

# **Assessing Skills Needs for Industry 4.0: A ChatGPT-Powered Analysis of Job Descriptions**

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## **Abstract**

Industry 4.0 and digital transformation are no longer academic concepts that should be expected as future trends in manufacturing. Many companies and industries are actively implementing Industry 4.0 technologies. During this period of disruptive growth, a key challenge faced by employers and employees alike is the maintenance of workforce skills needed to succeed with Industry 4.0. Academic resources have proposed for years that skills would be needed for coding languages, artificial intelligence (AI), software integration, and more, however with the onset of implementation, companies are selecting specific software and languages they prefer to use. Job descriptions for a wide range of titles include specific technology skills for Industry 4.0 technologies. Analyzing job descriptions is possible with natural language processing (NLP) models such as ChatGPT, which has become readily available. Those descriptions and skills are analyzed to identify trends which may benefit companies, individuals, and the education in future planning for skills development and standardization. Many skills appear frequently in job descriptions, including software skills such as Python and SAP, with data handling software skills being frequently present in the available job postings.

## **Keywords**

Industry 4.0, Skills, Digital Transformation, Hiring, Software

## **1. Introduction**

Digital transformation and Industry 4.0 have been academic concepts for several years, with many theoretical frameworks and applications detailed in the literature. As industry has progressed towards maturity in these areas, the gaps between theory and application have become more clear. One of the primary drivers in implementation challenges is a skills gap in the current workforce for the utilization of new technologies (Jones 2023). Oftentimes academic concepts are not perfectly reflective of industry outputs by the time research evolves into practical application. Job descriptions tend to focus on specific competencies desired by a company inclusive of specific aptitudes, skills, and experiences desired by a company (Bodnarchuk 2012). One specific gap between academic literature and job descriptions are the specific software and tool based competencies desired by a company or an industry. Where the literature may reflect a concept, for example Enterprise Resource Planning (ERP), a job description may reflect the specific tool related to that concept, such as SAP – a well known ERP software platform. Many papers describe high level and generic skills, such as data collection, data analysis, openness to novelty, digital content creation, and handling software (Bouwman et al. 2024).

### **1.1 Study Objectives**

The goal of this study is to examine the actual skills desired by industry. Understanding the nature of industry specific skills gaps and contrasting to academic skills described for digital transformation drives an understanding of how to interpret most current research into actionable knowledge towards skills and curriculum development programs.

## 2. Literature Review

The literature related to digital transformation often focuses on theoretical applications of digital technologies, including what is capable with new digital systems, such as the benefits to products and operations (Dalenogare et al, 2018). These performance focused papers sometimes touch on skills related to generic technologies that are theoretically described and analyzed, however they often focus on the systems themselves. A subset of the literature does specifically focus on the required skills. Bouwmans et al (2024) proposed the following skills framework for digital transformation:



Figure 1. Digital Skills Framework (Bouwmans et al. 2024)

The research community creates generic frameworks such as this one, however it has been demonstrated that the academic communities influence on higher education practices can impact the skills present in an industry, oftentimes resulting in a gap between early career professional skills and industry needs (Goulart et al, 2022). Although this gap is present, the current literature still serves as a starting point for understanding the trends and needs of future industry professionals. Chaka proposes the following categories of skills needed by an organization attempting to implement Industry 4.0 technologies:

- Information and communication technologies
- Innovation management
- Organizational learning
- Environment

These categories along with other proposed skillsets provide a starting point for specific methods, tools, and software packages to train employees with. Skills needs follow jobs posted by industry. These jobs often fall into certain

sectors of industry. Digital skills are not sought after for front line employees in manufacturing, for example, but they are desirable in more project focused roles. Operations management, supply chain, data science, and information technology are seeking digital skills for the architecture and deployment of Industry 4.0 systems (Pinzone et al, 2017). These role based skill applications will likely continue to evolve over time as digital systems are built and the operational skills required shift from project focused to sustained operations. Bongomin et al (2020) explored the frequency with which different Industry 4.0 technologies presented in the literature for a more specific breakdown of skills needs, however their complication high level categorical as opposed to specific software or hardware needs:

