growth. Given the direct extraction from job postings, these keywords may also serve as a leading indicator of future skills demand.

Rapid Growth Software Skills
2023

Skill	Postings	Projected Growth
Python (Programming Language)	3,774	24.5%
Microsoft Azure	2,791	28.9%
Operating Systems	2,677	22.6%
Amazon Web Services	2,555	24.0%
JIRA	2,360	24.1%
Microsoft PowerPoint	1,931	26.1%
Cascading Style Sheets (CSS)	1,585	21.4%
Angular (Web Framework)	1,580	21.9%
SAP Applications	1,334	21.6%
Kubernetes	1,201	22.0%
Firewall	1,110	20.4%
Dashboard	1,052	25.3%
Microsoft Outlook	987	25.0%
Salesforce	828	24.7%
Microsoft Power BI (Business Intelligence)	800	20.4%

■ Projected Growth ■ Postings

Current and Future Skills Assessment

The dataset for software skills encompassed 50 top skills, with 10 among them approaching the threshold for being characterized as "rapidly growing"—within 2.6 percent of the designation. This is in addition to the existing list of 15 skills, shown above, which already hold the distinction. Furthermore, only 3 skills are characterized as "stable," while 3 skills were listed as "lagging" relative to the market.

PHASE 1: IDENTIFYING IT OCCUPATIONS
MIDDLE SKILL JOBS ANALYSIS

WIN has previously released reports on "Middle Skill" occupations to help identify those with lower educational and training requirements for entry. Middle-skills jobs are those that require more than high school but less than a 4-year degree and pay over the state median wage of $21.80 per hour. There will be negative job growth in the coming years for jobs that currently only require a high school diploma and the jobs that will take their place are middle-skill. Employment prospects for those with a degree are still bright and middle-skill jobs can be part of a career pathway into more education and even more lucrative employment. With a shifting economic landscape, post-secondary training is more important than ever. In this analysis, 2 occupations were identified as displaying Middle Skill characteristics within the 3-county region. Additional consideration was given to the median wage and job growth of these respective occupations.

Information Technology Middle Skill Occupations

SOC	Description	2023 Jobs	2033 Jobs	2023 - 2033 % Change	Annual Openings	Median Hourly Earnings	Typical Entry Level Education
15-1231	Computer Network Support Specialists	1,067	1,109	3.9%	77	$31.12	Associate's degree
15-1232	Computer User Support Specialists	9,597	9,246	(3.7%)	629	$25.89	Some college, no degree

Middle Skill Occupation Trends

The two middle skill occupations identified for the IT industry demonstrated a divergent pattern between 2013 and 2023. Despite the negative growth projection for Computer User Support Specialists between 2023-2033, this occupation demonstrates much higher total employment.

Middle Skill Occupation Forecast

Lightcast utilizes a linear growth model for projecting job gains in the next 10 years. According to the data, employment for Computer User Support Specialists are expected to decline by 3.7% (351 jobs) by 2033 while Computer Network Support Specialists are expected to grow by 3.9% (42 jobs) in the same time period.


Data Source: Lightcast (2024) | Analysis: Workforce Intelligence Network
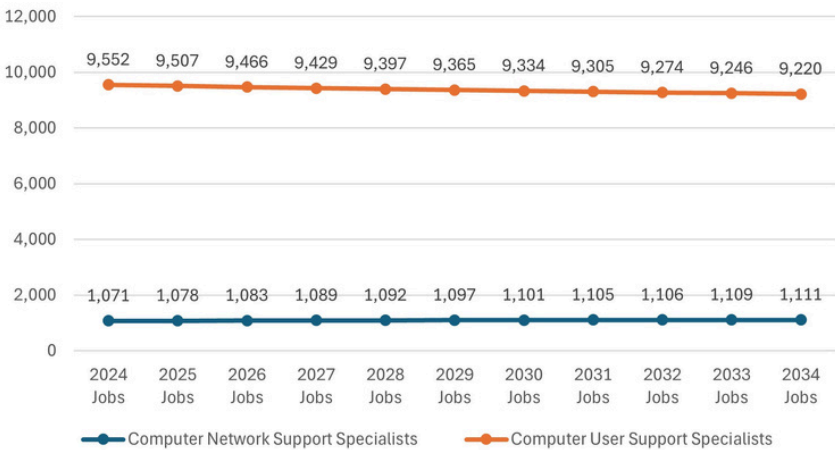
PHASE 1: IDENTIFYING IT OCCUPATIONS
SKILL SHAPES

Skill Shapes is a unique visualization which allows an easy comparison of the supply and demand for various skill sets in the analysis of job postings, as well as job seeker profiles. Where the "% of Total Profiles" shape extends beyond the "% of Total Postings" shape, this indicates an over-supply of skills relative to demand. Where the "% of Total Postings" shape extends beyond the "% of Total Profiles" shape, this indicates a supply shortage relative to demand. For each of these skills areas, the top ten skills by posting frequency were selected.

COMMON SKILL SHAPES
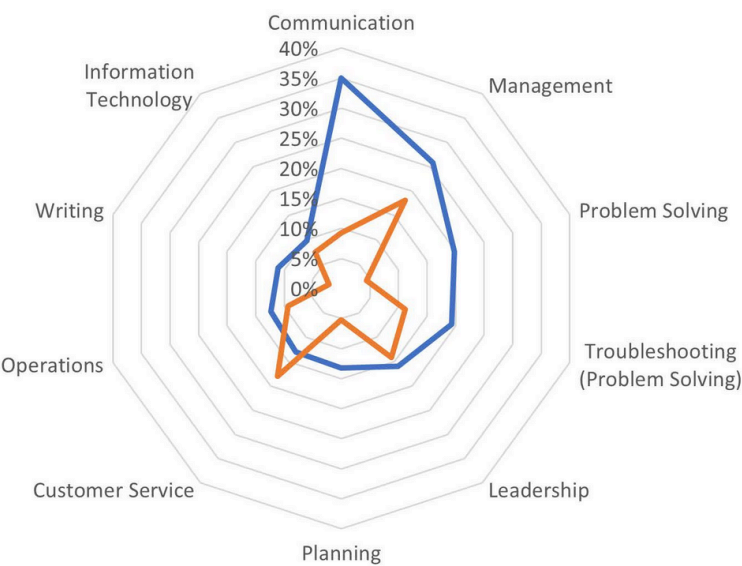
SOFTWARE SKILL SHAPES

SPECIALIZED SKILL SHAPES

Data Source: Lightcast (2024) | Analysis: Workforce Intelligence Network
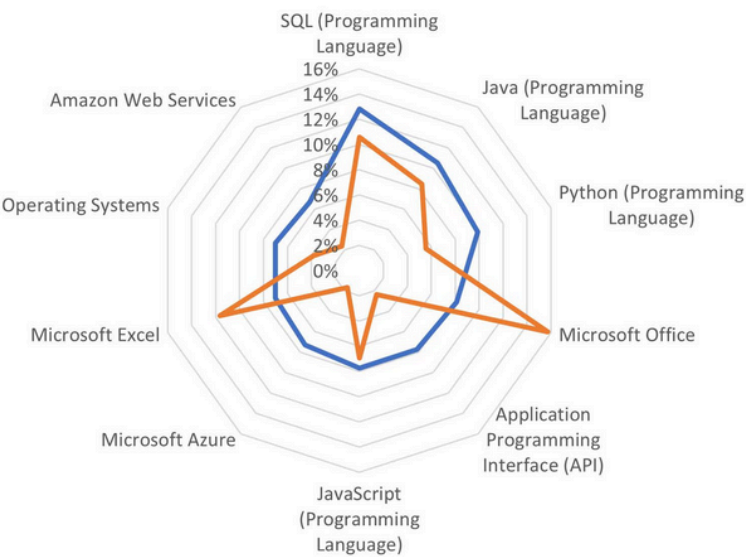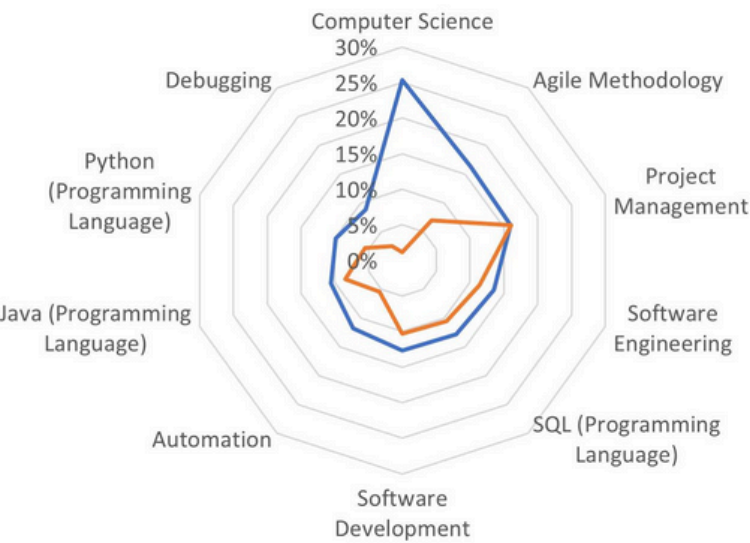
PHASE 1: IT OCCUPATION GROUP
LABOR MARKET ANALYSIS

Information Technology (IT) jobs include occupations that are associated with entry-level, technical, and professional careers related to the design, development, support and management of hardware, software, multimedia, and systems integration services. The Information Technology group is quickly growing, and about 4,300 job openings are reported in the area annually.

Employment Over Time
2013-2023

Year	Employment
2013	61,812
2014	62,718
2015	63,241
2016	65,149
2017	66,208
2018	66,605
2019	67,147
2020	63,458
2021	64,122
2022	66,099
2023	65,791

65,791 Information Technology Workers

0.5% decrease from 2022
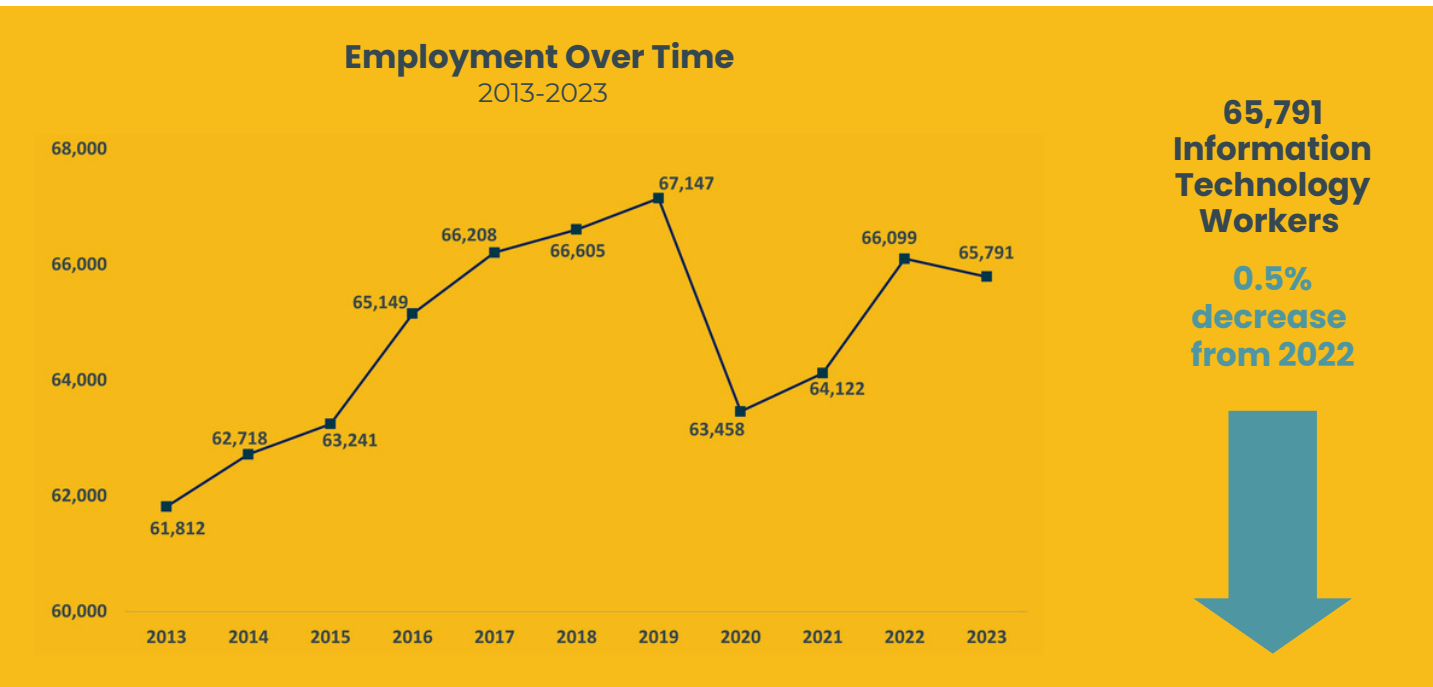
Information Technology Worker Demographics

According to 2023 Lightcast data, the 3-county region has 65,791 IT workers. The workforce is not too diverse, with most workers identifying as male (73.9 percent) and between the ages of 25 and 54 (77.0 percent). Workers age 55 years and older account for 17.9 percent, while only 5.1 percent are 24 years old or younger. Around 65.9 percent of the workforce identify as White, and workers who identify as Asian, make up 18.9 percent of the workforce.

Worker Gender Demographics

- 26.1% Females
- 73.9% Male
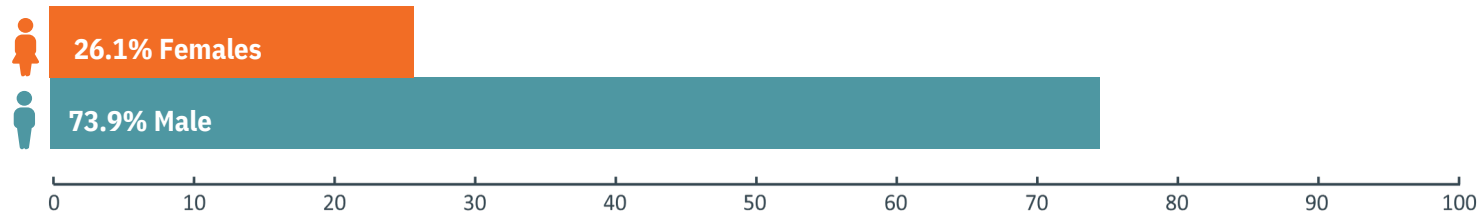
Race and Ethnicity Demographics

65.9% White | 18.9% Asian | 10.5% Black or African-American

Worker Age Demographics

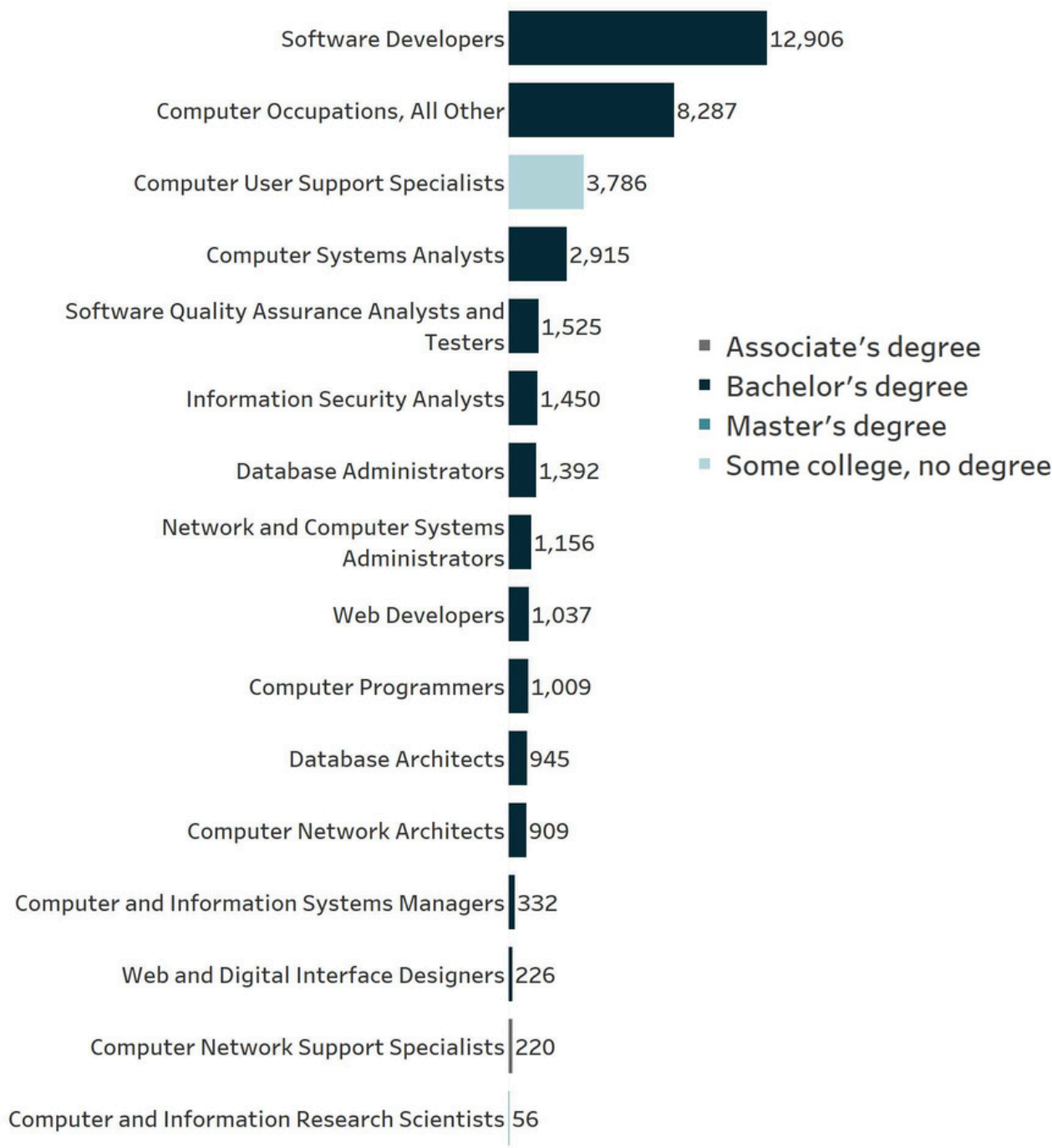| Age 14-24	Age 25-54	Age 55+
5.1%	77.0%	17.9%

PHASE 1: IT OCCUPATION GROUP
TOP POSTED JOBS

In 2023, there were a total of 38,151 job postings for IT workers, with Software Developers as the most sought-after occupation by IT industry employers, with 12,906 postings. Computer Occupations, All Other was in the second position with 8,287 postings. Other top posted jobs include Computer User Support Specialists (3,786 postings), Computer Systems Analysts (2,915 postings), and Software Quality Assurance Analysts and Testers (1,525 postings). Although the top IT jobs generally require a Bachelor's degree, Computer User Support Specialists, typically require some college, no degree.

Occupation	Postings
Software Developers	12,906
Computer Occupations, All Other	8,287
Computer User Support Specialists	3,786
Computer Systems Analysts	2,915
Software Quality Assurance Analysts and Testers	1,525
Information Security Analysts	1,450
Database Administrators	1,392
Network and Computer Systems Administrators	1,156
Web Developers	1,037
Computer Programmers	1,009
Database Architects	945
Computer Network Architects	909
Computer and Information Systems Managers	332
Web and Digital Interface Designers	226
Computer Network Support Specialists	220
Computer and Information Research Scientists	56

Legend:
- Associate's degree
- Bachelor's degree
- Master's degree
- Some college, no degree

PHASE 1: IT OCCUPATION GROUP
WAGE OVERVIEW

In-demand IT occupations provide high wages, even for those at entry-level and with fewer credentials. Software Developers, the most in-demand occupation, offers a median hourly wage of $50.45 per hour or almost $104,936 per year. Computer and Information Research Scientists earn the highest median wage at $64.37 per hour or nearly $133,889 per year. Other occupations that have fewer qualifications, such as Computer User Support Specialists and Web Developers and Digital Interface Designers, earn over $25.00 an hour.

Wage Overview for Top Posted Information Technology Jobs in 2023

Occupation Code	Occupation Name	10th Percentile Wages	25th Percentile Wages	Median Wages	75th Percentile Wages	90th Percentile Wages
15-1252	Software Developers	$33.96	$40.83	$50.45	$62.50	$68.99
15-1299	Computer Occupations, All Other	$25.21	$32.74	$46.48	$59.28	$67.46
15-1232	Computer User Support Specialists	$17.54	$20.36	$25.89	$32.87	$40.55
15-1211	Computer Systems Analysts	$37.02	$42.02	$51.77	$62.10	$67.64
15-1253	Software Quality Assurance Analysts and Testers	$27.52	$35.97	$41.23	$48.67	$57.90
15-1212	Information Security Analysts	$28.90	$37.85	$49.47	$63.10	$74.54
15-1242	Database Administrators	$27.69	$32.79	$45.73	$52.38	$62.40
15-1244	Network and Computer Systems Administrators	$30.14	$36.40	$42.31	$52.84	$64.45
15-1254	Web Developers	$21.27	$31.96	$41.49	$51.78	$61.79
15-1251	Computer Programmers	$25.45	$34.83	$41.06	$56.43	$70.49
15-1243	Database Architects	$36.01	$38.63	$46.68	$59.96	$67.20
15-1241	Computer Network Architects	$36.80	$47.17	$63.73	$73.13	$86.04
11-3021	Computer and Information Systems Managers	$48.74	$61.58	$67.25	$81.80	$104.26
15-1255	Web and Digital Interface Designers	$25.08	$31.90	$38.67	$50.52	$60.87
15-1231	Computer Network Support Specialists	$21.01	$24.14	$31.12	$39.02	$47.42
15-1221	Computer and Information Research Scientists	$43.70	$51.11	$64.37	$77.67	$83.42

In-Demand Education Level*

- High School or GED: 7.4%
- Associate Degree: 5.3%
- Bachelor's Degree: 58.5%
- Master's Degree: 15.3%

Not all job postings indicate the required educational attainment level, therefore the percentages found here may not add up to 100 percent

Top Posting Employers

- Deloitte
- Ford
- Actalent
- Stefanini
- General Motors
- V2Soft
- TEKsystems
- Humana
- General Dynamics
- Bosch

Job Postings by City

1. Detroit: 10,538 Postings
2. Auburn Hills: 3,727 Postings
3. Troy: 3,624 Postings
4. Dearborn: 3,495 Postings
5. Farmington: 2,266 Postings
6. Sterling Heights: 2,023 Postings
7. Southfield: 1,928 Postings
8. Warren: 1,618 Postings
9. Novi: 1,412 Postings
10. Livonia: 1,059 Postings

Data Source: Lightcast (2024) | Analysis: Workforce Intelligence Network

PHASE 1: 3-COUNTY REGION VS US
EMERGING IN-DEMAND OCCUPATIONS

Among the 16 identified IT occupations, 12 are recognized as emerging in-demand roles at the 3-county region, compared to 15 at the national level. Furthermore, projected job growth for 2023-2033 shows that most regional occupations are expected to experience single-digit percentage increases, whereas national projections indicate double-digit growth. For instance, the job growth for computer systems analysts is anticipated to be 0.2 percent regionally, compared to 16.7 percent nationally. Additionally, median hourly earnings for all occupations are consistently higher at the national level than at the 3-county region.