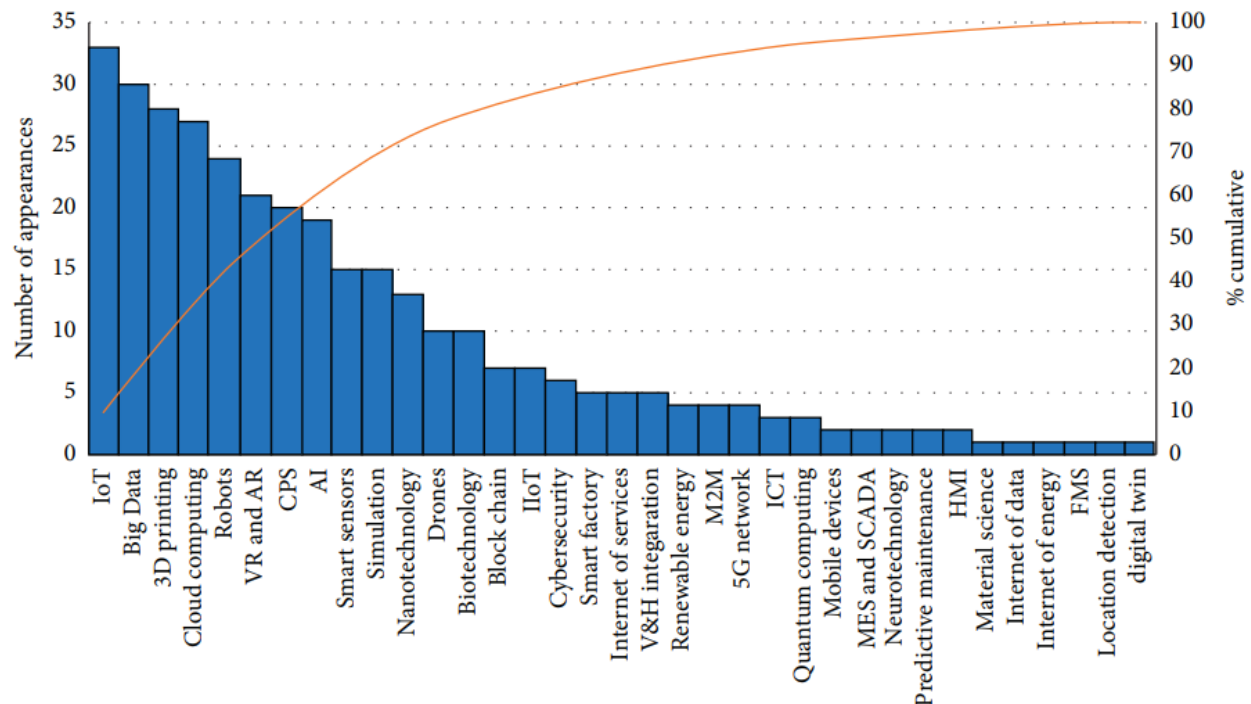


Figure 2. Pareto of Technologies for Skills Needs (Bongomin et al. 2020)

Categorical outputs are the common thread in skills itemizations present in the literature. Other generic skills proposals include the following (Islam, 2022):

- Programming Skills
- Data Analytics
- Data Visualization
- Virtual Collaboration
- Critical Thinking
- Cognitive Skills

The significant contribution of the literature is to provide relevant technologies and skills needed for the future of Industry 4.0, however the specific skills needed by each company must be provided by the company.

### 3. Method

The research proposes using Chat GPT as a natural language processor to compile data from industry job descriptions in order to sample a broad swath of posted jobs. Natural language processing allows a model such as Chat GPT to read and understand the language used to write job descriptions, with the benefit of being able to process mass quantities of written language very quickly, increasing the sample size of job descriptions analyzed for the study (Kalla et al, 2023). This methodology requires consistency in the prompt utilized to drive an appropriate output from the model. One set of skills needed for the utilization of models such as Chat GPT is prompt engineering, which serves as an emerging field in the Industry 4.0 landscape (Ekin, 2023). Chat GPT is capable of reading and utilizing public

domain based information, and as such the domains of Indeed.com and LinkedIn.com were utilized for collecting a sample of job descriptions.