National Emerging In-Demand Occupations (2023-2033)

SOC	Description	2023 Jobs	2033 Jobs	2023 - 2033 % Change	Annual Openings	Median Hourly Earnings	Typical Entry Level Education
11-3021	Computer and Information Systems Managers	604,810	740,609	22.5%	56,933	$81.50	Bachelor's degree
15-1211	Computer Systems Analysts	508,090	593,112	16.7%	40,849	$49.90	Bachelor's degree
15-1212	Information Security Analysts	185,846	249,313	34.2%	19,262	$57.87	Bachelor's degree
15-1221	Computer and Information Research Scientists	39,097	50,144	28.3%	3,897	$69.75	Master's degree
15-1231	Computer Network Support Specialists	163,033	185,922	14.0%	14,028	$34.39	Associate's degree
15-1232	Computer User Support Specialists	715,061	808,075	13.0%	60,425	$28.48	Some college, no degree
15-1241	Computer Network Architects	176,868	195,096	10.3%	11,920	$62.42	Bachelor's degree
15-1242	Database Administrators	77,416	88,377	14.2%	5,904	$48.80	Bachelor's degree
15-1243	Database Architects	59,727	69,586	16.5%	4,751	$64.76	Bachelor's degree
15-1244	Network and Computer Systems Administrators	335,383	369,455	10.2%	23,302	$45.84	Bachelor's degree
15-1252	Software Developers	1,669,433	2,206,527	32.2%	157,085	$63.59	Bachelor's degree
15-1253	Software Quality Assurance Analysts and Testers	203,550	258,262	26.9%	19,675	$48.94	Bachelor's degree
15-1254	Web Developers	85,166	107,129	25.8%	8,118	$40.84	Bachelor's degree
15-1255	Web and Digital Interface Designers	113,245	142,282	25.6%	11,909	$47.37	Bachelor's degree
15-1299	Computer Occupations, All Other	473,445	552,163	16.6%	40,006	$50.44	Bachelor's degree

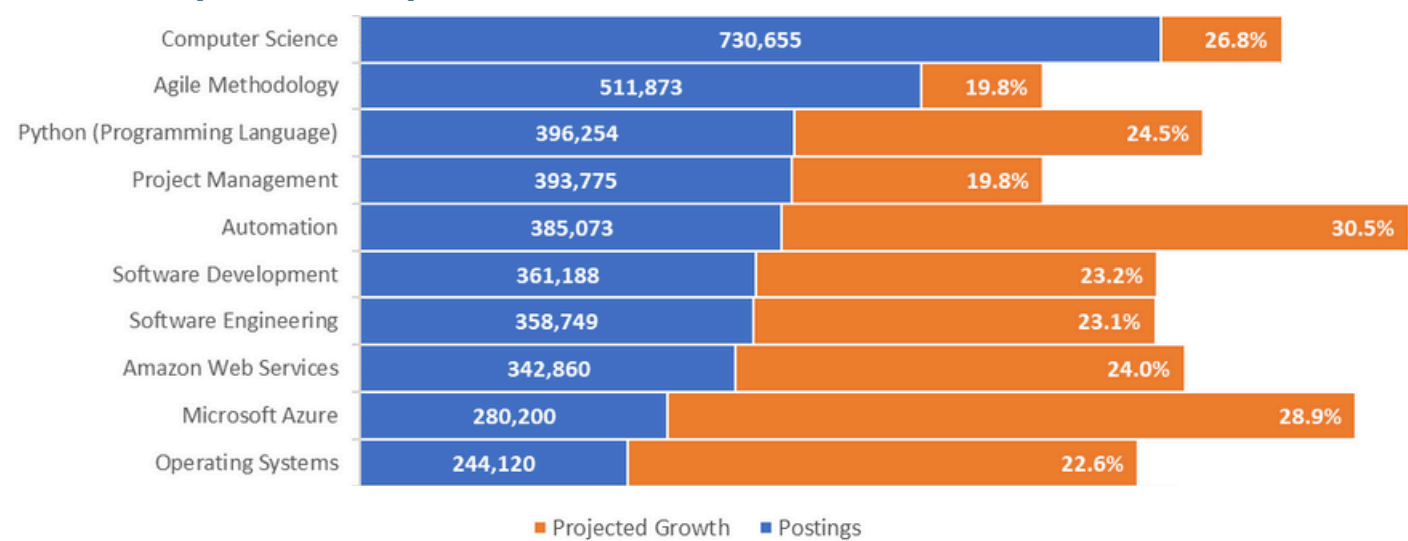### 3-County Region Emerging In-Demand Occupations (2023-2033)

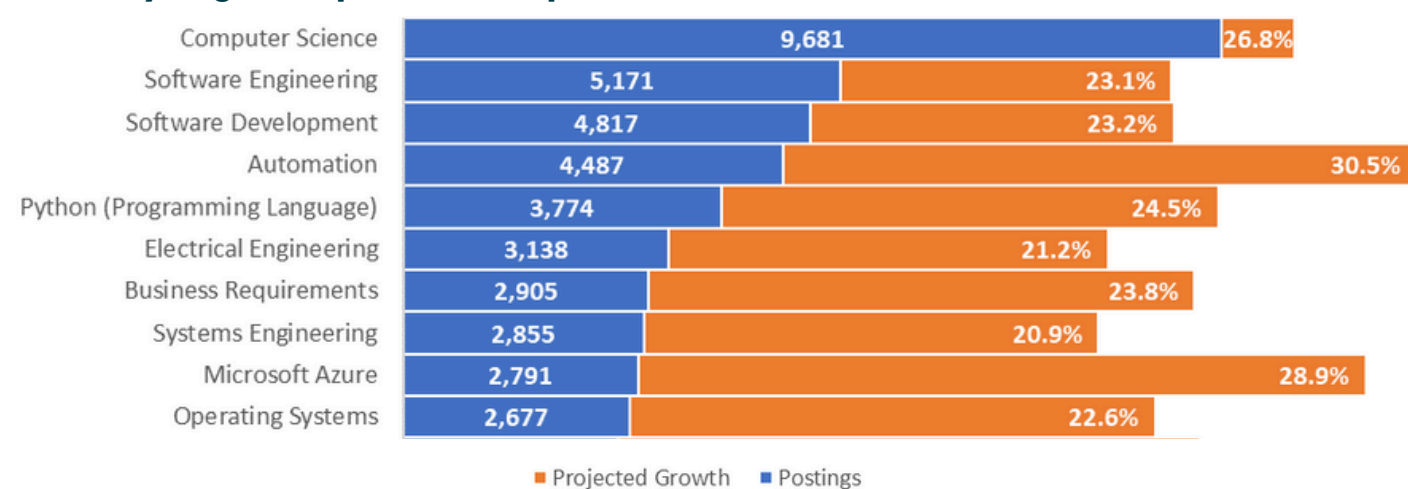| SOC	Description	2023 Jobs	2033 Jobs	2023 - 2033 % Change	Annual Openings	Median Hourly Earnings	Typical Entry Level Education
15-1252	Software Developers	22,842	24,718	8.2%	1,453	$50.45	Bachelor's degree
11-3021	Computer and Information Systems Managers	7,328	7,755	5.8%	527	$67.25	Bachelor's degree
15-1212	Information Security Analysts	1,794	2,082	16.1%	144	$49.47	Bachelor's degree
15-1299	Computer Occupations, All Other	3,854	4,030	4.6%	265	$46.48	Bachelor's degree
15-1221	Computer and Information Research Scientists	146	172	18.0%	13	$64.37	Master's degree
15-1211	Computer Systems Analysts	9,060	9,074	0.2%	546	$51.77	Bachelor's degree
15-1253	Software Quality Assurance Analysts and Testers	1,405	1,534	9.2%	103	$41.23	Bachelor's degree
15-1254	Web Developers	565	633	12.1%	44	$41.49	Bachelor's degree
15-1255	Web and Digital Interface Designers	562	648	15.2%	51	$38.67	Bachelor's degree
15-1242	Database Administrators	688	720	4.6%	44	$45.73	Bachelor's degree
15-1231	Computer Network Support Specialists	1,067	1,109	3.9%	77	$31.12	Associate's degree
15-1243	Database Architects	529	538	1.6%	32	$46.68	Bachelor's degree

PHASE 1: 3-COUNTY REGION VS US
RAPID GROWTH SPECIALIZED SKILLS

In 2023, the most sought-after specialized skills across job postings include Computer science, Python, software engineering, development, and automation. Regionally, high-demand specialized skills include Systems Engineering and Electrical Engineering. Nationally, there is also strong demand for skills such as Agile methodology, project management, and Amazon Web Services.

National Rapid Growth Specialized Skills (2023)

Skill	Postings	Projected Growth
Computer Science	730,655	26.8%
Agile Methodology	511,873	19.8%
Python (Programming Language)	396,254	24.5%
Project Management	393,775	19.8%
Automation	385,073	30.5%
Software Development	361,188	23.2%
Software Engineering	358,749	23.1%
Amazon Web Services	342,860	24.0%
Microsoft Azure	280,200	28.9%
Operating Systems	244,120	22.6%

■ Projected Growth ■ Postings

3-County Region Rapid Growth Specialized Skills (2023)

Skill	Postings	Projected Growth
Computer Science	9,681	26.8%
Software Engineering	5,171	23.1%
Software Development	4,817	23.2%
Automation	4,487	30.5%
Python (Programming Language)	3,774	24.5%
Electrical Engineering	3,138	21.2%
Business Requirements	2,905	23.8%
Systems Engineering	2,855	20.9%
Microsoft Azure	2,791	28.9%
Operating Systems	2,677	22.6%

■ Projected Growth ■ Postings

PHASE 1: 3-COUNTY REGION VS US
RAPID GROWTH COMMON SKILLS

The top five in-demand common skills in 2023 are consistent at both the national and regional levels: information technology, innovation, self-motivation, presentation, and prioritization. The only notable difference is that mathematics is a high-demand common skill at the national level, whereas it is not experiencing the same rapid growth regionally.

National Rapid Growth Common Skills (2023)

Skill	Postings	Projected Growth
Information Technology	344,903	24.8%
Innovation	255,671	25.8%
Self-Motivation	234,064	22.7%
Presentations	206,651	23.0%
Prioritization	166,179	20.5%
Mathematics	162,103	20.2%
Influencing Skills	146,196	22.4%
Consulting	133,378	24.6%
Microsoft PowerPoint	116,476	26.1%
Governance	112,064	22.7%

■ Projected Growth ■ Postings

3-County Region Rapid Growth Common Skills (2023)

Skill	Postings	Projected Growth
Information Technology	3,754	24.8%
Self-Motivation	3,232	22.7%
Innovation	3,193	25.8%
Presentations	2,917	23.0%
Prioritization	1,975	20.5%
Microsoft PowerPoint	1,931	26.1%
Consulting	1,830	24.6%
Influencing Skills	1,772	22.4%
Team Leadership	1,373	21.1%
Governance	1,125	22.7%

■ Projected Growth ■ Postings

PHASE 1: 3-COUNTY REGION VS US
RAPID GROWTH SOFTWARE SKILLS

The top five in-demand software skills in 2023 are consistent at both the national and regional levels: Python (Programming Language), Amazon Web Services, Microsoft Azure, operating systems, and JIRA. However, there are key differences: Docker, ServiceNow, and Power BI are in high demand at the national level, while SAP applications and Microsoft Power BI are more sought after regionally.

National Rapid Growth Software Skills (2023)

Skill	Postings	Projected Growth
Python (Programming Language)	396,254	24.5%
Amazon Web Services	342,860	24.0%
Microsoft Azure	280,200	28.9%
Operating Systems	244,120	22.6%
JIRA	159,651	24.1%
Kubernetes	147,203	22.0%
Cascading Style Sheets (CSS)	146,509	21.4%
Angular (Web Framework)	134,008	21.9%
Docker (Software)	133,627	19.9%
Firewall	118,312	20.4%

■ Projected Growth ■ Postings

3-County Region Rapid Growth Software Skills (2023)

Skill	Postings	Projected Growth
Python (Programming Language)	3,774	24.5%
Microsoft Azure	2,791	28.9%
Operating Systems	2,677	22.6%
Amazon Web Services	2,555	24.0%
JIRA	2,360	24.1%
Microsoft PowerPoint	1,931	26.1%
Cascading Style Sheets (CSS)	1,585	21.4%
Angular (Web Framework)	1,580	21.9%
SAP Applications	1,334	21.6%
Kubernetes	1,201	22.0%

■ Projected Growth ■ Postings

PHASE 1: 3-COUNTY REGION VS US
IT "MIDDLE SKILL" OCCUPATION

Middle-skill jobs are those that require education beyond a high school diploma but less than a four-year degree, with wages exceeding the state median of $21.80 per hour. Two middle-skill occupations in the IT industry showed divergent trends between 2013 and 2023. Employment for Computer User Support Specialists has steadily increased at both the national and regional levels since 2013, despite a slight decline in 2023. In contrast, employment for Computer Network Support Specialists has experienced a slight decline since 2019 at the national level and since 2015 at the regional level.

National IT Middle Skill Occupation Trends (2023)

3-County Region IT Middle Skill Occupation Trends (2023)

Computer User Support Specialists
Computer Network Support Specialists
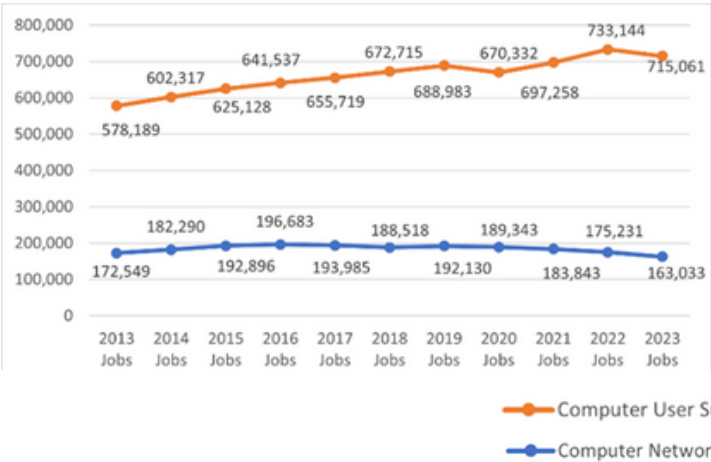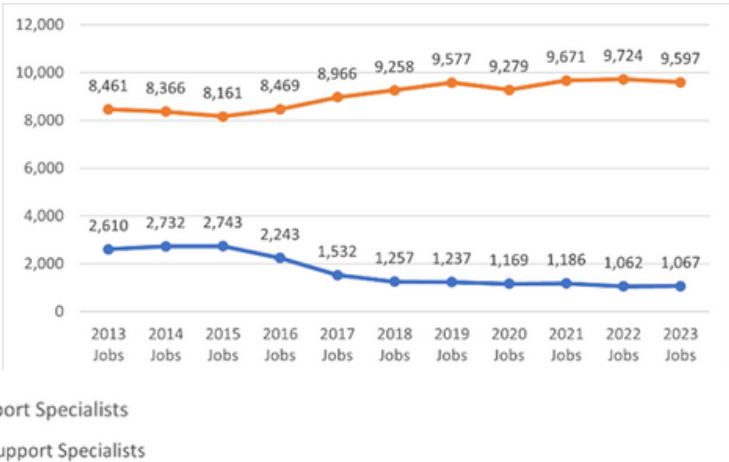
According to 2024 Lightcast data, employment for Computer User Support Specialists is projected to grow by 13.0% (93,041 jobs) by 2033, while Computer Network Support Specialists are expected to see a 14.0% increase (22,889 jobs) over the same period. In the 3-county region, however, employment for Computer User Support Specialists is anticipated to decline by 3.7% (351 jobs) by 2033, whereas Computer Network Support Specialists are projected to experience modest growth of 3.9% (42 jobs) during this timeframe.

National IT Middle Skill Occupation Trends (2023)

SOC	Description	2023 Jobs	2033 Jobs	2023 - 2033 % Change	Annual Openings	Median Hourly Earnings	Typical Entry Level Education
15-1231	Computer Network Support Specialists	163,033	185,922	14.0%	14,028	$34.39	Associate's degree
15-1232	Computer User Support Specialists	715,061	808,075	13.0%	60,425	$28.48	Some college, no degree

3-County Region IT Middle Skill Occupation Trends (2023)

SOC	Description	2023 Jobs	2033 Jobs	2023 - 2033 % Change	Annual Openings	Median Hourly Earnings	Typical Entry Level Education
15-1231	Computer Network Support Specialists	1,067	1,109	3.9%	77	$31.12	Associate's degree
15-1232	Computer User Support Specialists	9,597	9,246	(3.7%)	629	$25.89	Some college, no degree

PHASE 1: 3-COUNTY REGION VS US

LABOR MARKET ANALYSIS

In 2023, the total number of Information Technology jobs in the U.S. is 5,533,323, compared to 65,791 in the 6-county region. National employment in the IT sector has continued to grow since 2013, although the pace slowed somewhat during the COVID-19 pandemic. In contrast, employment in the 3-county region experienced a significant decline during the pandemic and has not yet fully recovered to pre-pandemic levels.

National IT Employment Over Time (2013-2023)

3-County Region IT Employment Over Time (2013-2023)

Data Source: Lightcast (2024) | Analysis: Workforce Intelligence Network
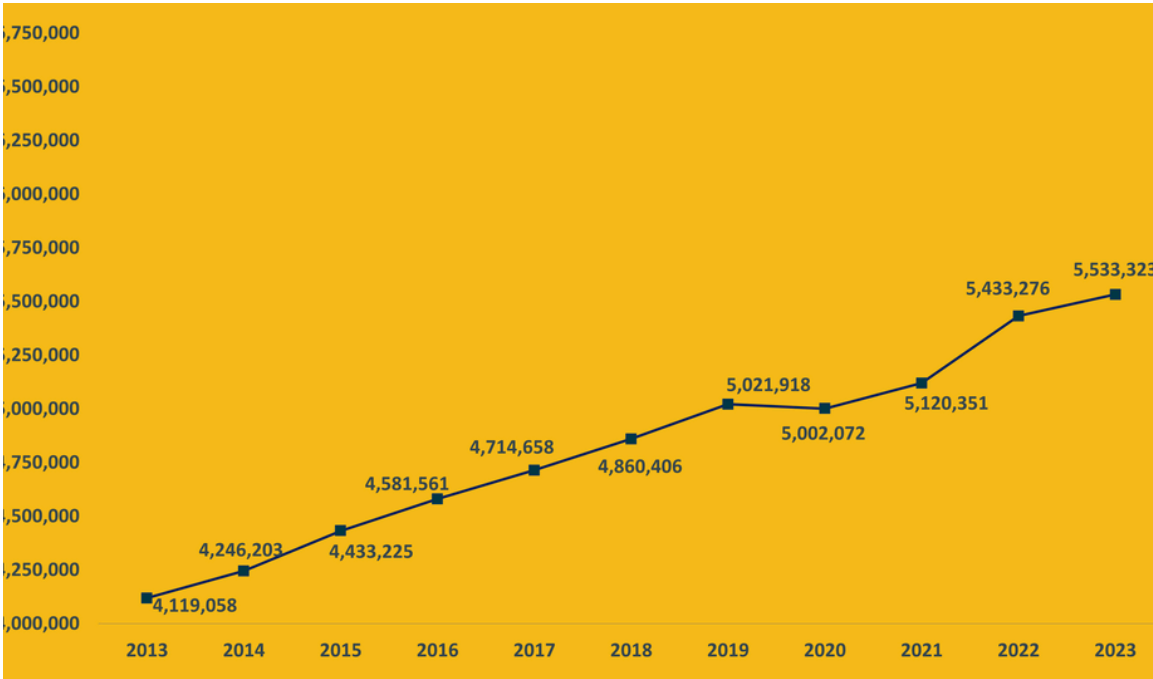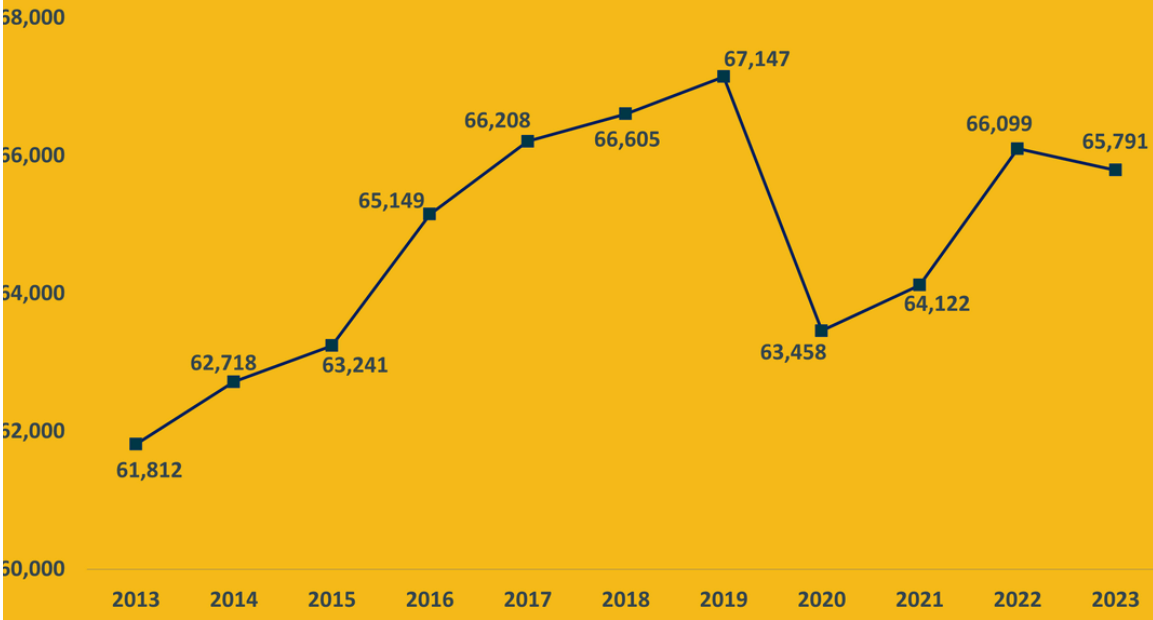
PHASE 1: 3-COUNTY REGION VS US

Top Posted Jobs

In 2023, there were a total of approximately 2,590,000 IT job postings in the United States and 38,151 postings in the 3-county region. Software Developers were the most sought-after occupation, with 768,826 postings nationally and 12,906 postings regionally. The second most common category was Computer Occupations, All Other, with 638,561 postings nationwide and 8,287 in the 3-county area. Other top posted jobs included Computer User Support Specialists (273,900 national postings and 3,786 regional postings) and Computer Systems Analysts (131,481 national postings and 2,915 regional postings). While most top IT positions generally require a Bachelor's degree, Computer User Support Specialists typically require some college education but not a degree.