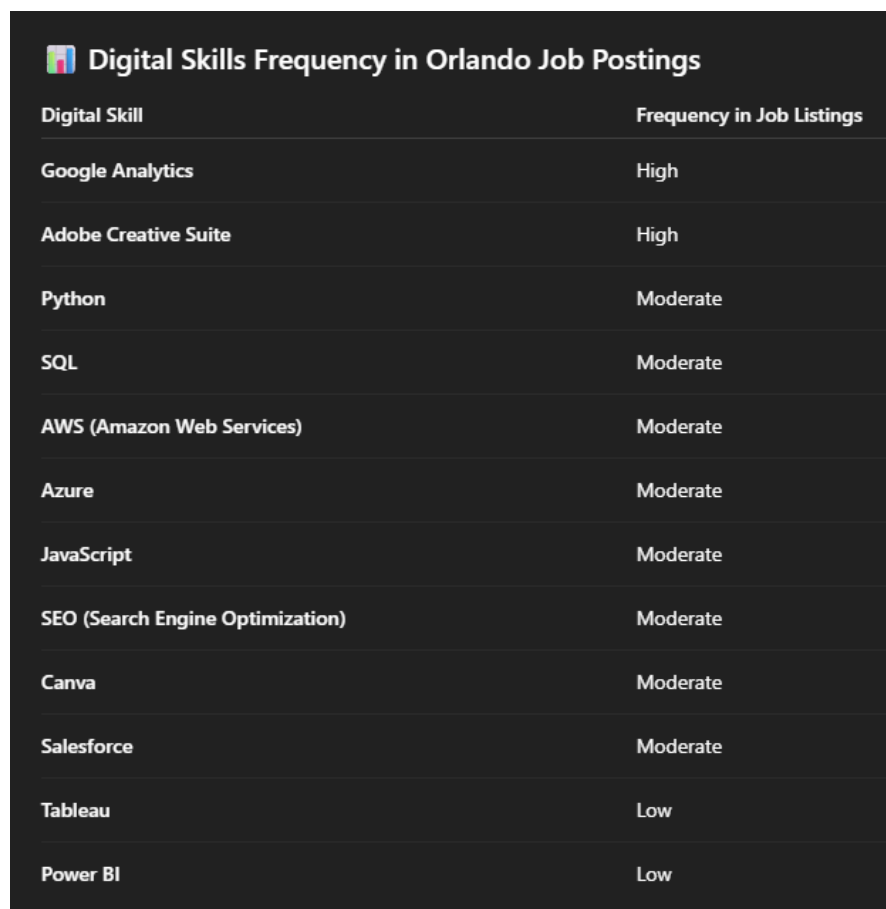
For this research the following prompts were utilized:

- 1) Count how many instances of specific digital skills are present in job descriptions on Indeed and LinkedIn for the Orlando Florida area, provide the data in a table
- 2) Count how many instances of specific digital skills are present in job descriptions on indeed and LinkedIn for the state of Florida, provide the data in a table
- 3) Count how many instances of specific digital skills are present in job descriptions on indeed and LinkedIn for the United States, provide the data in a table

The goal of this methodology is to extract specific skills from large datasets, using the nested datasets of Orlando Florida, the State of Florida, and the entire United States to identify trends or differences. This study could be duplicated across different cities and a larger subset of cities.

#### 4. Results

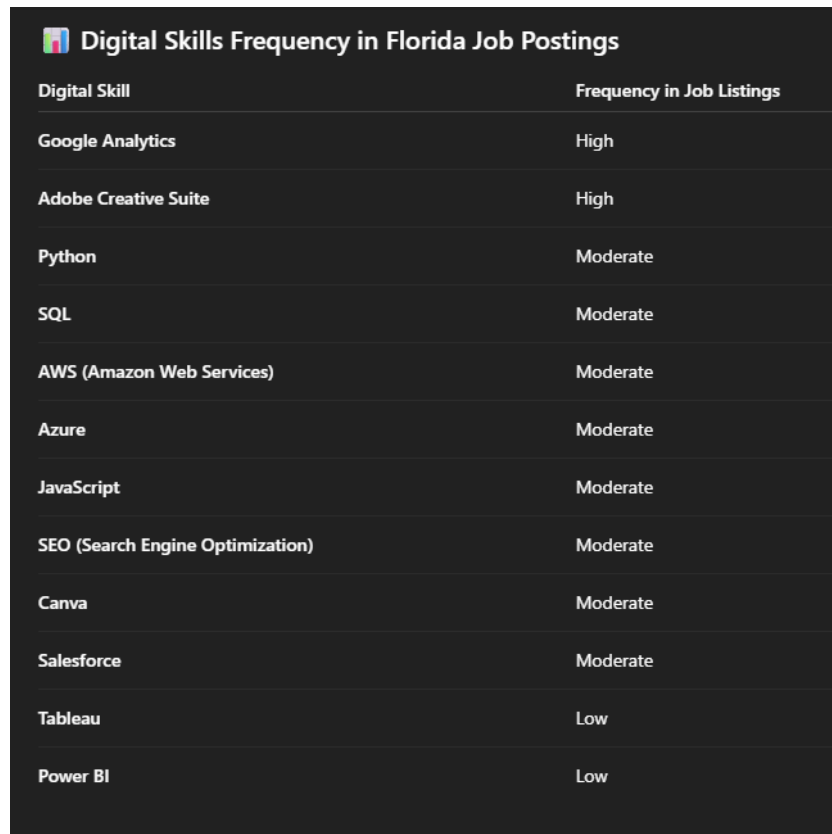
The first prompt entered into ChatGPT was “Count how many instances of specific digital skills are present in job descriptions on Indeed and LinkedIn for the Orlando Florida area, provide the data in a table” which provided the following output (OpenAI, 2025):



Digital Skill	Frequency in Job Listings
Google Analytics	High
Adobe Creative Suite	High
Python	Moderate
SQL	Moderate
AWS (Amazon Web Services)	Moderate
Azure	Moderate
JavaScript	Moderate
SEO (Search Engine Optimization)	Moderate
Canva	Moderate
Salesforce	Moderate
Tableau	Low
Power BI	Low

Figure 3. Skills Desired in the Orlando Area (OpenAI 2025)

The second prompt utilized for the study was “Count how many instances of specific digital skills are present in job descriptions on Indeed and LinkedIn for the state of Florida, provide the data in a table” which delivered the following output (OpenAI, 2025):



Digital Skill	Frequency in Job Listings
Google Analytics	High
Adobe Creative Suite	High
Python	Moderate
SQL	Moderate
AWS (Amazon Web Services)	Moderate
Azure	Moderate
JavaScript	Moderate
SEO (Search Engine Optimization)	Moderate
Canva	Moderate
Salesforce	Moderate
Tableau	Low
Power BI	Low

Figure 4. Skills Desired in the State of Florida (OpenAI 2025)

The final prompt entered into ChatGPT for this study was “Count how many instances of specific digital skills are present in job descriptions on Indeed and LinkedIn for the United States, provide the data in a table” which generated the following output (OpenAI, 2025)




 Digital Skills Frequency in U.S. Job Postings	
Digital Skill	Frequency in Job Listings
Microsoft Office	High
Python	High
SQL	High
AWS (Amazon Web Services)	High
Azure	High
JavaScript	High
Digital Marketing	Moderate
Salesforce	Moderate
Tableau	Moderate
Power BI	Moderate
ChatGPT	Low
Generative AI	Low

Figure 5. Skills Desired in the USA (OpenAI, 2025)

The results from all three prompts are compiled in Figure 6. Of note is the fact that for Orlando and the State of Florida, the results were identical. This is not surprising as local industry tends to follow similar trends, and the Orlando area, which was the prompt utilized in the model, may capture a significant percentage of the available jobs in the State of Florida. It is possible that the natural language processing model interpreted the Orlando area as inclusive of the entirety of central Florida, which may extend into both the Space Coast and Tampa areas, with Hillsboro and Polk counties being specifically designated as Central Florida in some publication (Harper pg 75, 1921). These geographical areas represent a significant portion of the State of Florida.