National IT Top Posted Jobs (2023)

Occupation	Postings
Software Developers	768,828
Computer Occupations, All Other	638,561
Computer User Support Specialists	273,900
Computer Systems Analysts	131,481
Computer Network Architects	121,416
Database Administrators	119,322
Database Architects	111,583
Network and Computer Systems Administrators	93,058
Web Developers	74,897
Web and Digital Interface Designers	60,445
Information Security Analysts	55,303
Software Quality Assurance Analysts and Testers	54,561
Computer Programmers	34,043
Computer and Information Systems Managers	24,913
Computer Network Support Specialists	11,822
Computer and Information Research Scientists	6,592

- Associate's degree
- Bachelor's degree
- Master's degree
- Some college, no degree

3-County Region IT Employment Over Time (2013–2023)

Occupation	Postings
Software Developers	12,906
Computer Occupations, All Other	8,287
Computer User Support Specialists	3,786
Computer Systems Analysts	2,915
Software Quality Assurance Analysts and Testers	1,525
Information Security Analysts	1,450
Database Administrators	1,392
Network and Computer Systems Administrators	1,156
Web Developers	1,037
Computer Programmers	1,009
Database Architects	945
Computer Network Architects	909
Computer and Information Systems Managers	332
Web and Digital Interface Designers	226
Computer Network Support Specialists	220
Computer and Information Research Scientists	56

- Associate's degree
- Bachelor's degree
- Master's degree
- Some college, no degree

REGIONAL INDUSTRY IT SKILL NEEDS ASSESSMENT

PHASE 2

During phases 2 and 3, the key objectives were to obtain primary data for core and soft skills. These skills are critical for success within current and emerging information technology occupations.

The project plan for obtaining this data included surveys, interviews, and focus groups.

PHASE 2: STAKEHOLDER ENGAGEMENT
METHODOLOGY: RESEARCH DESIGN

This study employs a mixed-methods approach, integrating both quantitative and qualitative data collection techniques. The primary data sources include a structured survey and a focus group discussion. The combination of these methods allows for a comprehensive understanding of the research questions, providing both breadth and depth in the data collected.

- Employers
- Education
- Workforce Development
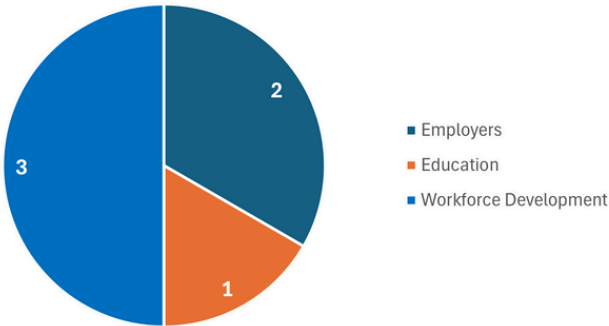
SURVEY OVERVIEW

Population and Sample: The target population for this study comprises professionals working in the IT industry across various regions. A sampling approach was used to ensure representation from different sectors of the workforce, including working professionals, IT employers, education, and workforce development.

Sample Size: Over 1,300 participants were selected for the survey, while a smaller, more focused group of 15 participants was chosen for the focus group discussion. The survey participants were randomly selected from a larger database of IT professionals, whereas the focus group participants were comprised of volunteers from among the survey respondents.

Survey Instrument: A structured survey was developed, consisting of 22 multiple-choice or multiple-selection questions and seven open-ended questions. The multiple-choice/selection questions were used to measure various aspects of IT skills, challenges, and industry needs. The open-ended questions were designed to gather more detailed insights into specific issues.

Focus Group: A focus group was convened to facilitate the discussion, comprising seven open-ended questions designed to explore the themes identified in the survey in greater depth. The questions focused on participants' experiences, perceptions, and recommendations regarding IT skills and industry challenges.

Procedures: The survey was administered online using a survey platform (e.g., Microsoft). Participants received an email invitation containing a link to the survey. The survey was available for four weeks to ensure ample time for responses. Reminder emails were sent midway through the survey period to encourage participation.

The focus group was conducted in a virtual setting using video conferencing software (e.g., Teams). The session lasted approximately 90 minutes and was moderated by a trained facilitator. Participants were encouraged to share their views openly and interact with each other. The session was audio-recorded with participants' consent for subsequent transcription and analysis.

PHASE 2: STAKEHOLDER ENGAGEMENT
RESPONDENT BACKGROUND

How long have you been working for your current employer?

The survey explored participant backgrounds through questions about their tenure with current employers, years of IT experience, and primary service areas. These inquiries aimed to gather insights into respondents' professional profiles, offering a snapshot of their experience levels and geographic service coverage. Data collection included key stakeholders such as employers, industry associations, educational institutions, workforce development agencies, and IT professionals to understand and generalize their perspective on IT skills needs and challenges.
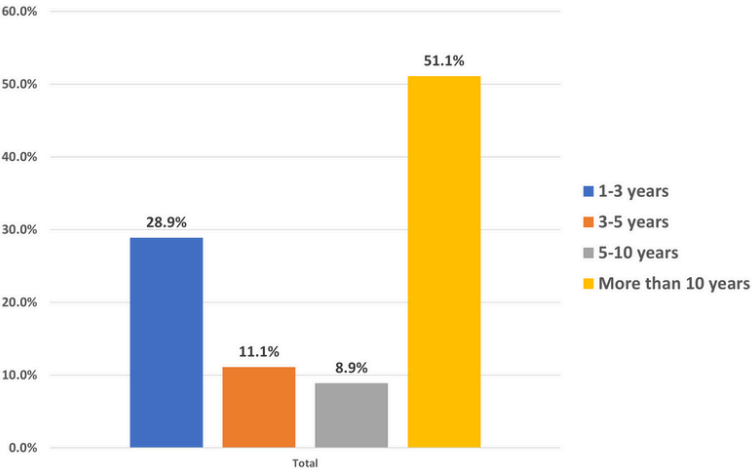
The distribution highlights a wide range of experience levels among the survey respondents. The majority of participants have over 10 years of working experience, representing 51.1 percent of the respondents. Additionally, 28.9 percent of participants have between 1 and 3 years of experience with their current employers. Participants with 3 to 5 years of experience constitute 11.1 percent, while the remaining 8.9 percent have between 5 and 10 years of experience. This diverse range of experience ensures a broad spectrum of insights and perspectives for the study.

How many years of experience do you have in the IT field?

In a survey, findings show that the majority of participants, representing 53.3 percent, possess over 10 years of experience in the IT field. Additionally, 8.8 percent of respondents have between 1 and 3 years of experience in IT. Those with less than one year of experience constitute 4.4 percent of the survey, while the remaining 28.89 percent responded 'not applicable'.
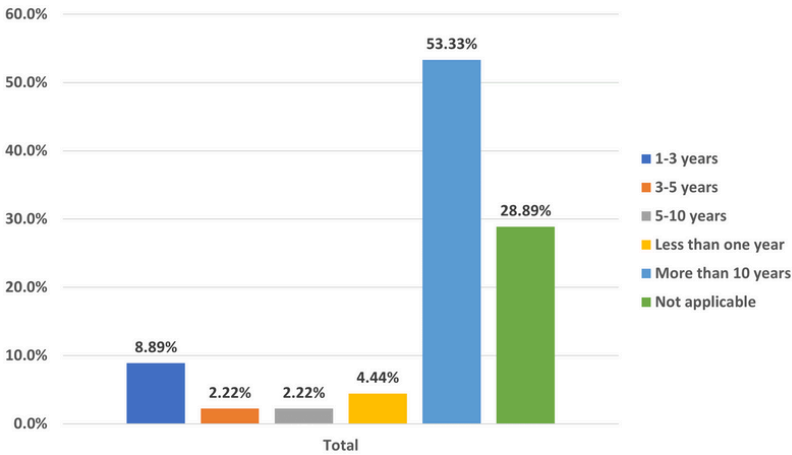
Where is your primary service area?
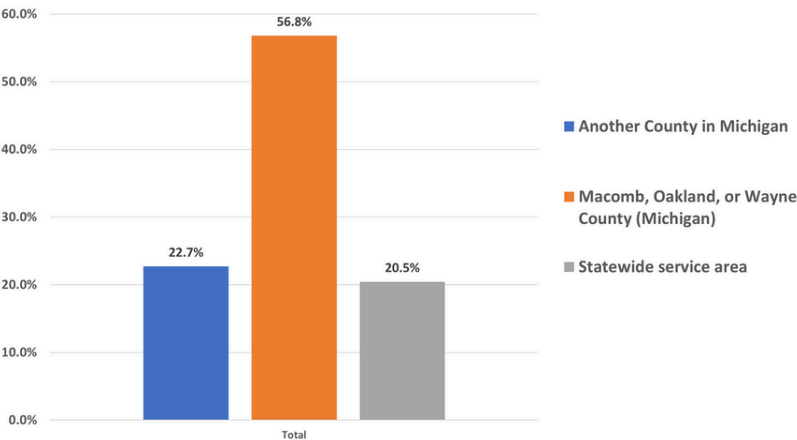
Among participants, the majority, accounting for 56.8 percent, primarily provide their services in Macomb, Oakland, and Wayne counties in Michigan. Additionally, 22.7 percent of participants serve other counties within Michigan, while 20.5 percent offer services across the entire state

Data Source: Workforce Intelligence Network, MCC IT Skill Needs Survey, 2024
Analysis: WIN

PHASE 2: STAKEHOLDER ENGAGEMENT
EMERGING SKILLS AND TECHNOLOGY

Data collection included key stakeholders such as employers, industry associations, educational institutions, workforce development agencies, and IT professionals to understand and generalize their perspectives on IT skills needed and challenges. Labor market information was also used for benchmarking and assessing the availability of these skills within the current workforce, as well as to identify any significant gaps or opportunities.

Employers

Workforce Development Agencies

Educational Institutions

Industry Associations

IT Professionals

Which emerging skills do you consider as the most important for the next five years?

The figure highlights the top emerging skills and skill groups that IT employers or employees predict will rise in prominence over the next five years. These include critical thinking and analysis, reasoning, as well as problem-solving, analytical thinking, and innovation which have consistently remained high on the agenda. Using the *Lightcast* labor market data as a reference, newly emerging skills in self-management, such as resilience, stress tolerance, and flexibility, are also gaining importance. Additionally, active learning and emotional intelligence are expected to be required as emerging skills.

PHASE 2: STAKEHOLDER ENGAGEMENT
EMERGING SKILLS AND TECHNOLOGY

Which IT emerging technologies will have the greatest impact during the next five years?
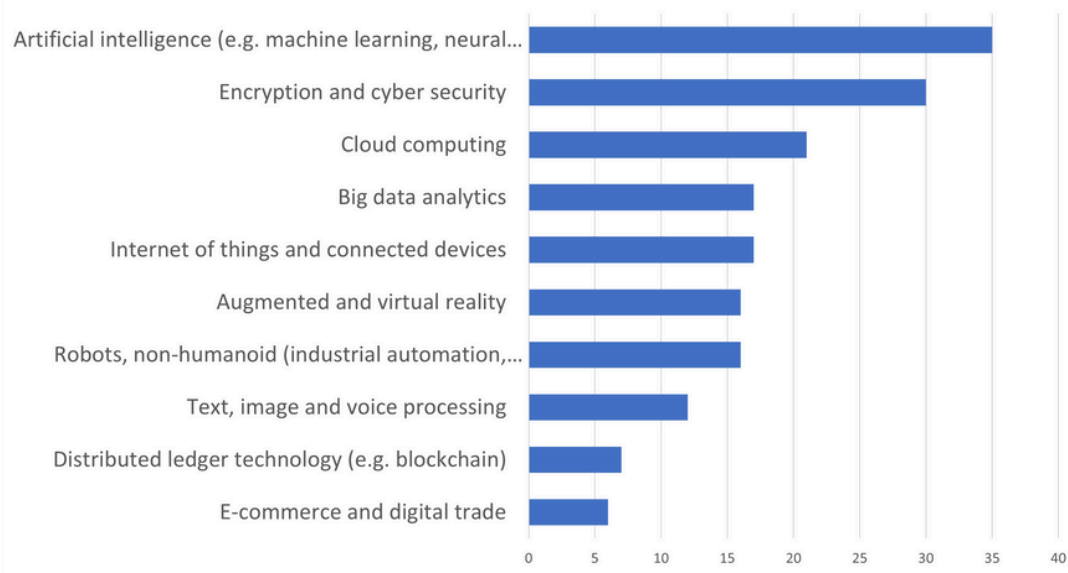
One of the survey questions aimed to identify which emerging IT technologies will significantly influence the next five years. The figure presents a set of high-growth emerging technologies, currently dominated by the AI technology cluster, including machine learning, neural networks, and NLP. The data demonstrates that the integration of AI is significantly influencing IT professionals. The second greatest impact among emerging IT technologies is expected to be in encryption and cybersecurity, followed by cloud computing.

What are considered the most important generative AI skills?
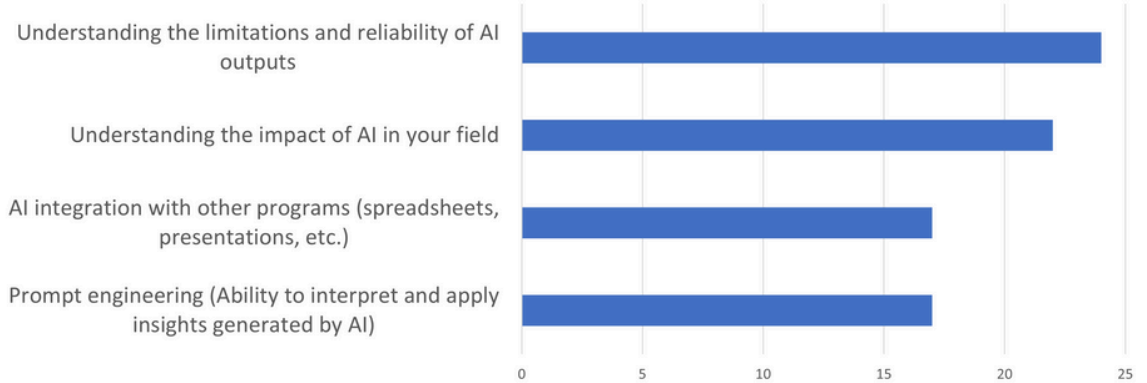
According to the survey results, the most crucial generative AI skills identified are diverse. Participants emphasized the importance of first understanding the limitations and reliability of AI outputs. Second, respondents underscored the significance of comprehending the impact of AI within their respective fields, emphasizing the need for strategic insight into how AI technologies reshape industries. Additionally, integrating AI with other programs emerged as a critical skill, emphasizing the importance of interoperability and synergy across technological platforms. Finally, prompt engineering was highlighted as a key skill, reflecting the demand for agile and efficient development practices in the context of AI applications.

Data Source: Workforce Intelligence Network, MCC IT Skill Needs Survey, 2024
Analysis: WIN

PHASE 2: STAKEHOLDER ENGAGEMENT

UPSKILLING AND RESKILLING
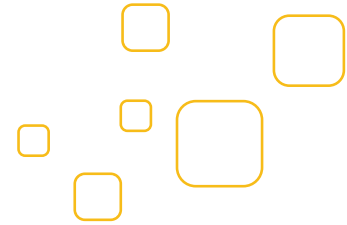
As technological advancements continue to reshape industries, both individuals and organizations are increasingly focused on up-skilling and re-skilling to remain competitive over the next five years. Despite this focus, there are significant challenges to achieving these up-skilling and re-skilling goals.
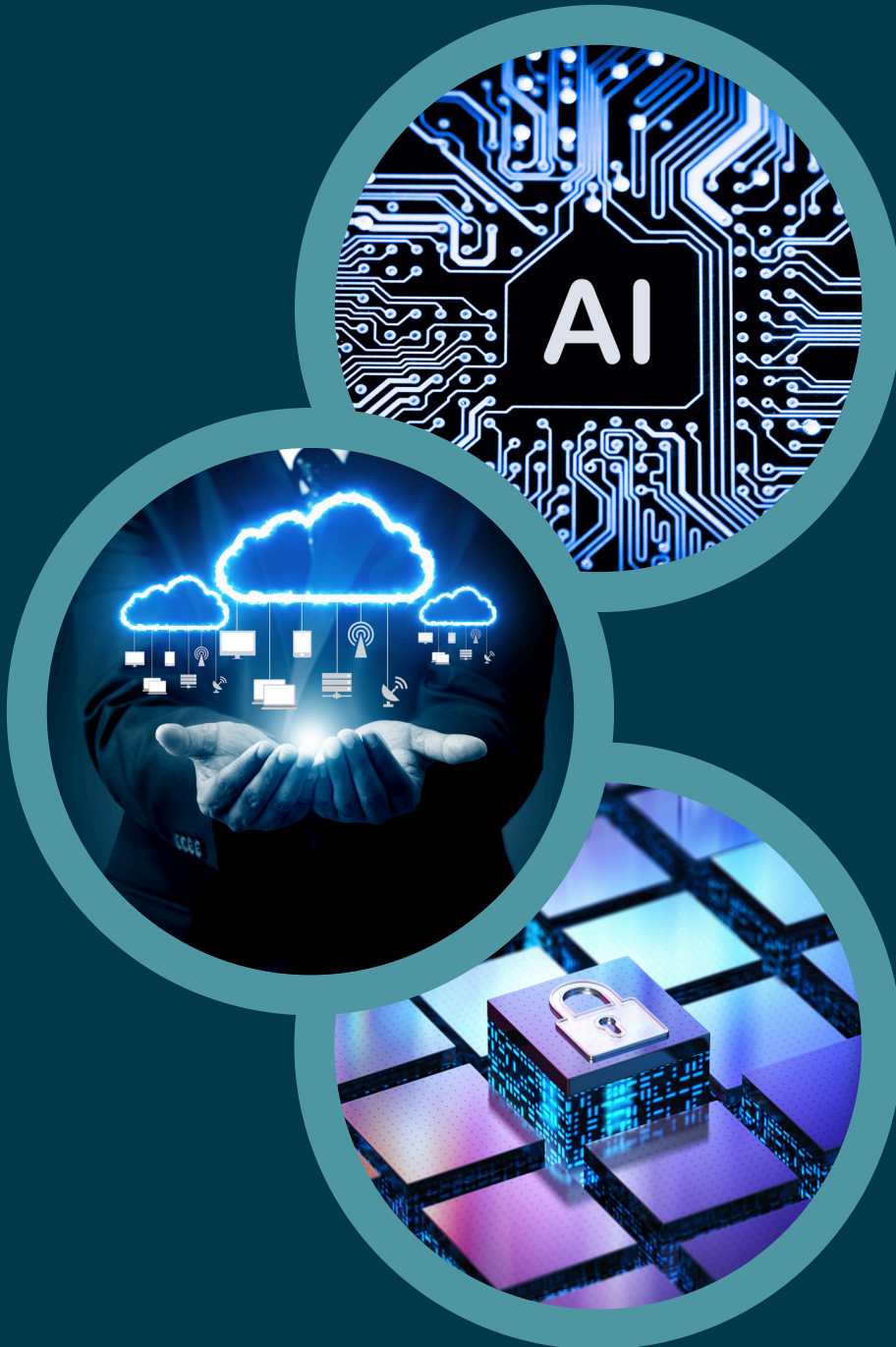
Describe any personal upskilling or reskilling plans due to technological advancements in the next five years:

- **Cloud Computing and AI:** Some plan to learn more about cloud computing and AI to integrate these technologies into their work.
- **Tech Savviness:** Improving tech savviness is mentioned as a way to keep up with relevant emerging technologies.
- **Learning and Embracing AI:** A few responses indicate intentions to upskill in Linux, the Cloud, and to use AI and automation for business tasks.
- **AI in Education:** Some plan to incorporate AI into classroom workflows and curriculum.
- **Cybersecurity and EV Training:** There are plans to focus on cybersecurity, electric vehicle (EV) adoption, and transitioning to cloud services.
- **Data Science and AI Courses:** Individuals are considering courses in data science, AI, and cloud computing, as well as self-learning product features.

PHASE 2: STAKEHOLDER ENGAGEMENT
UPSKILLING AND RESKILLING

Describe any organization-wide upskilling or reskilling plans due to technological advancements in the next five years:

Training and Learning Opportunities
- Training on existing software and understanding benefits
- Providing learning opportunities for staff to improve proficiency with digital tools and adapt to technological changes
- Formal training on new products
- Training on Electric Vehicle (EV) adoption and EVSE2

AI Integration and Education
- Embracing AI in future plans
- Incorporating AI into marketing, data analysis, and forecasting
- Integrating AI training for staff
- Using Chat GPT on company hardware
- Prioritizing AI education and proper use
- Companywide AI initiative
- Understanding AI and its use in organizations
- Reskilling in AI with Data Analysis
- Staying on top of AI changes
- Integrating AI into workflows

IT and System Changes
- Cross-training IT professionals
- Moving on-premises systems to the cloud

Describe the most significant challenges to attaining upskilling or reskilling goals:

Challenges to upskilling/reskilling in IT:
- Balancing work and personal life
- Staying ahead of the IT curve
- Accessing quality and relevant training programs
- Overcoming complacency
- Adapting to rapid changes in AI

Organizational and cost barriers:
- Training and reimbursement processes
- Availability and affordability of training providers
- Cost of AI technology and certification
- Creating and applying for grants and apprenticeship programs

Cognitive and ethical issues in AI training:
- Education and comprehension challenges
- Focusing on complex learning tasks
- Trust and acceptance of AI technology
- Elimination of cheating and bias
- Unintended consequences of AI systems

Data Source: Workforce Intelligence Network, MCC IT Skill Needs Survey, 2024
Analysis: WIN

PHASE 2: STAKEHOLDER ENGAGEMENT

LEARNING AND EDUCATION
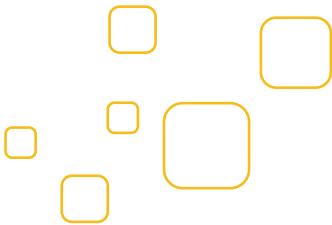
In the swiftly evolving landscape of information technology, the quest for knowledge remains a pivotal aspect of professional growth. Our recent survey sheds light on the learning modalities that resonate most with IT professionals. Furthermore, there was a meaningful overlap in the data between survey respondents preferences and observations, and real-time job posting analytics data.

What is your preference for learning new IT skills?

Learning Preference	Percentage
Online courses	30.68%
Workshops	27.27%
On-the-job training	21.59%
Self-study	12.50%
Internship/Mentorship program	6.82%
Off site intensive training.	1.14%
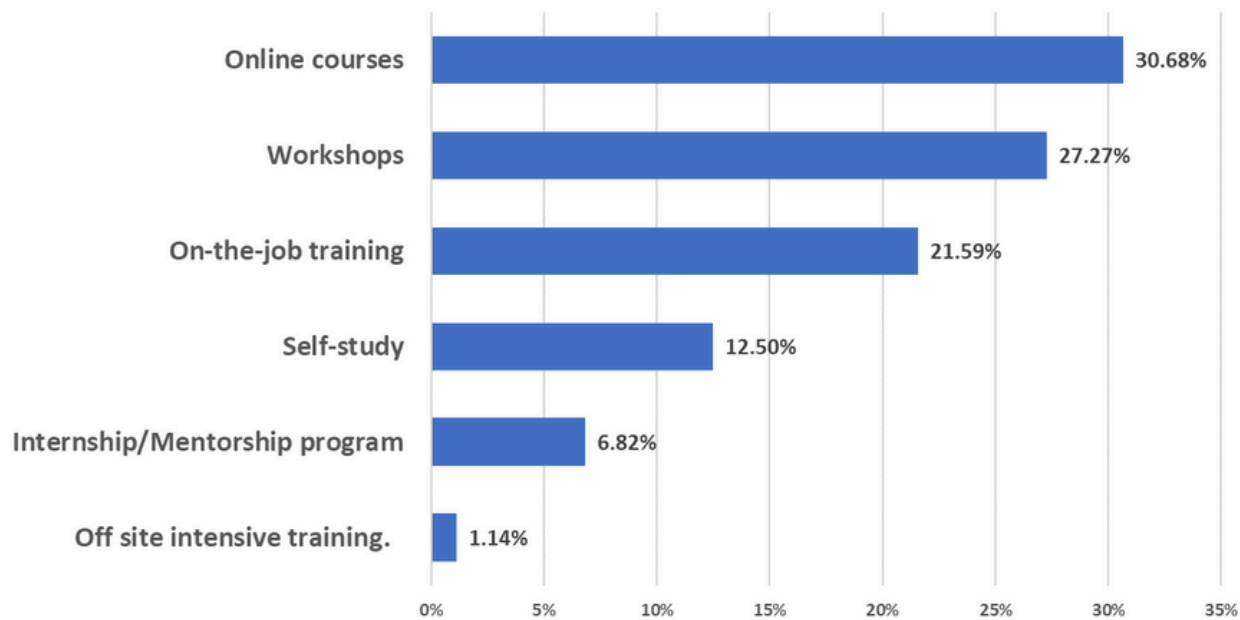
Over 30% of respondents preferred online courses, underscoring the value of flexibility and accessibility in their education. Close behind, an additional 27% preferred workshops while 21% favored on-the-job training, indicating a continued appreciation for interactive and hands-on learning experiences.

PHASE 2: STAKEHOLDER ENGAGEMENT
LEARNING AND EDUCATION
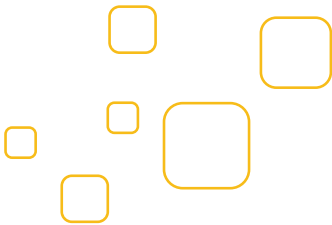
What specialized designations or certifications enhance employability beyond a college degree?

One key objective of this report was to identify the core technical and soft skills required for various IT roles based on input from stakeholders (primary data) and labor market analysis (secondary data). Another finding from the WIN survey revealed considerable agreement between respondents and the existing job postings data. Notably, both sources underscored the importance of certain IT certifications, painting a clear picture of the market's valuation of expertise.

The Certified Information Systems Security Professional (CISSP), CompTIA A+, Cisco Certified Network Associate (CCNA), and Microsoft Certified Professional (MCP) emerged as the most in-demand credentials shared across the data sets. This overlap not only validates the relevance of our survey but also highlights the key qualifications that are shaping the IT workforce landscape.

As these certifications become the common currency of IT proficiency, they serve as a beacon for aspiring professionals navigating their career paths and for educators tailoring curriculum to meet the industry's pulse.

Lightcast Data

Certification	Percentage
Certified Information Systems Security Professional	7.37%
CompTIA A+	4.17%
Cisco Certified Network Associate	3.37%
Microsoft Certified Professional	2.94%
CompTIA Security+	2.43%
Certified Scrum Master	2.27%
ITIL Foundation Certification	1.30%

WIN Survey

Certification	Percentage
Microsoft Certified Professional	29.73%
AWS Certified Solutions Architect	21.62%
Cisco Certified Network Associate (CCNA)	17.57%
CompTIA	13.51%
Certified ScrumMaster (CSM)	12.16%
ITIL Foundation Certification	2.70%
Smart Automation Certification Alliance	1.35%
Certified Information Systems Security Professional (CISSP)	1.35%

PHASE 2: STAKEHOLDER ENGAGEMENT
LEARNING AND EDUCATION

Learning and education can take on many forms in the modern landscape of talent development. Workshops, online courses, internships, and even registered apprenticeship programs (RAP) are all viable ways for prospective employees to gain the skills needed for success in the workplace. This array of options is also flexible enough for current workers to pursue up-skilling and re-skilling opportunities. As shown below, many employers are also open to supporting RAP.

Does your organization currently have IT registered apprenticeship programs?

If not, would you consider apprenticeships to meet your talent development goals?

The landscape of talent development within the information technology sector is primed for a transition as evidenced by our latest survey results. Out of 44 responses, 84.1% of organizations reported that they do not currently have IT Registered Apprenticeship Programs. However, nearly half of these organizations, or 48.5 percent, are open to the idea of integrating registered apprenticeships into their talent development strategies. This openness signals a burgeoning recognition of apprenticeships as a viable conduit for cultivating the next generation of IT professionals. By bridging the gap between academic preparation and practical expertise, registered apprenticeships may offer a viable way for organizations to sculpt a workforce that is not only adept at navigating current technological landscapes but also equipped to pioneer the innovations of tomorrow.

Have an IT Apprenticeship

No
Yes

15.9%

n=44
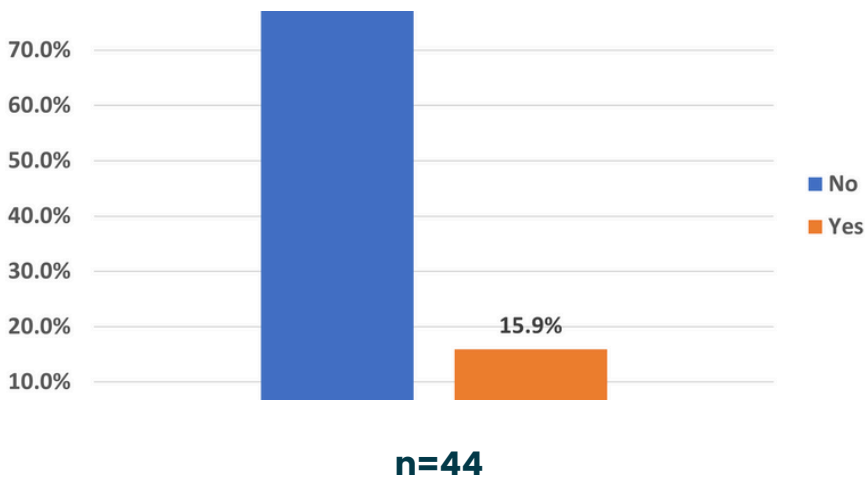
Would Consider IT Apprenticeship

51.5%

48.5%

No
Yes

Total

n=33
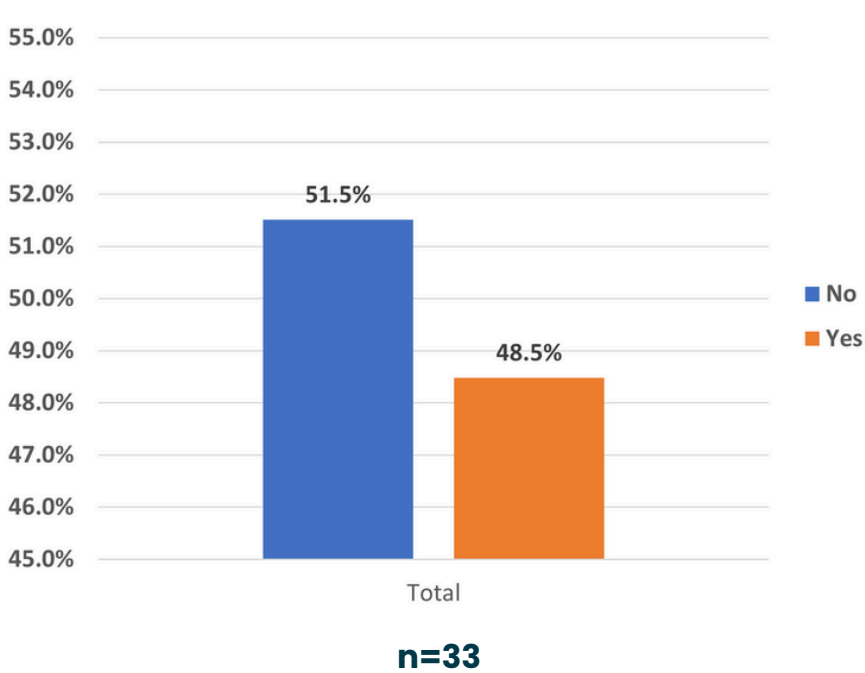
PHASE 2: STAKEHOLDER ENGAGEMENT
CHALLENGES AND BARRIERS
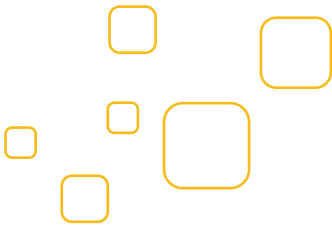
The quest to keep pace with advancements in technology presents a multifaceted challenge for today's IT professionals. Across various locales and demographics, there are an array of challenges that prevent the would-be IT workforce of tomorrow from achieving their employment goals. Likewise, this creates a gap in talent acquisition for employers and results in a downstream loss of productivity.

What are the greatest challenges in adapting to technological advancements and acquiring new IT skills?

Time constraints - Difficulty balancing training with work or personal commitments. — 38.37%

Cost - Training programs or resources are expensive and not affordable. — 31.40%

Relevance - Difficulty finding training programs or resources that meet my specific learning needs. — 12.79%

Accessibility - Limited availability of training programs or resources in my area. — 9.30%

Lack of awareness - Limited knowledge about available training options or resources. — 6.98%

Workload — 1.16%

According to our survey, a significant 38.4% of respondents cited time constraints as the primary hurdle in adapting to new technologies and upskilling. Meanwhile, 31.4% pointed to cost as the primary barrier, underscoring the financial investment required to stay current in a field characterized by rapid innovation. In a distant third, 12.8% of participants expressed difficulty in locating programs that align with their specific professional needs, reflecting a gap in the IT education market. These insights reveal the relative perception of obstacles that IT workers face, highlighting the need for more accessible, cost-effective, and tailored educational opportunities to empower the workforce of the future.

PHASE 2: STAKEHOLDER ENGAGEMENT
CHALLENGES AND BARRIERS
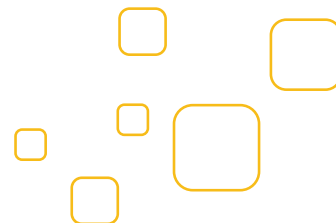
What are the most significant challenges for IT talent acquisition?

Challenge	Percentage
Lack of qualified candidates or limited talent availability	29.51%
A perception among workers that your salary and bonus incentives are too low.	24.59%
Limited promotion and career development opportunities at your company.	16.39%
Competition from other companies trying to hire the same employees (or "poach" them from your business after you've hired them).	14.75%
High levels of work-related stress.	9.84%
Few, if any applications for posted jobs.	1.64%
Its hard to find people with both experience and also the right soft skills.	1.64%
Budget	1.64%

What does a "qualified" candidate mean to you? (Focus Group summary)

From the WIN survey, 29.5% of respondents indicated that the most significant challenge for IT talent acquisition is a lack of qualified candidates. As we sought to explore the nuances of this topic in further detail, the focus group was quite illuminating. According to focus group participants, **educational qualifications**, such as degrees or certifications, are not a primary consideration for the speaker's organization. Some believe these are not essential to perform a job, potentially because IT is so fragmented in nature. Hiring decisions are **tailored individually**, depending on the specific role. **Years of experience** are considered but are not always a reliable indicator of ability. When evaluating a resume', the focus would be on **generic skills,** rather than just educational qualifications or specific certifications.

Technical skills are important, but the process of assessing them can be flawed due to **keyword stuffing** in resumes. Therefore, they also place significant importance on a candidate's **cultural fit** within the organization. These points suggest a holistic approach to hiring which values practical skills and cultural alignment over formal education credentials.

PHASE 2: STAKEHOLDER ENGAGEMENT
FOCUS GROUP

During phases 2 and 3, the key objectives were to obtain primary data for core and soft skills. These skills are critical for success within current and emerging information technology occupations. The project plan for obtaining this data included surveys, interviews, and a focus group.

Which IT (or AI) skills are required for success in IT?

Based on the discussion, respondents mentioned several IT skills that are required for success in IT, however, discussion about soft skills or even basic employment skills commanded the conversation.

This included communication/teamwork/ collaboration, problem-solving/troubleshooting, project/time management and **curiosity/lack of fear/willingness to learn.** Some technical skills were mentioned, such as programming, cloud computing, and database management.

Additionally, obtaining and maintaining relevant IT certifications or degrees was also mentioned as important for demonstrating technical knowledge and skills.

"Curiosity in the end is a core component. If you don't have curiosity this is not the type of role or journey you'll sit in... You can craft the nature of the product you're working on."

-Jakob, Thoughtworks

What specific areas of IT or AI have recognized skills gaps or need improvement?

AI was a significant topic of discussion. There are many nuances, including differentiation between AI purpose-built programs and Generative AI (genAI) which is available to the masses. Newer programmers with skills in **Data Engineering and Large language models** are likely to be in-demand for AI Development roles. Because of the sharp increase in demand for AI programs, there will naturally be a shortage of supply (workers) with this specific skill set.

Employers may struggle to "weed out" candidates with the right skill sets because different employers are often solving different problems. This seems to be the nature of IT. Many candidates understand how to code in a specific programming language but may not have the direct experience working on the same specific problem.

There may also be a gap in reasoning/critical thinking skills to best conceptualize the problem being addressed.

Issues and Observation

There seems to be some consensus that the classroom and certifications can only take you so far. Because of the complexity and specificity of IT-related projects, there is a significant demand for hands-on learning.

Employers want prospects who have worked on things and can quantify that experience with projects. They seem to agree that, while classroom time and studying for a specific designation like CompTIA is value-added, the gap seems to be in actual experience.

PHASE 2: STAKEHOLDER ENGAGEMENT
FOCUS GROUP

What are your observations about the readiness or preparedness of recent IT graduates in entry-level positions?

Niche-specific skills are increasingly important, and a growing number of college graduates possessing the right qualifications for specialized roles. The job market has evolved from valuing **generic skills** to requiring **specialized expertise** due to client demands for specific skill sets, i.e. a Python developer may not be suitable for a **data engineering** role without additional knowledge, such as database optimization. Candidates are expected to have a focused education in areas like machine learning or contributions to **open-source projects.**

Portfolios showcasing contributions to open-source projects on platforms like GitHub are becoming more important, allowing hiring agents to assess a candidate's actual capabilities.

In summary, there is increased importance of specialized skills and practical experience demonstrated through tangible contributions, reflecting a shift in the hiring landscape towards more targeted expertise.

"We're trying to figure out what the needs of the industry are right now. And we're getting a lot of Ala carte answers…"

-Patrick, MCC

How effectively do current IT (or AI) related programs and courses align with industry demands and emerging technologies?

There seems to be a consensus that current coursework is sufficient for basic employment needs (i.e. "foot in the door") but falls short of most employer demands. This is, in part, due to the nature of curriculum development versus the speed of IT innovation. Below are some highlights from this discussion:

Educational Program Development- The process of developing and approving new educational programs is lengthy and often cannot keep pace with the rapid changes in technology. This makes it challenging for educators to ensure that their programs remain relevant and up-to-date.

Underlying Fundamentals- Despite the fast pace of technological change, there are fundamental principles and patterns that remain constant and are still taught in educational settings. These fundamentals are applicable in real-world business scenarios.

Industry Expectations- Companies often look for problem-solvers rather than candidates with a specific set of skills. The ability to adapt and offer solutions is highly valued.

What is the strategic role that educational institutions can provide for the professional development of the IT labor force?

There were several comments from respondents about specific things that may be helpful for the up-and-coming labor force:

- Short-term training
- Mock interviews
- Testing out of (individually) redundant courses
- Resume preparation

Issues and Observations

Based on feedback from both Beau (UP Michigan Works) as well as Patrick (MCC), the current landscape of IT is overly specific. This creates a unique challenge because the training needed doesn't necessarily align with the traditional format of a college course.

Furthermore, the specificity creates a challenge in getting sufficient enrollment and filling seats.

REGIONAL INDUSTRY IT SKILL NEEDS ASSESSMENT
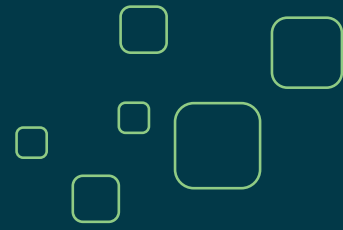
PHASE 3

A core component of this research entails identifying the primary technical and common skills needed for various IT roles.

The following content provides insight into the supply and demand of relevant skills for several of the top in-demand IT jobs. This is achieved by comparing the frequency of skills present in real-time job postings against the availability of these skills in today's workforce using online resume's and candidate profiles.
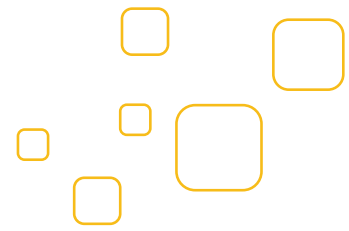
PHASE 3: SKILL ASSESMENT
IN-DEMAND SKILLS AND SKILL GAPS

A core component of this research entails identifying the primary technical and common skills needed for various IT roles. The following content provides insight into the supply and demand of relevant skills for several of the top in-demand IT jobs. This is achieved by comparing the frequency of skills present in real-time job postings against the availability of these skills in today's workforce using online resume's and candidate profiles.

Software Developers

Software Developers are responsible for researching, designing, and developing computer and network software or specialized utility programs. They analyze user needs and develop software solutions by applying principles and techniques of computer science, engineering, and mathematical analysis. This role involves creating software that meets specific user requirements and enhances business operations.