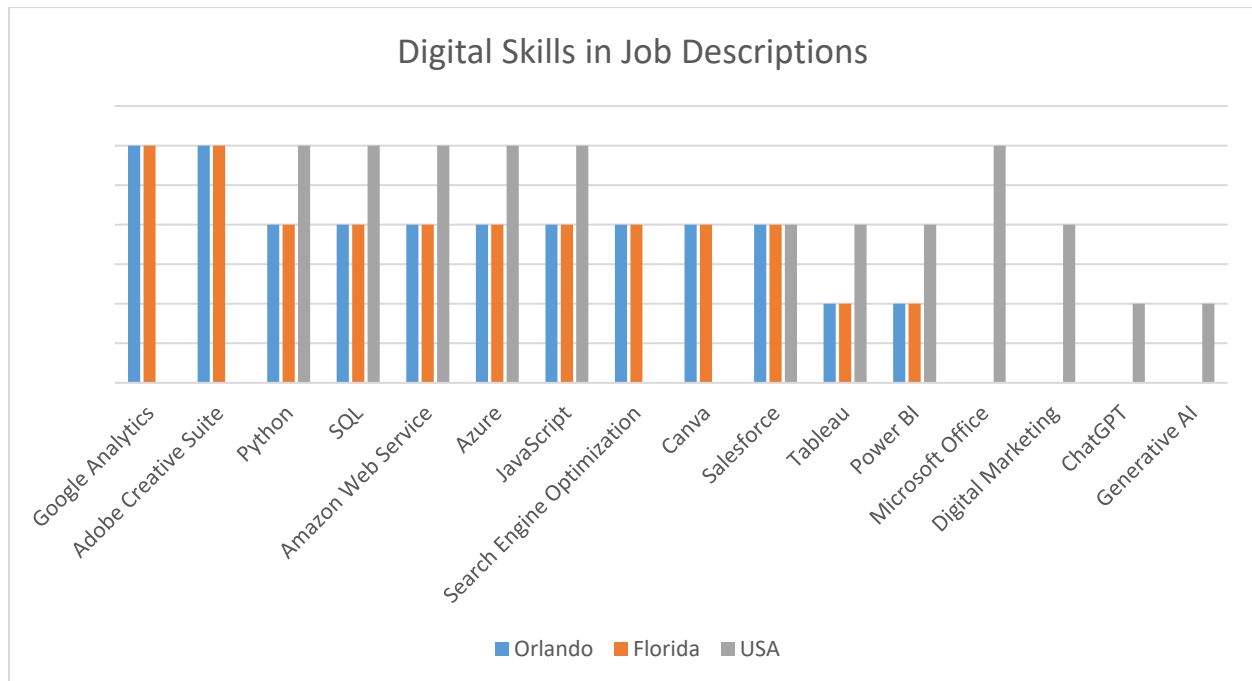


Figure 6. Compiled Digital Skills

As demonstrated in the compiled results, many specific broad software applications from large companies are present in the results. A key differentiator between the skills requested in actual job descriptions and the skills detailed in the literature is the inclusion of specific software applications.

Only two generic skills are present in the results: Digital Marketing and Generative AI. Digital Marketing skills utilize many softer skills and people skills, creating a situation where it is much more challenging to itemize specific tactical skills required by an individual. Skills such as relationship fostering, client engagement, and communication skills are detailed in digital marketing skills needs (Royle et al 2014). These softer skills are appropriate to bundle into a more generic high level skill bucket. At this time Generative AI likely reflects the relative immaturity of Generative AI as a technology option. Annapureddy et al (2025) developed the following model of Generative AI competencies:

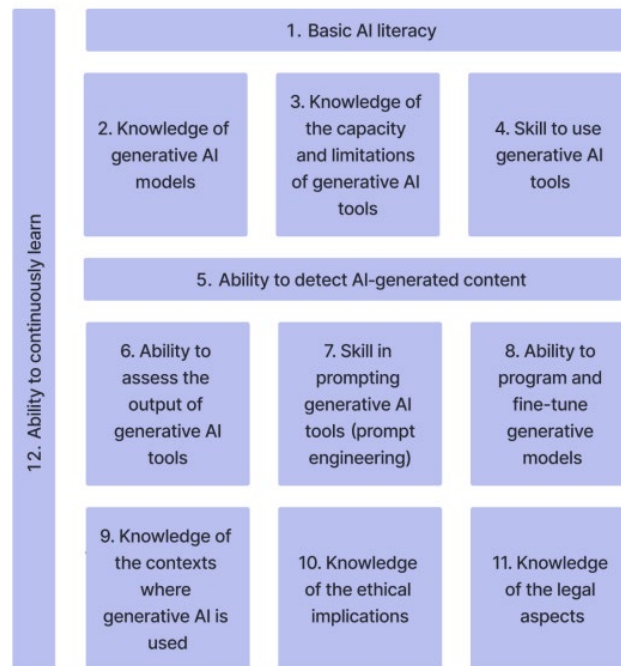


Figure 7. Generative AI Skills (Annapureddy et al. 2025)