Common Skills

In 2023, the total employment volume for Software Developers was 22,842 in Macomb, Oakland and Wayne counties. Additionally, there were 12,849 unique job postings during the same time frame. In terms of the skills gap, the most significant differences between frequency of skills found in job postings versus those found in profiles were among the following:

- Communication
- Problem-Solving
- Writing
- Planning
- Innovation
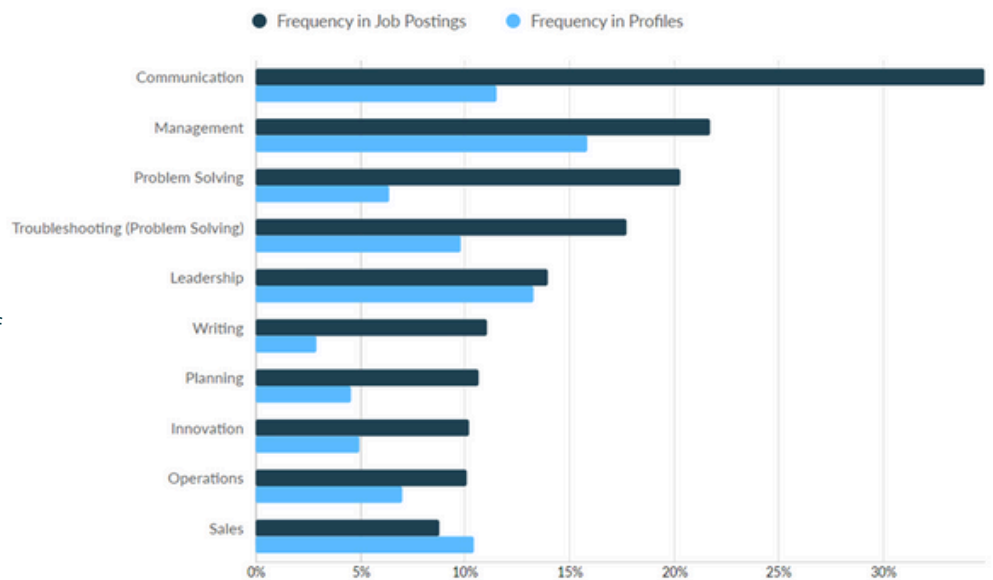
Technical Skills

With respect to technical skills, the largest gaps between job postings versus those found in profiles include the following:

- Computer Science
- Agile Methodology
- Debugging
- Software Development
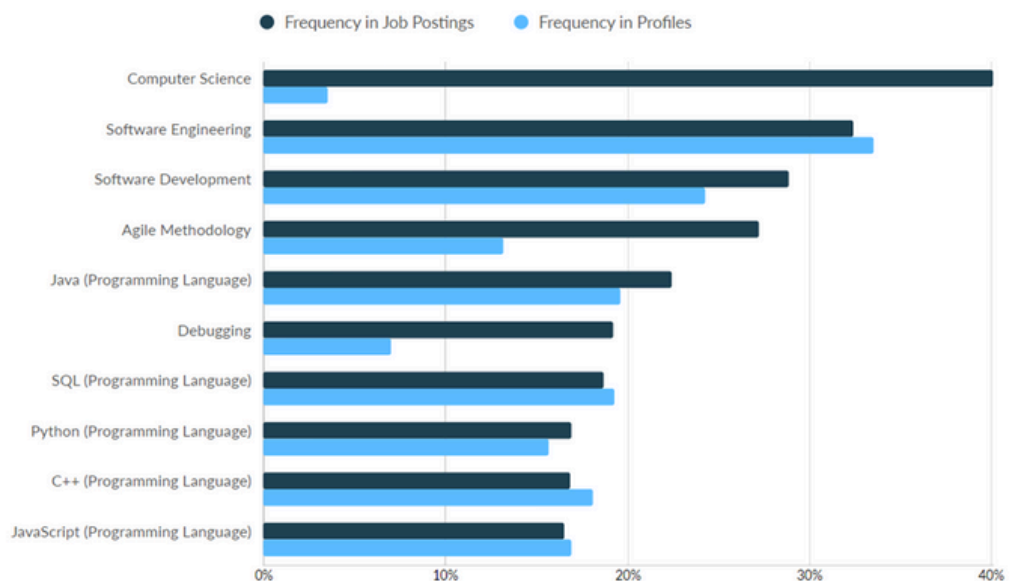
PHASE 3: SKILL ASSESMENT
IN-DEMAND SKILLS AND SKILL GAPS
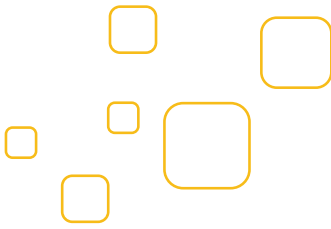
Computer User Support Specialists

Computer User Support Specialists provide technical assistance to computer users by addressing their questions and resolving computer-related problems. This role involves supporting clients in person, over the phone, or electronically. Support may cover a wide range of issues, including the use of computer hardware and software, installation, troubleshooting, and maintenance.
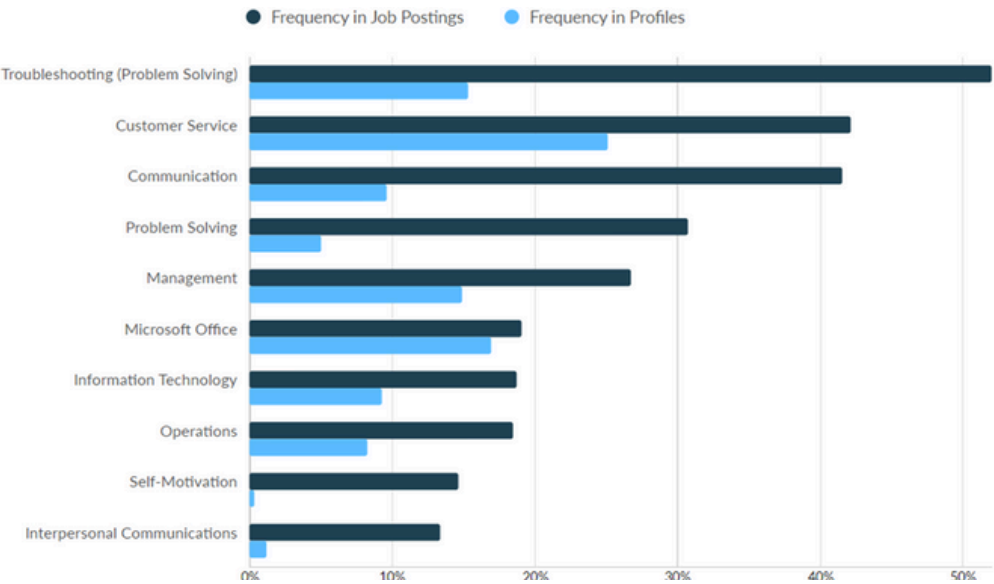
Common Skills

In 2023, the total employment volume for Computer User Support Specialists was 9,597 in Macomb, Oakland and Wayne counties. Additionally, there were 3,604 unique job postings during the same time frame. In terms of the skills gap, the most significant differences between frequency of skills found in job postings versus those found in profiles were among the following:

- Troubleshooting
- Communication
- Customer Service
- Management
- Self-Motivation

Technical Skills

With respect to technical skills, the largest gaps between job postings versus those found in profiles include the following:

- Technical Support
- Help Desk Support
- Operating Systems
- Active Directory
- Computer Science
- Computer Hardware
- Microsoft Office 365
- Microsoft Windows 10
- Desktop Support
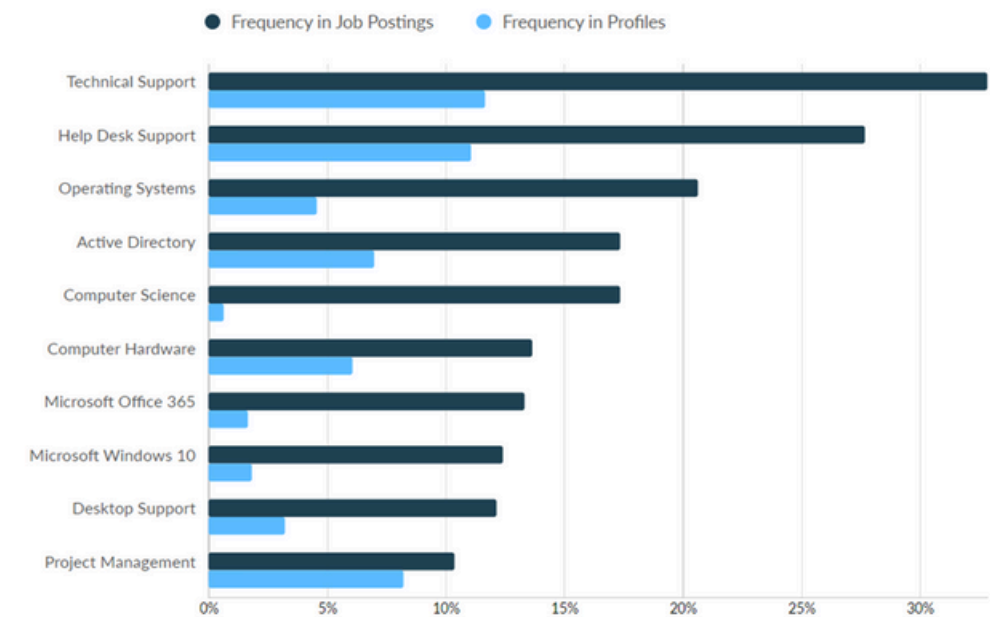
PHASE 3: SKILL ASSESMENT
IN-DEMAND SKILLS AND SKILL GAPS

Computer Systems Analysts

Computer Systems Analysts are tasked with identifying and resolving data processing challenges in science, engineering, business, and other sectors. They develop and implement solutions for complex application issues, system administration challenges, and network problems. Their primary responsibilities include enhancing existing computer systems, managing system operations, integrating different technologies, and assessing system capabilities and limitations.

Common Skills

In 2023, the total employment volume for Computer Systems Analysts was 9,060 in Macomb, Oakland and Wayne counties. Additionally, there were 1,715 unique job postings during the same time frame. In terms of the skills gap, the most significant differences between frequency of skills found in job postings versus those found in profiles were among the following:

- Communication
- Problem Solving
- Planning
- Writing
- Detail Oriented
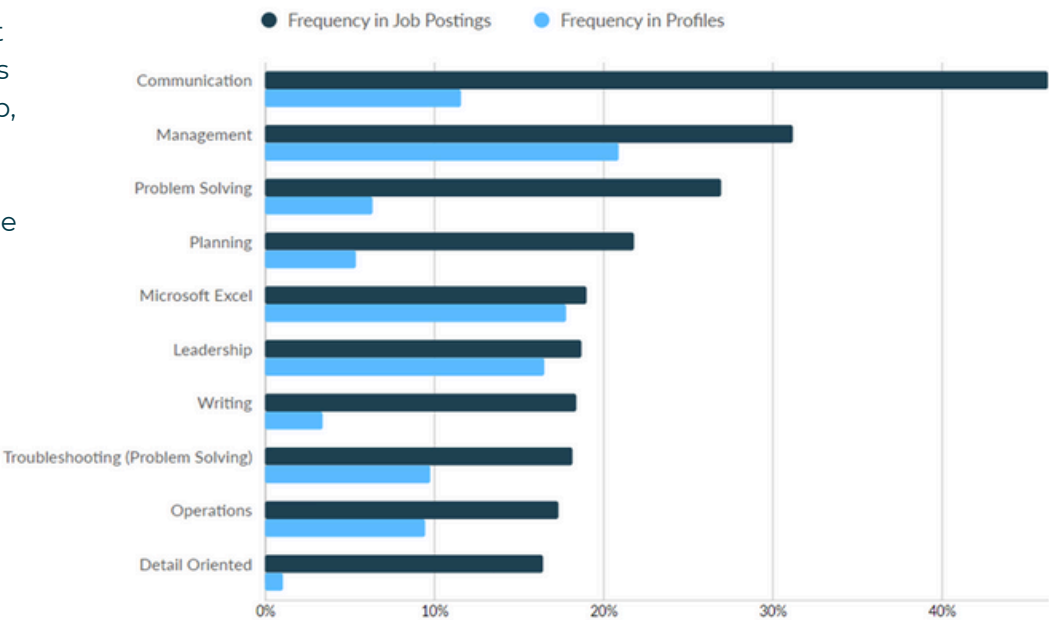
Technical Skills

With respect to technical skills, the largest gaps between job postings versus those found in profiles include the following:

- Business Process
- Business Requirements
- Auditing
- Workflow Management
- Agile Methodology
- SQL (Programming Language)
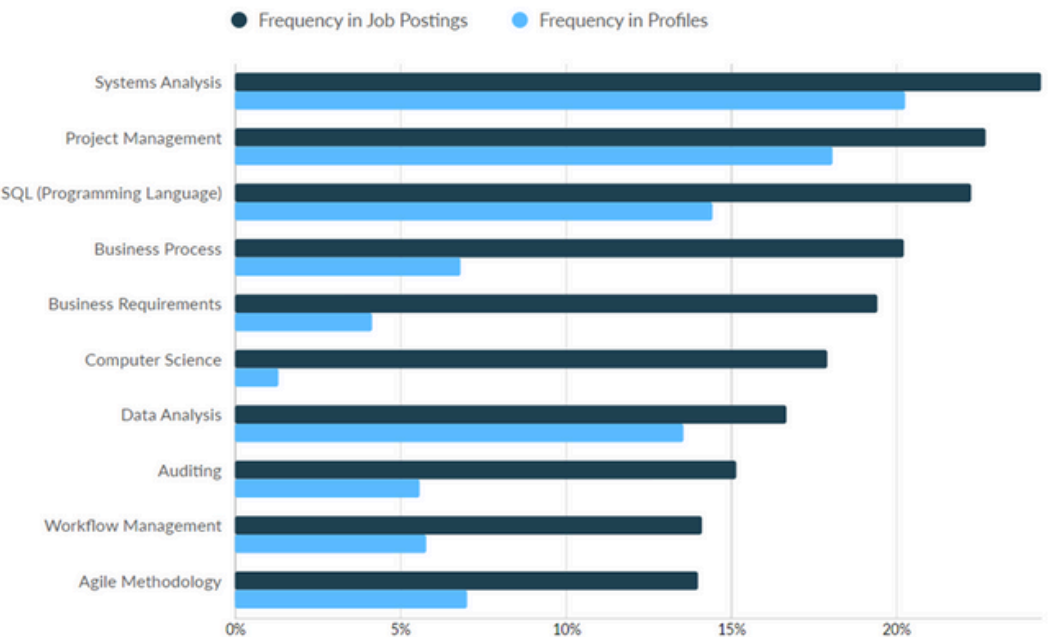
PHASE 3: SKILL ASSESMENT
IN-DEMAND SKILLS AND SKILL GAPS
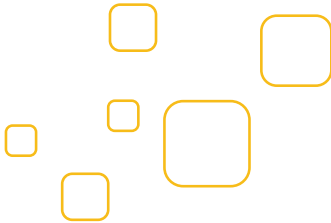
Computer and Information System Managers

Computer and Information Systems Managers oversee the planning, directing, and coordinating of activities in electronic data processing, information systems, systems analysis, and computer programming. They are essential in aligning an organization's technology infrastructure with its strategic business objectives.
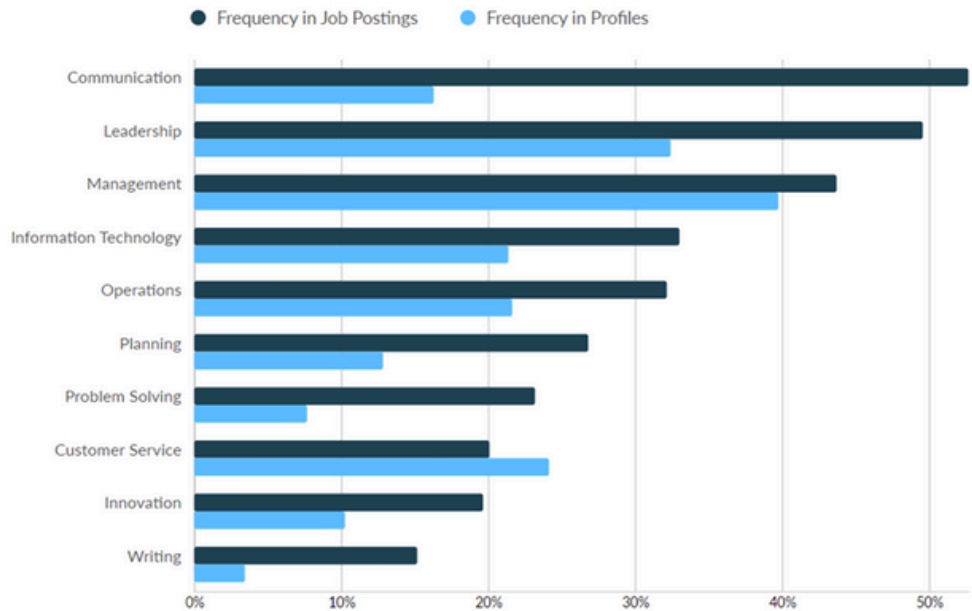
Common Skills

In 2023, the total employment volume for Computer Systems Analysts was 7,328 in Macomb, Oakland and Wayne counties. Additionally, there were 224 unique job postings during the same time frame. In terms of the skills gap, the most significant differences between frequency of skills found in job postings versus those found in profiles were among the following:

- Communication
- Leadership
- Planning
- Problem Solving
- Writing
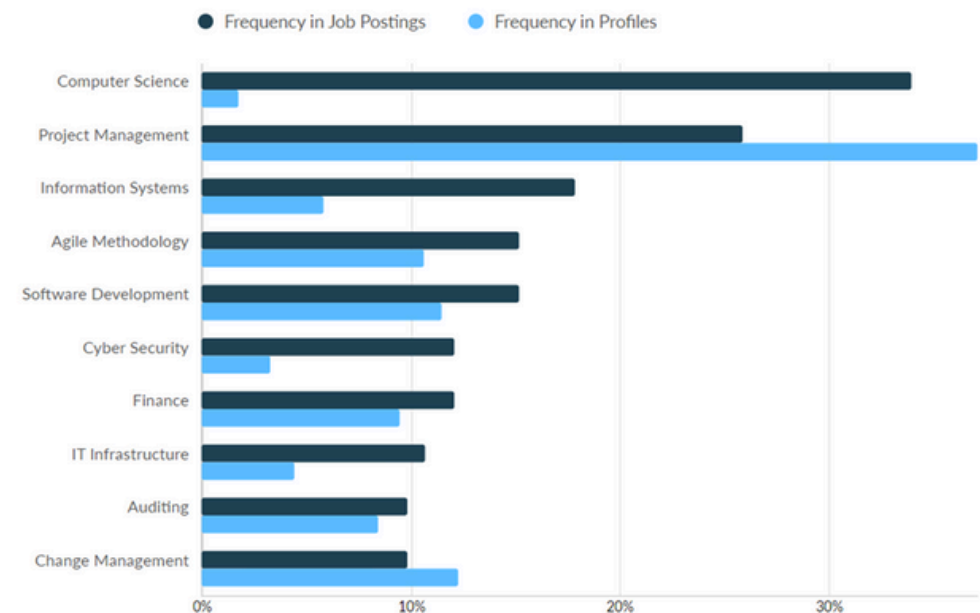
Technical Skills

With respect to technical skills, the largest gaps between job postings versus those found in profiles include the following:

- Computer Science
- Information Systems
- Cyber Security
- IT Infrastructure

PHASE 3: SKILL ASSESMENT
IN-DEMAND SKILLS AND SKILL GAPS
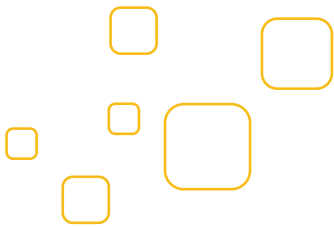
As revealed in the previous skill gap outlines, there are many overlapping skill gaps across the common skills group for these IT positions. Here, results have been aggregated into one of two categories: Frequent Gaps and Infrequent Gaps. The observation that common skills have considerably more overlap than technical skills seems to confirm the focus group findings, which imply that IT is a highly fragmented and specialty-driven industry.

Common Skills

Frequent Gaps
- Communication
- Problem-Solving
- Writing
- Planning

Infrequent Gaps
- Innovation
- Troubleshooting
- Customer Service
- Management
- Self-motivation
- Detail Oriented
- Leadership

Technical Skills

Frequent Gaps
- Agile Methodology
- Computer Science

Infrequent Gaps
- Information Systems
- Cyber Security
- IT Infrastructure
- Business Process
- Business Requirements
- Auditing
- Workflow Management
- Agile Methodology
- SQL (Programming)
- Technical Support
- Help Desk Support
- Operating Systems
- Active Directory
- Computer Science
- Computer Hardware
- Microsoft Office 365
- Microsoft Windows 10
- Desktop Support
- Computer Science
- Debugging
- Software Development

REGIONAL INDUSTRY IT SKILL NEEDS ASSESSMENT
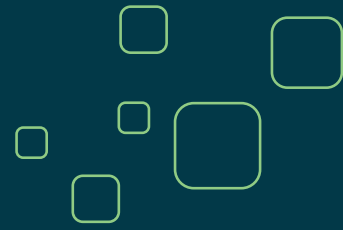
PHASE 4

The following report is based on a comprehensive literature review pertaining to addressing skills gaps through workforce training and development strategies. For many aspects of workforce training there are either few studies that qualify as "best-evidence" or the number of studies is too few for conclusions to be drawn with confidence.

As such, this report has been developed to serve the entire spectrum of workforce development activities, from apprenticeship training to specific education modalities. In some instances, there were sufficient anecdotal frameworks which provided for a general theme.

For this reason, sample training protocols are provided instead of a one-size-fits-all framework. Training institutions should tailor the program to the specific needs of their student demographics.

PHASE 4: BEST PRACTICES
REVIEW
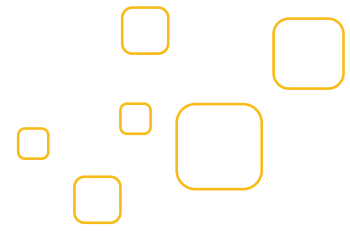
In today's rapidly evolving IT industry, addressing skill gaps has become a critical priority for organizations striving to maintain a competitive edge. Effective workforce development strategies are essential to bridge these gaps, ensuring that employees are equipped with the necessary skills to meet current and future demands. By integrating comprehensive training programs and dynamic curricula, both industry leaders and educational institutions can collaboratively foster a robust pipeline of talent. This synergy between education and industry not only enhances the skill sets of the existing workforce but also prepares the next generation of IT professionals to thrive in an ever-changing technological landscape.

Implementing these best practices demands a holistic and coordinated approach, where all stakeholders are actively engaged in continuous dialogue and collaboration to equip the workforce with the necessary skills for the evolving IT industry. The framework illustrated in figure 1.0 underscores the importance of collective effort from all parties involved to effectively address skill gaps and enhance workforce readiness.

The diagram outlines key actions required to bridge these gaps, categorizing them into five primary stakeholder groups: Employers, Employees/Job Seekers/Students, Education Providers, Policymakers, and Researchers. Each group has specific responsibilities and recommended actions, with connections between groups indicating areas of collaboration or mutual influence.

Figure 4.1 – Stakeholder Collaboration

EMPLOYERS	EDUCATION	EMPLOYEES, JOB-SEEKERS & STUDENTS	POLICYMAKERS	RESEARCHERS
• Identify Skill Needs • Continuous Analysis • Training Culture • Internships & Mentorships	• Innovation Methods • Personalized Learning • Balanced Education • Collaboration	• Self-Assessment • Lifelong Learning • Mentorship	• Incentivize Skill Development • Policy Formulation • Early Development • Accessibility & Affordability	• Industry Alignment • Workshops & Strategies • Regional Needs • Guidance Frameworks • Best Practices

PHASE 4: BEST PRACTICES
THEME 1: PROVIDE HANDS–ON EXPERIENCE

Most of the research analyzed suggests that one of the best ways to address skill gaps in IT is to provide ample opportunities for hands-on learning. Educators should focus on real-world project experience, industry tools, problem-solving skills, and effective communication. The University of Central Florida's partnership with Lockheed Martin exemplifies this approach. Despite 81% of companies valuing learning and on-the-job training, only 34% see reskilling as a way to increase talent availability. Hands-on learning has been shown to improve student comprehension and reduce failure rates. Active learning techniques also lead to better educational outcomes, even if students feel they learn more from traditional lectures. Several items emerged for consideration during review of the literature:

"The most commonly reported knowledge deficiencies that educators should address involve providing some type of real-world project experience, ensuring that students are exposed to the tools most commonly used in the software industry, making sure that students have effective problem solving skills and that they can effectively communicate their solutions to others..."

-Radermacher, Walia, & Knudson, 2014

"University of Central Florida has a long-standing partnership with Lockheed Martin called the College Work Experience Program that provides students with hands-on work experience. The program is a paid year-round learning and work experience for full-time students. Students collaborate on real projects with Lockheed Martin employees that give students experience while they test different potential avenues for their careers"

-Collins, 2021

"While 81% of companies consider investing in learning and on-the-job training to be a key strategy for delivering their business goals... only 34% consider providing reskilling and upskilling to be a way to increase talent availability specifically."

-World Economic Forum, Future of Jobs Survey, 2023

"This parameter was measured qualitatively in departmental course coordination meetings. Teaching the core and professional courses was found to be easier by institution's faculty members as the grasping level of student increased due to hands-on component in industry collaborative courses. This also resulted in general decrease of failure rates."

-Misra, 2020

*"Study shows students in 'active learning' classrooms learn more than they think "For decades, there has been evidence that classroom techniques designed to get students to participate in the learning process produces better educational outcomes at virtually all levels. And a new Harvard study suggests it may be important to let students know it. The study, published Sept. 4 in the Proceedings of the National Academy of Sciences, shows that, though students felt as if they learned more through traditional lectures, **they actually learned more when taking part in classrooms that employed so-called active-learning strategies.**"*

-Reuell, 2019

PHASE 4: BEST PRACTICES
THEME 2: INDUSTRY COLLABORATION

Postsecondary institutions and industry partnerships aim to bridge the gap between academic training and employer expectations in a rapidly evolving job market. Programs like the Google IT certificate and the College Work Experience Program at the University of Central Florida, in collaboration with Lockheed Martin, provide students with practical skills and work experience. Despite these successful examples, there is a need for more widespread infrastructure and incentives to support such collaborations, ensuring that graduates possess the technical, human, and occupation-specific skills required for workplace success. Furthermore, collaborations can offer a meaningful way to bring employers to the conversation by offering shared training costs while minimizing the risk of talent poaching. Within the literature that was reviewed, there were certain programs that stood out from the rest, including:

- The **CyberAmbassadors project**, which was recognized for its global impact and funded by the National Science Foundation to enhance communication, teamwork, and leadership skills among CyberInfrastructure professionals.
- The **expansion of professional skills training** to college students and professionals across STEM disciplines.
- The importance of **partnerships between postsecondary institutions and industry**, such as Google's IT certificate program with community colleges, to align educational outcomes with employer expectations.
- The need for **collaborative efforts** among employers, educators, researchers, policymakers, and learners to address skill gaps and ensure continuous skill development in response to technological changes.

In 2023, the CyberAmbassadors project was recognized for its global impact by the American Society for Engineering Education. The CyberAmbassadors project was funded through a workforce development grant from the National Science Foundation. Starting in 2017, the initial focus of this project was to develop, test, and refine new curriculum to help CyberInfrastructure (CI) Professionals strengthen their communications, teamwork and leadership skills. **With support and collaboration from a number of academic and professional organizations**, the CyberAmbassadors project was expanded to offer professional skills training to college students and professionals working across STEM (science, technology, engineering, math) disciplines (Luchini-Colbry, Joel-Luchini Colbry, Rojewski & Briliyanti, 2019).

PHASE 4: BEST PRACTICES
THEME 2: INDUSTRY COLLABORATION

"Postsecondary institutions and industry partnerships are an important strategy to close the gap between what colleges produce in their students and what employers expect in their employees. The speed of technological change and job creation and destruction is ever increasing, and postsecondary institutions have struggled to keep pace with the pressing demands for the continuous innovation and upgrading of skills needed in the marketplace....For example, technology companies like Google are partnering with community colleges and JFF to offer the Google IT certificate, a credential that students can earn to increase their chances for employment in IT fields. Over 100 community colleges in 15 states are implementing the certificate program to provide their students with access to IT credentials, skills, and potential employers."

-Collins, 2021

"One dominant action crystallized: collaborating and creating partnerships among these stakeholders. In particular, employers should collaborate with education, researchers, and policymakers. In addition to collaborating with other stakeholders, there are actions proposed to each stakeholder. Among others, employers should work on a skill strategy, support the upskilling of their workforce, and define clear requirements of their skill needs towards education providers. Education providers should deliver highly relevant training by understanding industry needs and implementing innovative learning methods. Employees, students, and job seekers should keep themselves updated with the changes impacting their work or future work, and take initiative in learning new skills, as lifelong learning becomes the new normal. Policymakers can find the right incentives for the stakeholders to take action, foresee skill needs, and motivate children and other groups to join industry. Lastly, the research community should support the collaboration of stakeholders, create skill frameworks for changing jobs, and carry out workshops with employers and employees to understand skill gaps."

-Braun, Rikala, Jarvinen, Hamalainen & Stahre, 2024

PHASE 4: BEST PRACTICES
THEME 3: APPRENTICESHIPS & MENTORSHIPS

The apprenticeship model in workforce development is a structured program that combines paid on-the-job training with classroom instruction, allowing workers to gain practical experience while learning theoretical aspects of their trade. Apprenticeship training has a long and well-documented history in modern civilization. This model benefits employers by creating a pipeline of skilled workers tailored to their specific needs, improving employee retention, and boosting productivity. Additionally, it is cost-effective, reducing recruitment costs and fostering a culture of continuous learning and development within the organization. Overall, apprenticeships help address the skills gap and contribute to a more engaged and capable workforce. Below are a few examples of successful apprenticeship programs identified.

Expand Access to Paid Internship

"Bunker Hill Community College's Learn and Earn internship is an example…Over 150 Learn and Earn students a year earn $18 an hour and a one-time transportation stipend of up to $500 to work in large corporations, small businesses, nonprofits, and civic organizations, directly applying what they learn in the classroom on the job. Since 2016, 11 Bunker Hill Community College partner companies have hired student interns into full-time jobs."

-Collins, 2021

5 Ways Companies are Addressing Skills Gaps in Their Workforce

"Apprenticeships in the IT and telecommunications sector grew by more than 300% between 2011 and 2020, while cybersecurity apprenticeships grew by 600% during the same period, according to the Department of Labor… Verizon…uses the apprenticeship model to fill software engineering jobs and reports that 95% of an initial cohort accepted full-time offers at the company after completing an apprenticeship program."

-Chopra-McGowan, 2023

**95%
of the Initial
Cohort Accepted
Full–Time Job
Offers**

**150
Learn and
Earn Students
A Year**

PHASE 4: BEST PRACTICES
THEME 4: TRAINING PROTOCOLS
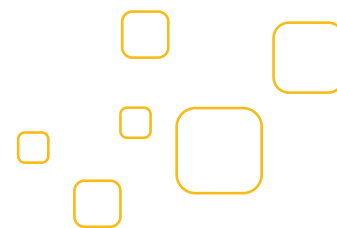
Boot Camps

As described previously, one key objective of this literature review is to provide various frameworks of training that can be emulated at the local level. Rather than prescribing a specific set of criteria, each of the programs described below should be evaluated for best fit and practicality. Each offers a unique set of benefits, although there is considerable overlap amongst them.

Closing the Skills Gap: Creating Workforce Development Programs that Work for Everyone

"In delivering training, one proven approach is to provide two- to three-month 'boot camps.' During the boot camp, competency is assessed regularly, based on actual demonstrations. Employers collaborate with the training providers and can offer their staff as trainers. The boot camp must be practical, including in-person simulations, on-site apprenticeships, and 'serious games' customized to the workplace, where learners can play virtually and repeatedly. Programs need to have a strong in-person component to deliver the necessary dosage of intensive practice and to build the trust that allows providers to support learners…At the same time, technology-based solutions, such as online applications, mobile apps that track learner performance, and digital workplace simulations can significantly increase the efficiency and effectiveness of these in-person programs… Some go even further, providing postgraduate mentorship for the first few months on the job, which is the period of greatest vulnerability."

-Laboissiere & Mourshed, 2017

PHASE 4: BEST PRACTICES
THEME 4: TRAINING PROTOCOLS
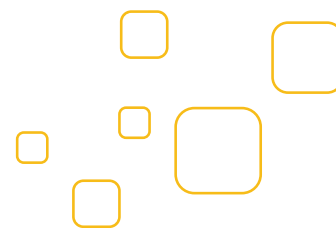
Web-Based Learning

Engaging Online Learners: The Impact of Web-Based Learning Technology on College Student Engagement

Online learning platforms (**Web-based learning**) leverage online platforms to provide flexible learning opportunities that can be accessed anywhere, allowing individuals to learn at their own pace. Web-based learning in Information Technology (IT) refers to the use of internet technologies and web tools to facilitate and enhance educational experiences. This approach leverages online platforms, resources, and tools to deliver, support, and manage learning activities. [The Research team] investigates the impact of Web-based learning technology on college student engagement and self-reported learning outcomes in both face-to-face and online learning environments. (Pu-Shih Daniel Chen, Amber D. Lambert, and Guidry, 2010)

Study: Online Classes Really Do Work

Online classes, specifically Massive Open Online Courses (MOOCs), are demonstrated to be as effective as traditional classroom courses, irrespective of students' initial preparation levels.

- **Study Context and Purpose**

  - Conducted by MIT researchers including David Pritchard.
  - Published in the International Review of Research in Open and Distance Learning.

- **Findings**

  - MOOCs are as effective in teaching as traditional classes.
  - Effectiveness remains consistent regardless of student preparation levels.
  - Improvement in learning comparable to or better than traditional lectures.

- **Methodology**

  - Utilized pre- and post-testing for assessment.
  - Applied item-response theory for detailed analysis.

- **Comparative Effectiveness**

  - MOOCs showed equal or better learning gains compared to traditional classes.
  - Interactive engagement pedagogy (students interact frequently in small groups to grapple with concepts and questions) in traditional settings yielded superior results.

- **Implications and Future Research**

  - Potential for further insights from detailed data on student interactions.
  - Study opens avenues for refining educational methodologies in MOOCs.

PHASE 4: BEST PRACTICES
THEME 4: TRAINING PROTOCOLS
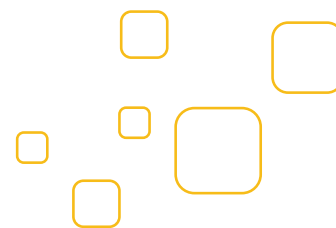
Problem-Based Learning

Effects on Academic Performance and Perceptions of Engineering Students in Computer Sciences

Problem-based learning (PBL) in information technology (IT) is an instructional method where students learn by actively engaging in solving complex, real-world problems. Instead of passively receiving information, students are presented with a problem and work collaboratively to research, analyze, and develop solutions. In IT, PBL helps students develop practical skills like problem-solving, critical thinking, and teamwork while also applying theoretical knowledge to real-world scenarios. It's a hands-on approach that bridges the gap between theory and practice. Outcomes: The study found a positive relationship between the use of learning technology and student engagement and learning outcomes in terms of better understanding of course content, improved grades, and enhanced problem-solving. For instance, students in the PBL group showed a 20% improvement in coding proficiency compared to those in traditional lecture-based courses. There was a 30% increase in problem-solving efficiency for students in the PBL group.

- **Problem-Based Learning Program** (University of Waterloo - School of Computer Science):

  - **Program:** Bachelor of Computer Science (BCS) Co-op Program

  - **Description:** The co-op program integrates PBL by having students alternate between academic study and work terms in industry. During their work terms, students solve real problems in professional settings, applying their classroom knowledge to practical challenges.

PHASE 4: BEST PRACTICES
THEME 4: TRAINING PROTOCOLS

Cohort-Based Courses

5 Ways Companies are Addressing Skills Gaps in Their Workforce

Cohort-based courses (CBC) emphasize active learning, hands-on projects, and community interaction, enhancing learning outcomes and accountability. The **community element**, especially in regards to young learners who are often introduced to social influence at a young age, taps into the ethos of this generation in a way that other learning modalities do not.

"Now, a new delivery format called "cohort-based courses" has emerged as a way to improve completion rates. Groups of participants together take a course with defined start and end dates, regular homework assignments, and an instructor to run periodic live online discussion sessions. Within this more structured format, participants still access much of the learning material on their own time, making it easier for them to complete the course and have the chance to apply what they learn over its duration. One of the pioneers of this space, altMBA, says its learners have achieved a 96% completion rate. Boston Consulting Group (BCG) is one leading employer that has embraced cohort-based courses...Lidia Juszko, BCG's executive director of global learning and teaming, describes how the format works particularly well for a professional services firm like hers. 'We've found that cohort-based courses offer a level of structure and support that makes them more engaging than standard online learning,' she said. 'Our colleagues report that the combination and cadence of 'office hours' with instructors, live discussion sessions with the rest of the cohort, and short videos and exercises to be completed each week are a more accessible way for them to learn. Learning and development opportunities like this allow us to continue to attract and retain the best talent."

-Chopra-McGowan, 2023

*"**The altMBA** — one of the most successful online learning experience to date...uses digital tools like Slack, WordPress and Zoom to engage more than 100 students at a time in an intense four-week course...altMBA students voluntarily opt-in to the ~3–5 hours of work per day everyday on top of their full-time jobs during the four week program...'We spent months looking at different combinations on the x-y axes spectrum and what the trade-offs and gains would be. One of the guiding principles that came out of this questioning was this: Scale isn't the point. Change is the point. And once we discarded scale, we added coaches into the mix...From there, finding the platonic ideal of 10 coaches, 10 students per coach seemed a natural place to settle."*

-Habif, 2016

PHASE 4: POTENTIAL EMPLOYERS AND EDUCATIONAL PARTNERSHIPS

Employers and educational partnerships are crucial for addressing skills gaps because they create a direct link between the skills taught in educational institutions and the needs of the workforce. These partnerships allow employers to communicate their specific skill requirements to educators, ensuring that training programs are aligned with industry demands. This alignment helps produce a workforce that is better prepared and more capable of meeting current and future job requirements.

Additionally, such collaborations can reduce training costs for employers, as educational institutions often have the resources and expertise to provide specialized training. These partnerships also enhance productivity and employee retention by fostering continuous learning and development. Overall, by working together, employers and educational institutions can more effectively bridge the skills gap, leading to a more competent and competitive workforce. Following the analysis of best practices to address skills gaps, this review also identifies prospective employers and initiatives to help satisfy those frameworks. A brief review of each is provided below.

Girls Who Code

Girls Who Code works to close the gender gap in the technology industry by changing the image of what programmers look like and do. It consists of clubs for 3rd-5th and 6th-12th grades, summer programs for high school students and college and career programs. With only around 24% of individuals in the IT profession being women, there is room for great growth in the field by expanding efforts to recruit girls, women, and nonbinary individuals.

Suggestion: Create a College Loop at MCC: Girls Who Code | College Loops. There are many clubs near MCC:

2. Iroquois Middle School
3. Gene L. Klida Utica Academy for International Studies
4. Athens High School
5. International Academy East
6. Center Line High School
7. Wilkinson Middle School
8. ROMS GWC Coding Club
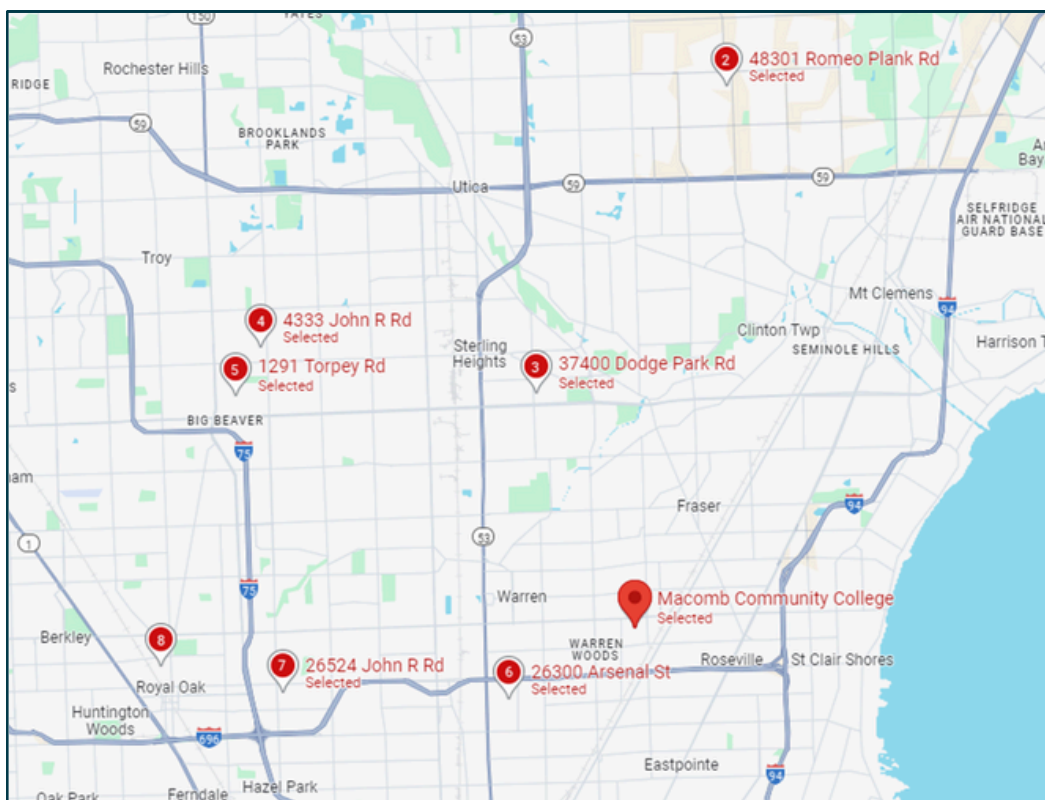
PHASE 4: POTENTIAL EMPLOYERS AND EDUCATIONAL PARTNERSHIPS

Code for Good (West Michigan)

Code for Good West Michigan is a volunteer organization dedicated to helping local nonprofits thrive through technology. This organization hosts many events, including "Weekend for Good", "Lead for Good", and "Workshop for Good."

## Guide Star Helps to Keep Computer Science Talent in Upper Michigan

*"Many of the students in the computer science program are a part of an apprenticeship program with the IT and cybersecurity company Guide Star... And so, **getting in with them at the high school level and using that as a feeder program is a great strategy** for us... Almost 50 students enrolled in the computer science class in 2024."*

-Rierson, 2024

Local Software Company Launches Region's First Application Developer Registered Apprenticeship Program

*"A first-of-its-kind apprenticeship program in northern Michigan will help a Petoskey based software company train its employees. The Pesto Group, **in partnership with Northwest Michigan Works!,** has launched a unique U.S. Department of Labor registered apprenticeship for Application Developer... Registered under the Northwest Michigan Works! U.S. Department of Labor (USDOL) Standards of Apprenticeship, the Pesto Group is providing seven apprentices with **12 months of on-the-job learning along with a minimum of 200 hours of related education... The study plan complements the hands-on learning** while providing an innovative, robust experience to expand the career pathways for the apprentices... The Pesto Group has partnered with Northwest Michigan Works! to develop our initial registered apprenticeship program... "*

-Boss, 2023
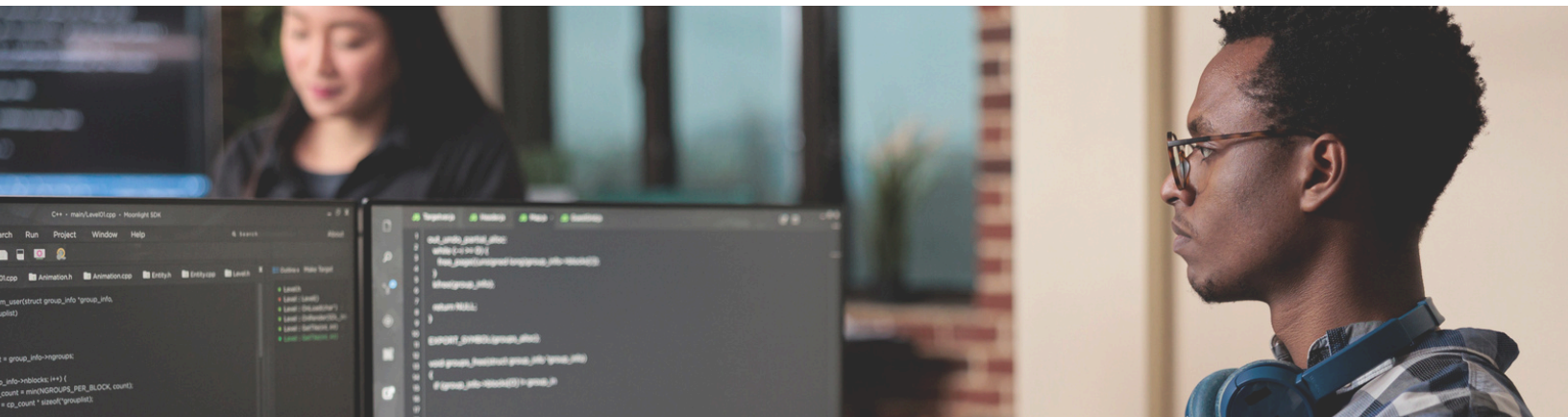
PHASE 4: BEST PRACTICES
SUMMARY
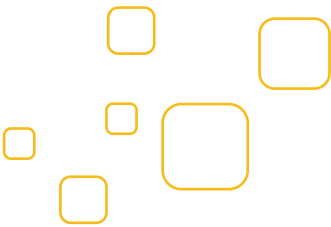
The diagram below presents key best practices identified through comprehensive IT training programs, diverse pedagogical strategies, and curricula, as well as the active roles of stakeholders such as employers and education providers. These practices offer practical insights for employers, educators, and policymakers aimed at fostering the development of high-demand IT skills.
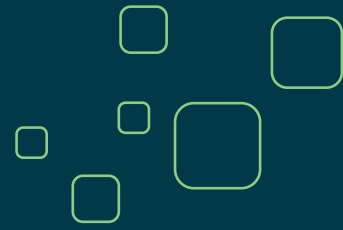
Employers continually assess evolving skill requirements, prioritizing upskilling and reskilling efforts. Education providers are encouraged to incorporate hands-on learning opportunities to equip IT students with both specialized and broadly applicable skills sought by employers.

Additionally, job seekers can enhance their capabilities through experiential learning pathways, including apprenticeships, mentoring, boot camps, accelerated training programs, online learning platforms, and networking initiatives. A range of local programs supporting these efforts are available within the t-county region, as illustrated in the Best Practices Diagram below.

Figure 4.2 – Summary of Phase 4 Best Practices

EMPLOYERS	EDUCATION PROVIDERS	EXPERIENTIAL PROGRAMS	LOCAL PROGRAMS
• Identify IT Skill Needs • Continue to Identify Upskills & Reskills	• Hands-on Experience • Web-based Learning • Problem-based Learning Program • Cohort-based Course	• Apprenticeship & Mentoring • Boot camps & Accelerated Training Program • On-the-job Training • Online Learning Platform • Mentorship & Networking	• Girls Who Code • Code for Good • Cyber Ambassador • Guide Star (Computer Science Talent in Upper MI) • Local Software Company Launches Region's First Application Developer Registered Apprenticeship Program

COLLABORATION
(Employers, Education Providers, Policymakers & Researchers)

REGIONAL INDUSTRY IT SKILL NEEDS ASSESSMENT

PHASE 5

In the rapidly evolving landscape of information technology, several key trends are poised to shape the future of the industry. Among these, Artificial Intelligence (AI) continues to revolutionize various sectors by enhancing automation, decision-making, and predictive analytics. Cybersecurity remains a critical focus as organizations strive to protect sensitive data and infrastructure from increasingly sophisticated threats. Immersive-reality technologies, including virtual and augmented reality, are transforming user experiences and creating new opportunities for interaction and engagement. Meanwhile, cloud computing is driving innovation by providing scalable, flexible, and cost-effective solutions for data storage and processing. Together, these trends are not only redefining the IT industry but also paving the way for groundbreaking advancements and applications.

PHASE 5: FUTURE TRENDS
EMERGING SKILLS AND TECHNOLOGY

Which IT emerging technologies will have the greatest impact during the next five years?

The figure presents a set of high-growth emerging technologies, currently dominated by the AI technology cluster, including machine learning, neural networks, and NLP. The data demonstrates that the integration of AI is significantly influencing IT professionals. The second greatest impact among emerging IT technologies is expected to be in encryption and cybersecurity, followed by cloud computing.
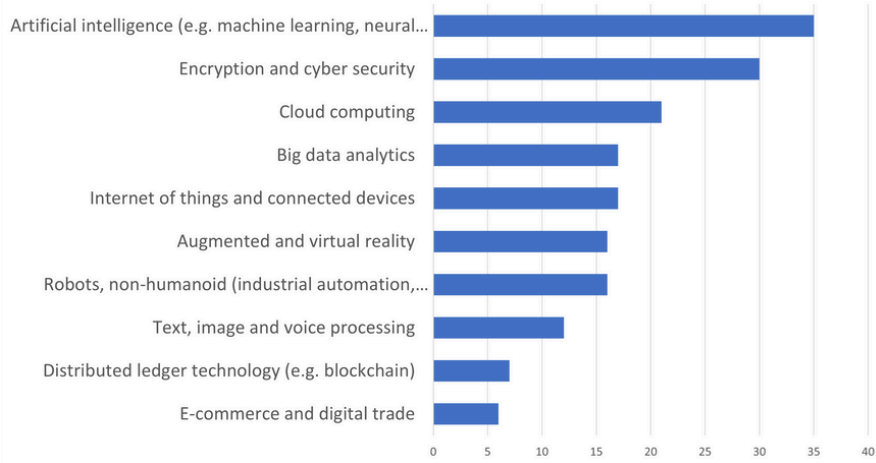
Future trends of Technology

Each trend is scored based on its level of innovation, interest, investment, and adoption.

Innovation, interest, investment, and adoption, by technology trend, 2023
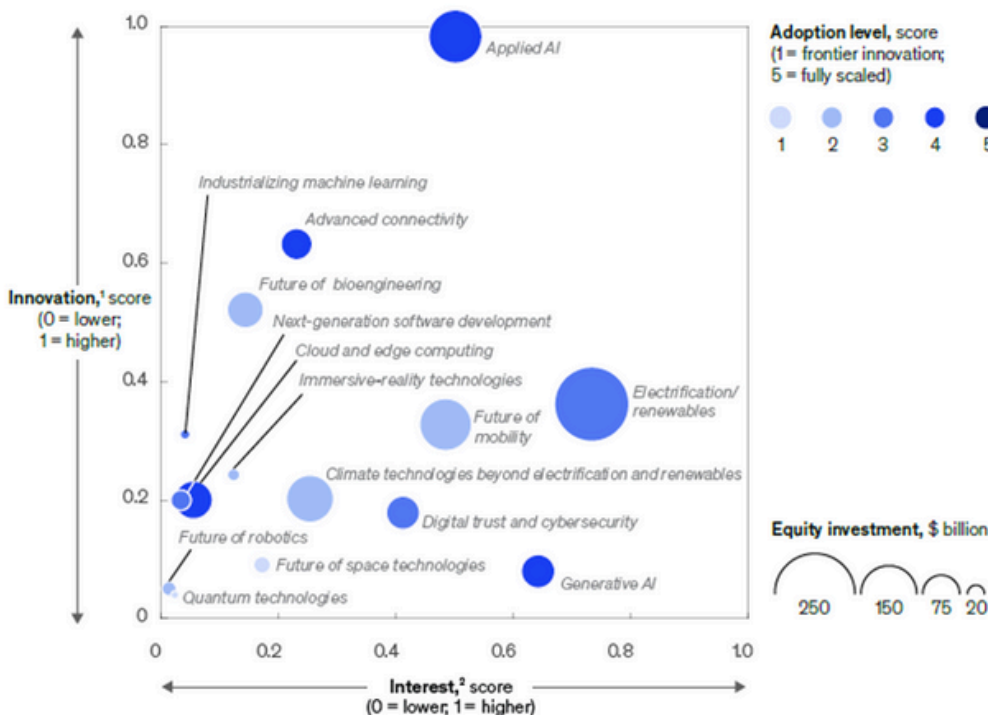
Note: Innovation and interest scores for the 15 trends are relative to one another. All 15 trends exhibit high levels of innovation and interest compared with other topics and are also attracting significant investment.

1 The innovation score combines the 0–1 scores for patents and research, which are relative to the trends studied. The patents score is based on a measure of patent filings, and the research score is based on a measure of research publications.

2 The interest score combines the 0–1 scores for news and searches, which are relative to the trends studied. The news score is based on a measure of news publications, and the searches score is based on a measure of search engine queries.

Data Source: Mckinsey & Company, 2024

PHASE 5: FUTURE TRENDS
GENERATIVE AI TRENDS
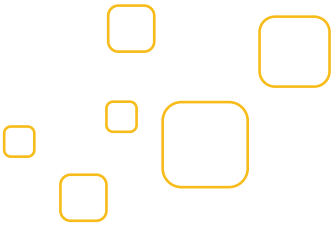
Rapid Advancements: Gen AI has made significant progress, expanding machine capabilities by producing unique outputs from unstructured data like text, code, images, music, and 3D models.
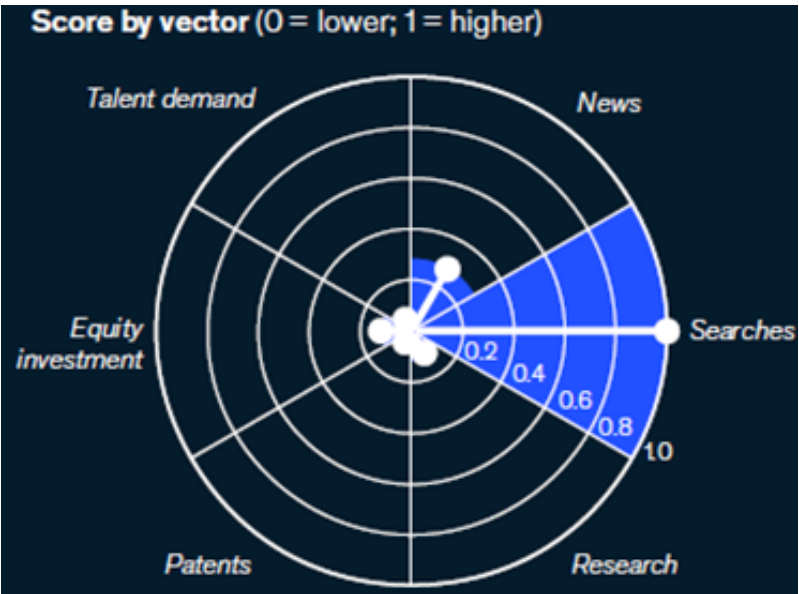
Notable Models: Models such as OpenAI's GPT-4, Anthropic's Claude, Google's Gemini, and tools like DALL-E 3 and Midjourney have achieved impressive results in text and image generation, with new innovations like OpenAI's Sora for text-to-video generation and Suno for music composition.

2021 & 2022

1

Image-text models* proliferate

2021
- OpenAI CLIP
- Google ALIGN
- Salesforce ALBEF

2022
- Google LiT
- Google COCA
- DeepMind FLAMINGO
- Salesforce BLIP

2023

2

LLMs understand images
- Salesforce BLIP 2
- Microsoft KOSMOS
- OpenAI GPT-4
- LLaVA
- Adept FUYU-8B

Models tackle more sensory data
- Google PALM-E
- Meta ImageBind

Natively multimodal models emerge
- Google Gemini

Data Source: CB Insights, 2024

Widespread Adoption: Gen AI has sparked significant interest across various regions and industries, with 65% of organizations now using it regularly in at least one business function, a sharp increase from the previous year.

Economic Potential: Gen AI use cases could generate an annual value between $2.6 trillion to $4.4 trillion, highlighting its vast economic impact.

Scoring the Trend

Score by vector (0 = lower; 1 = higher)

Talent demand — News — Searches — Research — Patents — Equity investment

0.2 0.4 0.6 0.8 1.0

Rapid Growth: Gen AI experienced a significant surge in 2023, largely driven by the late-2022 launch of ChatGPT.

Key Models: Earlier models like DALL-E 2 and Stable Diffusion also contributed to this growth.

Increased Interest: There was a sevenfold increase in searches and investments in Gen AI from 2022 to 2023, indicating heightened excitement and interest in the technology.

Data Source: Mckinsey & Company, 2024

PHASE 5: FUTURE TRENDS
GENERATIVE AI (GEN AI) JOB DEMAND TRENDS

Significant Growth: Since 2019, roles related to Gen AI have seen a 111% increase in job postings by 2023.

High Demand: This surge is fueled by growing interest and investment in the Gen AI field.

Widespread Role Growth: Almost all Gen AI-related roles, especially individual contributor positions, have experienced a notable rise in demand, with the exception of regulation affairs directors.
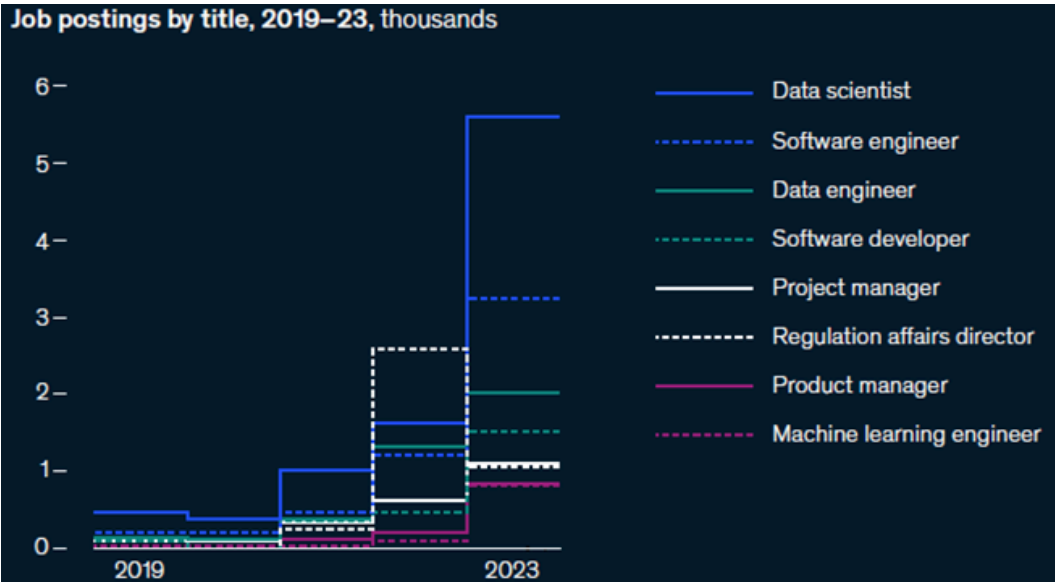
Data Source: Mckinsey & Company, 2024

Focus on Scaling: Organizations are prioritizing the expansion of internal capabilities to leverage Gen AI, leading to a sharp increase in demand for data scientists, software engineers, and data engineers.

Generative AI Demand Soars 1,800% for US Employers

- In 2022, there were only 519 job postings calling for generative AI, Lightcast data shows. So far in 2023, and since the debut of ChatGPT in December 2022, there have been 10,113 generative AI postings, an increase of 1,848%. There were more than 385,000 postings for all forms of Artificial Intelligence roles so far in 2023.
- Most of the occupations involved are those already involved in AI development, such as Machine Learning Engineers and Artificial Intelligence Engineers. This reflects the intense development process companies are going through as they develop new applications.

Data Source: Lightcast, 2023

PHASE 5: FUTURE TRENDS
GENERATIVE AI

Real-World Application

Data Analysis and Content Creation: Gen AI can analyze various types of data, such as text, images, and voice, enabling the creation of new content on demand. This capability enhances personalization and improves customer and employee engagement experiences.

Companies like Bell Canada are using a combination of generative and predictive AI to foresee and mitigate risks associated with environmental events, such as snowstorms, which can lead to network outages. This predictive capability allows for better resource allocation and workforce readiness, thereby reducing the costs associated with major service disruptions **(Predictive maintenance and risk management)**.

The telecommunications industry, which has long struggled with growth and profitability, is finding new opportunities for margin improvements through Gen AI. By enhancing customer life cycle management and reducing operating costs, companies can achieve significant returns on investment within a few years **(Profitability improvements)**.

Gen AI is revolutionizing sales operations by absorbing and processing sales documentation, pricing models, and customer experience data. This technology can power advanced chatbots that answer sales-related queries and provide real-time insights, enhancing overall sales efficiency **(Sales Operations)**.

Customer Service: Gen AI boosts agent productivity by automating the transcription and summarization of customer interactions. This creates smarter customer service knowledge centers and improves agent performance, leading to higher customer satisfaction and operational efficiency.

Marketing Operations: Gen AI enables hyper-personalization in marketing by analyzing customer data to identify sales leads and tailor content to individual preferences. For instance, a European telecom provider reportedly increased its customer conversion rates by 40% using Gen AI to personalize marketing content.
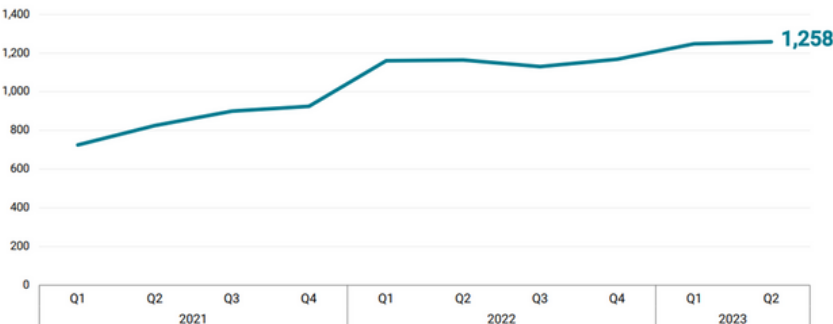
Data Source: Gordon, 2024
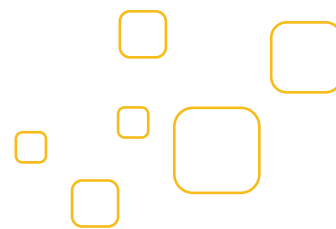
PHASE 5: FUTURE TRENDS
DIGITAL TRUST AND CYBERSECURITY

Digital Trust and Cybersecurity Trends

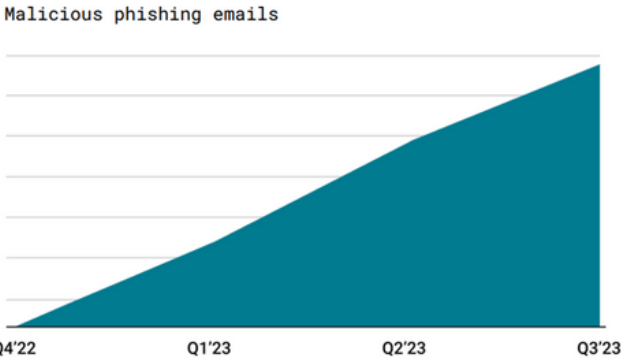**Cyber-Attacks Continue to Rise, with AI a Driving Force**
Global average weekly cyber-attacks per organization hit an all-time peak in Q2 23

Data Source: CB Insights, 2024

Chat GPT Drives an Explosion of Email Phishing Attacks
One email security vendor recorded a 1,256% increase in phishing emails from Q4 22 to Q3 23

Data Source: CB Insights, 2024

Growing Importance: As organizations adopt emerging technologies (e.g., cloud computing, applied AI), the need for robust digital trust and cybersecurity is increasing.

Challenges: Adoption faces hurdles such as integration challenges, organizational silos, talent shortages, and undervaluation as a critical component of value propositions.

Leadership and Strategy: Realizing the full benefits of digital trust and cybersecurity requires strong leadership and deliberate strategic changes across multiple areas.

Key Role in Risk Management: Digital trust and cybersecurity are crucial for managing technology and data risks, accelerating innovation, and protecting organizational assets.

Enhancing Performance: Trust in data and technology governance can boost organizational performance and improve customer relationships.

Relevant Technologies: This trend includes digital identity, privacy-enhancing technologies, cybersecurity capabilities (like identity and access management), and Web3 technologies (such as blockchain).

PHASE 5: FUTURE TRENDS
DIGITAL TRUST AND CYBERSECURITY

Scoring the Trend
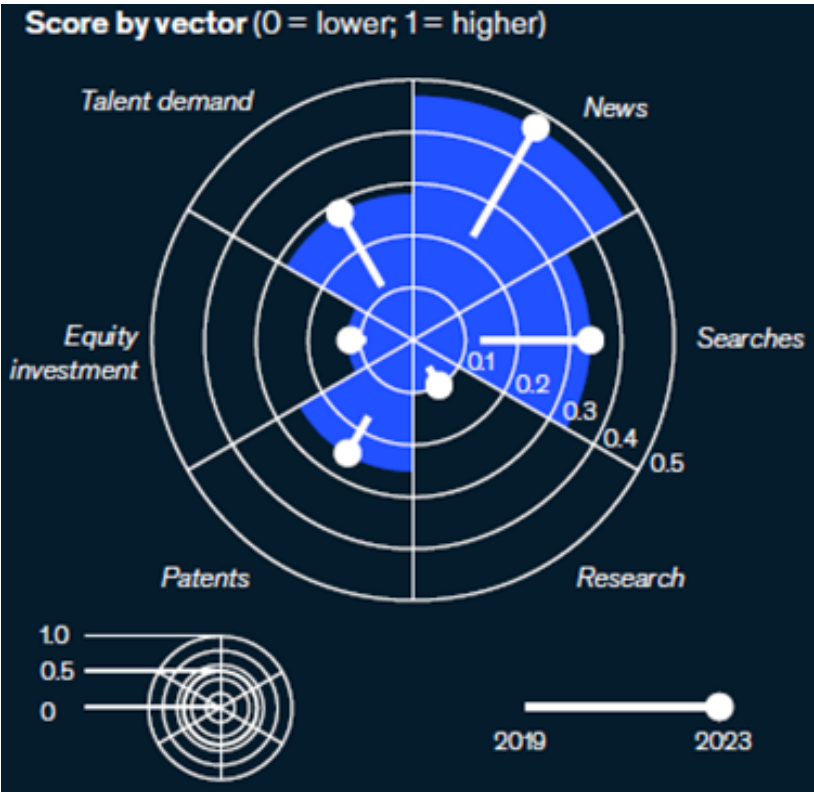
Data Source: Mckinsey & Company, 2024

Strong Growth in 2021: The cybersecurity market saw a growth rate of 12.4% in 2021.

Impact of Macroeconomic Slowdown: In 2023, the digital trust and cybersecurity trend experienced a decline in investment and talent demand compared to 2022, due to the macroeconomic slowdown.

Long-Term Robust Growth: Over a five-year period (2019–2023), the market demonstrated strong growth across all dimensions.

Ongoing Digitization: As enterprises continue to digitize, the digital trust and cybersecurity trend is expected to keep gaining momentum.

Job Demand Trends in Digital Trust and Cybersecurity

Short-Term Decline

34%

Job postings for digital trust and cybersecurity decreased by 34% between 2022 and 2023.

Long-Term Growth

123%

Despite the recent decline, there was a 123% increase in job postings between 2019 and 2023.

High-Demand Roles

Security analysts are the most in-demand jobs in this field, followed by software and security engineers.

PHASE 5: FUTURE TRENDS
## DIGITAL TRUST AND CYBERSECURITY
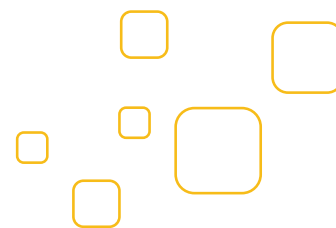
Real-World Application

Salesforce's Einstein Trust Layer: Salesforce developed the Einstein Trust Layer to secure interactions between users and large language models (LLMs) within its platform. This system masks personally identifiable information (PII) before it is processed by LLMs and operates with a zero-retention architecture, ensuring no Salesforce data is stored outside the platform or used to train the LLM. It also monitors outputs for inappropriate content, enhancing data confidentiality and privacy.

Cisco's Trust Portal: Cisco introduced the Cisco Trust Portal, a self-service tool that provides customers with on-demand access to documents related to security, trust, data protection, and privacy compliance. This portal helps customers evaluate the security of Cisco's offerings and better understand the company's security measures.

Skyflow Data Privacy Vault: Skyflow offers a platform called the Skyflow Data Privacy Vault, which acts as a secure central hub for managing, protecting, and utilizing sensitive data. It isolates and encrypts sensitive data while allowing users to access it through secure APIs without decrypting the original information, ensuring privacy and compliance.

Franklin Templeton's Blockchain Mutual Fund: Franklin Templeton launched the Franklin OnChain U.S. Government Money Fund, the first U.S.-registered mutual fund to use a public blockchain for transactions and share ownership records. By March 2024, the fund had exceeded $330 million in assets, using the Stellar and Polygon blockchains, with plans to expand to other blockchains.

Citibank's Citi Token Services: Citibank developed Citi Token Services, a blockchain-based token service that converts institutional clients' deposits into digital tokens. This service facilitates immediate cross-border payments, liquidity, and automated trade finance solutions, integrating these tokenized deposits into Citi's global network to enhance its cash management and trade finance functions.

Data Source: Mckinsey & Company, 2024
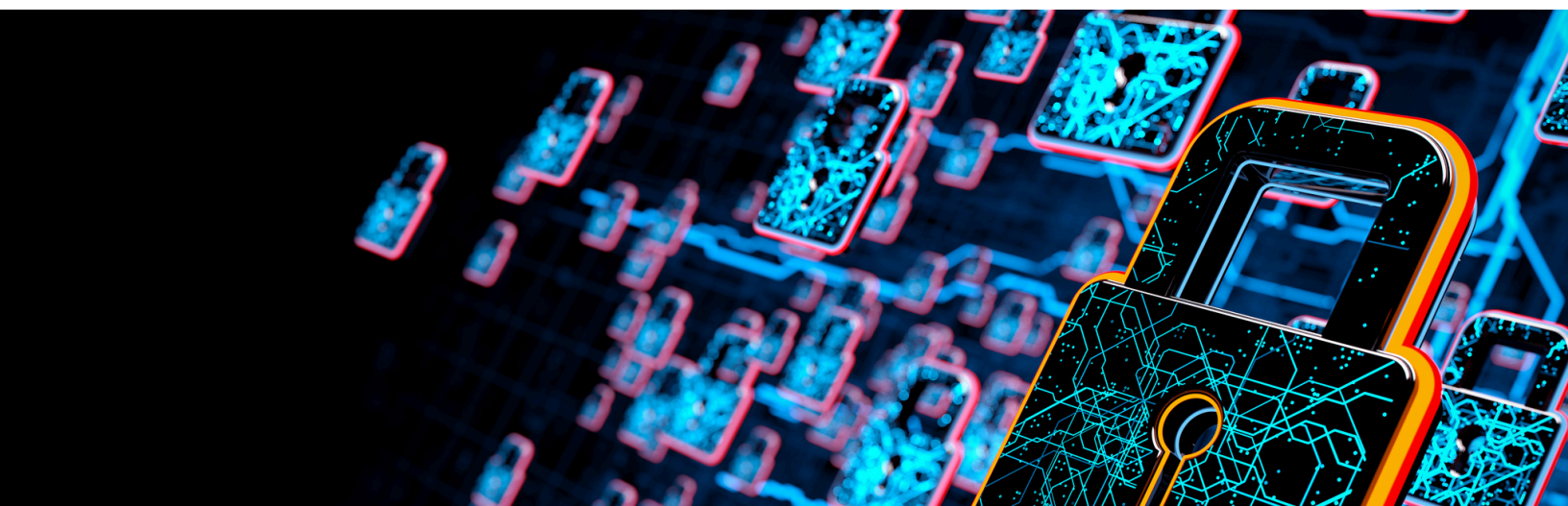
PHASE 5: FUTURE TRENDS
IMMERSIVE-REALITY TECHNOLOGIES (AR & VR)

Immersive-Reality Technologies Trends

*'Virtual-reality and augmented-reality experiences are poised to reshape our lives in the coming decade, with innovation driving advancements across both enterprise and consumer use cases. Recently, we have seen growth in B2B applications of immersive-reality technologies such as spatial computing—specifically digital twins gaining traction for training, testing, and design in industrial sectors such as aerospace and defense. On the consumer side, virtual- and augmented-reality experiences are reshaping consumer engagement by offering immersive brand interactions.'*

-Eric Hazan, Senior Partner, Paris

2023 Market Trends: Investment and consumer demand for immersive-reality technologies declined significantly in 2023, with start-up funding dropping by about 50% and VR headset sales down 40% compared to 2022.

Notable Developments: Despite financial and market challenges, highlights include the launch of Apple's Vision Pro headset and ongoing enterprise interest in digital-twin technology, indicating some resilience in the sector.

Scoring the Trend
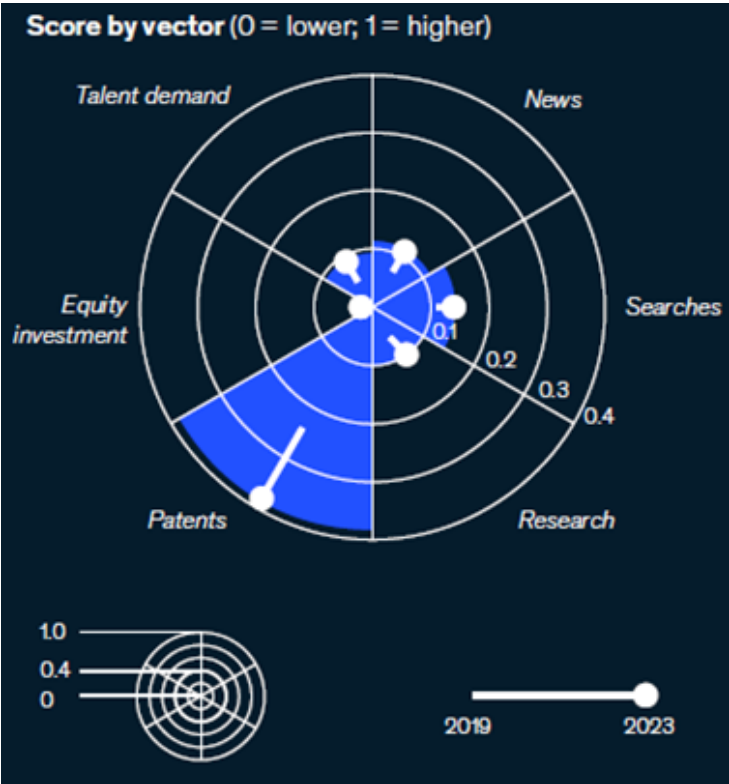
Increased Activity: Between 2019 and 2023, there was a notable rise in scores across news, searches, publications, and patents related to immersive-reality technologies.

The increases suggest that companies see significant **long-term potential** in developing immersive-reality technologies.

Continued innovation and growing interest point to technological advancements and exploration of broader use cases.

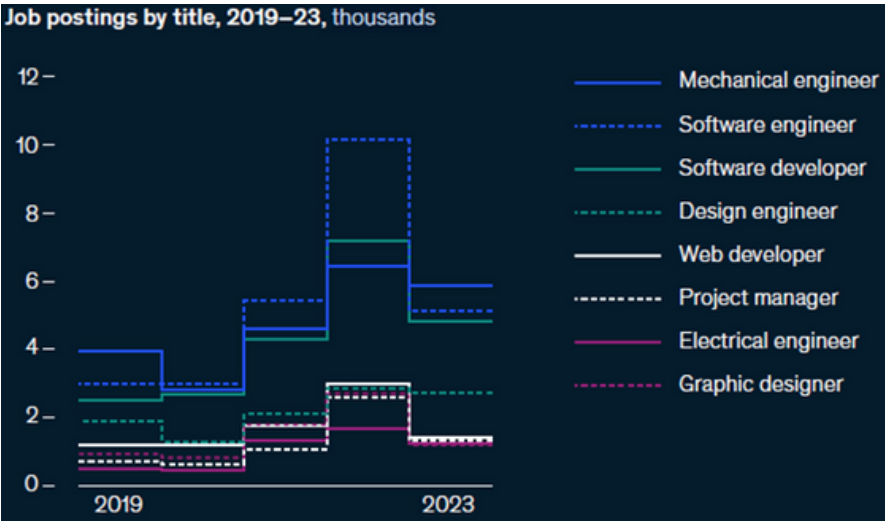**Broader Applications:** New use cases being explored include consumer engagement and the development of digital twins.

Data Source: Mckinsey & Company, 2024

PHASE 5: FUTURE TRENDS
IMMERSIVE-REALITY TECHNOLOGIES (AR & VR)

Job Demand Trends in Immersive-Reality Technologies

Job Market Growth: Immersive-reality job postings have doubled since 2020.

2023 Talent Demand Decline: There was a decline in talent demand in 2023, indicating that the job market is adjusting as the industry's use cases and support structures evolve.

Job postings by title, 2019–23, thousands

Legend:
- Mechanical engineer
- Software engineer
- Software developer
- Design engineer
- Web developer
- Project manager
- Electrical engineer
- Graphic designer

Interdisciplinary Field: The immersive-reality field intersects technology, art, and business management.

High-Demand Roles: There is particularly high demand for graphic designers, project managers, and mechanical, software, and design engineers.

Real-World Application

Disney and Epic Games Collaboration: Disney acquired a $1.5 billion stake in Epic Games and announced a collaboration to create a virtual entertainment universe, allowing consumers to engage with Disney characters and stories through games, shopping, and media experiences.

Porsche and Meta Partnership: Porsche partnered with Meta to use Quest 3 MR headsets for event presentations and vehicle walk-throughs, enabling shared VR environments for product showcases.

Mercedes-Benz and Nvidia Digital Twins: In September 2023, Mercedes-Benz implemented digital-twin technology on Nvidia's Omniverse platform, using digital twins of its factories and assembly lines across 30 locations to optimize production line layouts.

Apple Vision Pro and Immersive Experiences: Following the launch of Apple's AR headset, Apple Vision Pro, in February 2024, companies like Lowe's and the PGA began leveraging the technology to enhance customer experiences. Lowe's launched an app for 3D AR kitchen design, while the PGA introduced PGA Tour Vision, allowing fans to virtually explore golf courses during events.

PHASE 5: FUTURE TRENDS
CLOUD AND EDGE COMPUTING TRENDS

Transition from Traditional Storage: Enterprises are moving away from traditional on-site storage and management to a distributed approach across multiple infrastructure points, including remote hyperscale data centers and on-site edge servers.

Public Cloud Benefits: The public cloud enables remote hosting of workloads, offering scalability in computing and storage resources on demand, leading to improved economies of scale, flexibility, and faster application deployment.
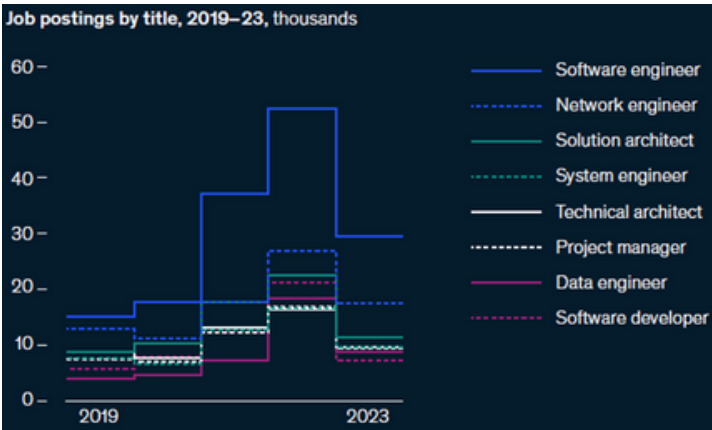
Data Source: Mckinsey & Company, 2024

Edge Computing Advantages: Edge computing allows data to be processed closer to where it is generated, reducing latency, lowering data-transfer costs, and enhancing data privacy, while also complying with data residency laws.

Amplified AI Capabilities: Cloud and edge computing have enhanced AI capabilities, particularly for training and inferencing on foundational models, driving further adoption of these technologies.

Optimizing Workloads: Balancing workloads across cloud, edge, and intermediate locations helps enterprises optimize resources, latency, data privacy, and security at scale, unlocking significant business value.
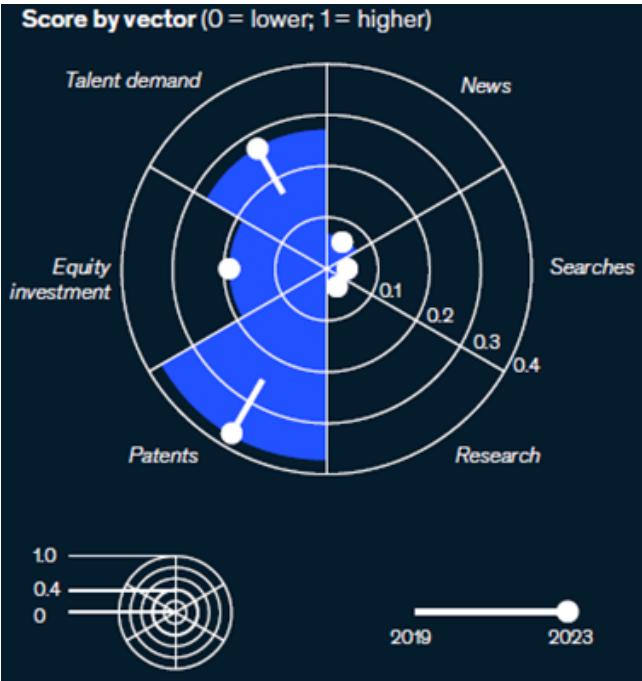
Data Source: Mckinsey & Company, 2024

Scoring the Trend

Investment scores have increased since 2019, with significant funding during 2020–2022.

Innovation scores, including patents and publications, have trended upward since 2019.

Interest scores show growth in search activity, while news searches have remained steady.

These trends indicate that early 2020s investments are being used to rapidly deploy new innovations.

PHASE 5: FUTURE TRENDS
CLOUD AND EDGE COMPUTING
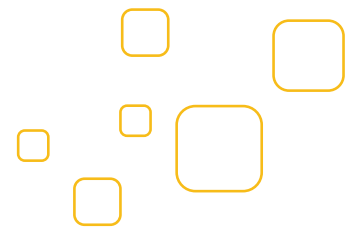
Job Demand Trends in Cloud and Edge Computing

- Cloud and edge job postings decreased overall but remained high for software engineers.

- Data engineers and software developers experienced a larger relative decrease in job postings compared to other technical roles.

- The growth of AI significantly influences cloud and edge computing, leading to notable postings for roles such as machine learning (ML) engineers.

Real-World Application

McDonald's and Google Cloud announced a multiyear global partnership to use edge computing for the restaurant's mobile app, self-service kiosks, and other machinery. They will use a combination of Google's cloud and edge capabilities and McDonald's own software to draw insights on equipment performance and reduce complexity for staff.

> *"We see tremendous opportunity for growth in our digital business and our partnership with Google Cloud allows us to capitalize on this by leveraging our size and scale to build capabilities and implement solutions at unmatched speeds," said Brian Rice, McDonald's Executive Vice President and Global Chief Information Officer. "Connecting our restaurants worldwide to millions of datapoints across our digital ecosystem means tools get sharper, models get smarter, restaurants become easier to operate, and most importantly, the overall experience for our customers and crew gets even better."*
>
> *-McDonald's and Google Cloud Announce Strategic Partnership, 2023*

PHASE 5: FUTURE TRENDS
CONCLUSION

Job Postings in Technology

- The tech sector saw significant layoffs in 2023, especially among large tech companies.

- Job postings related to key tech trends declined by 26%, a steeper drop than the 17% decrease in global job postings.

- The decline was likely due to cost-cutting measures amid lower revenue growth projections.

- Despite overall declines, job postings in areas with strong investment, such as generative AI and electrification/renewables, increased, reflecting high demand for advanced skills.

- A significant skills gap exists, with fewer than half of candidates having in-demand tech skills.

- Despite short-term decreases, tech-related job postings in 2023 were still 8% higher than in 2021, indicating potential for long-term growth.

Mckinsey & Company, 2024

Does AI Create Job Opportunities or Lead to Layoffs?
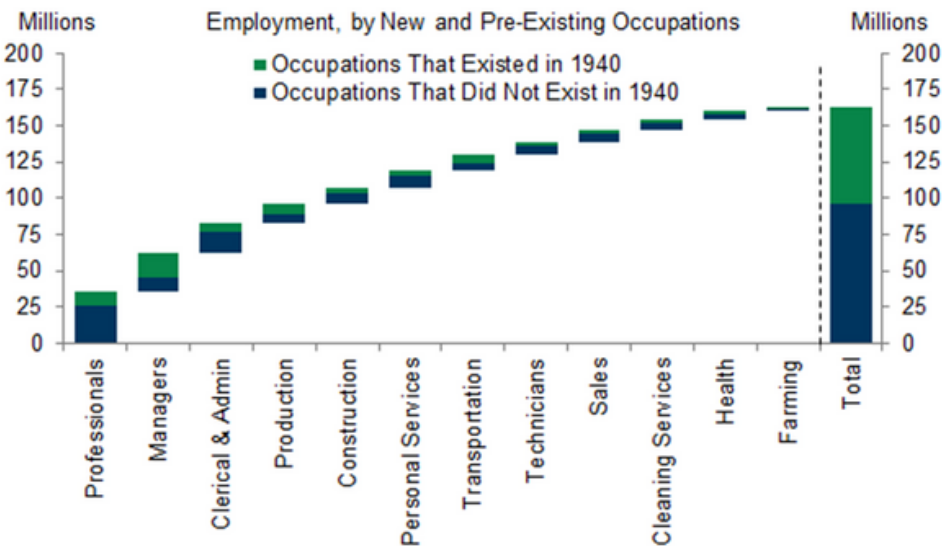
Data Source: Goldman Sachs, 2023
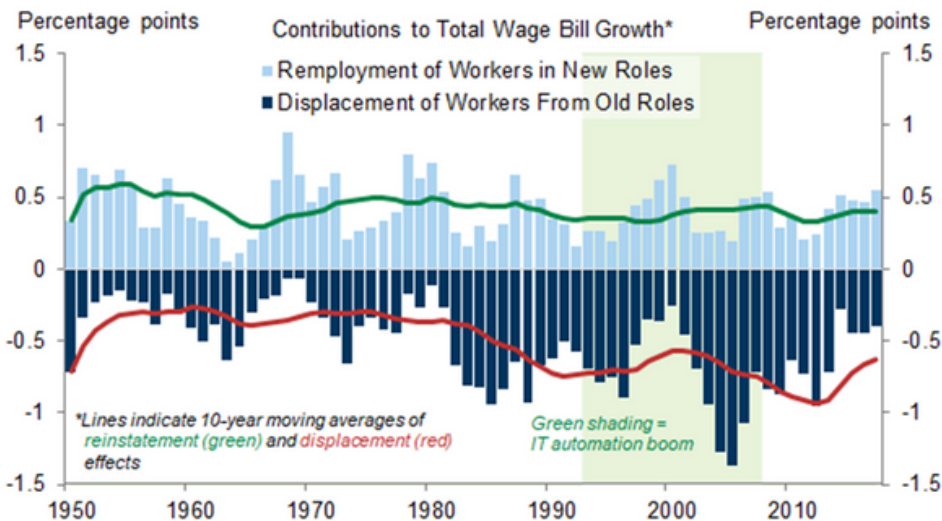
Data Source: Goldman Sachs, 2023

REFERENCES

CBINSIGHTS, "2024 Tech Trends," 2024

Chávez, D. A., Gámiz-Sánchez, V., and Cañas Vargas, A., "Problem-based Leaning: Effects on Academic Performance and Perceptions of Engineering Students in Computer Sciences" Journal of Technology and Science Education," 2020

Chen, P., Lambert, A. D., Guidry, K. R., "Engaging online learners: The impact of Web-based learning technology on college student engagement" Computers & Education, 2010

Chopra-McGowan, A., "5 Ways Companies Are Addressing Skills Gaps in Their Workforce," June 15, 2023

Collins, M., "Ensuring a More Equitable Future: Addressing Skills Gaps Through Multiple, Nuanced Soulutions," May 2021

Habif, S., "How to design an online course with a 96% completion rate," September 2016

Hatzius, J., Briggs, J., Kodnani, D., and Pierdomenico, G., "The Potentially Large Effects of Artificial Intelligence on Economic Growth," Goldman Sachs, 2023

Laboissiere, M., and Mourshed, M., "Closing the skills gap: Creating workforce-development programs that work for everyone," Mckinsey & Company, February 2017

Lighcast, "Generative AI Demand Soars 1,800% for US Employers," October 2023

Luchini-Colbry, K., Colbry, D., Rojewski, J., and Briliyanti, A., "Partners in Professional Development: Initial Results from a Collaboration between Universities, Training Programs, and Professional Societies," American Society for Engineering Education, 2019

Mckinsey Digital, "Technology Tends Outlook 2024," July 2024

Radermacher, A., Walia, G., and Dean, K., "Investigating the Skill Gap Between Graduating Students and Industry Expectations," May 2014

Rierson, B., "Guide Star helps to keep computer science talent in Upper Michigan," June 2024

Zahidi, S., "Future of Jobs Report 2023," World Economic Forum, May 2023

WIN WORKFORCE INTELLIGENCE NETWORK

SEMCA Workforce Intelligence Network for Southeast Michigan (WIN)

25363 Eureka Rd.
Taylor, MI 48180
WINintelligence.org
info@WINintelligence.org