Beyond the general skills, ChatGPT compiled the following technical competencies appearing at various frequencies in job descriptions across the searched sample spaces (OpenAI, 2025):

- Google Analytics
- Adobe Creative Suite
- Python
- SQL
- Amazon Web Service
- Azure
- JavaScript
- Search Engine Optimization
- Canva
- Salesforce
- Tableau
- Power BI
- Microsoft Office
- ChatGPT

This list represents a more specific view of many of the skill detailed in the literature. Many of these software platforms or coding languages are utilized to handle big data, which is a background concept in many Industry 4.0 applications. Software that can handle significant volume of data and diverse data variety is critical to many of the Industry 4.0 systems being developed and implemented today (Raptis et al, 2019). This dataset highlights a more specific list of skills needed to be a competent professional in the digital space.

#### 4.1 Methodological Limitations

One major consideration in research utilizing NLP models such as ChatGPT is the validation of the results. With prompt engineering being a new body of knowledge it is becoming clear that NLP models still require consistency and skill to generate appropriate results. Liu et al (2023) demonstrated through standard training data that prompting an NLP model required a level of consistency to achieve consistent results.



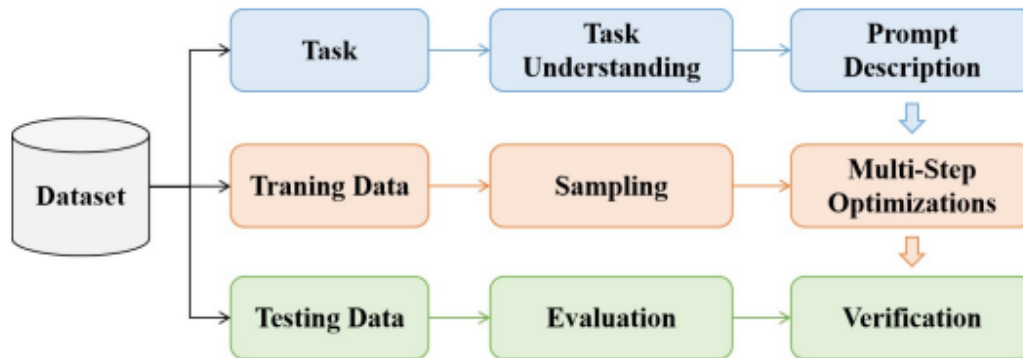


Figure 8. Prompt Engineering Test Method (Liu et al. 2023)

This finding presents a challenge with the potential ambiguity or misunderstanding of “digital skills” by the model. Furthermore, the model should be capable of generating specific data tables, highlighting total instances of every phrase and skill it encounters, however the outputs of prompts in this research were highly generalized, categorizing skills into frequency buckets. It is advisable that this study is a preliminary template of what type of analysis may be capable with NLP models such as ChatGPT, however the research should be expanded to include other models and more prompt engineering. In addition to the prompt engineering challenges, in order to ensure that the model correctly categorizes and recognizes the skills it is being asked to detect, state of the art model training is required (Xames and Shefa, 2023). If the model has not been trained with job skills and skills frameworks in mind it may over generalize or mis-interpret the available data.

## 5. Conclusion

Digital transformation related job needs in industry are continuing to become more clear as companies adopt specific technologies into their operating models. Academic literature and publication has highlighted technology categories which will be required for digital success for many years, however, there has been a gap between the category level and specific skill level. It is not possible to determine which software to learn or which training to participate in from a generic categorical descriptor, however knowing which software to learn or which training to participate in is a critical need for industry professionals growing into the digital space. Current trends highlight data management software packages and coding languages capable of handling big data with diverse datasets as a common area of skills need for the workforce, as represented in actual job descriptions.

Moving forward, it will become ever more necessary to tailor publication and training offerings to the specific needs of industries and developing professionals. College curriculums and the broader academic community must embrace the skills required by industry, including pursuit of specific knowledge of software and hardware packages that are relevant to industry. It will be beneficial for the academic community to develop and maintain relationships with local industry in order to remain current with the state of the art in technology needs. Technology development represents a cycle between pure research and business implementation, and while businesses must learn from research efforts made by the academic community, so too must the academic community be aware of the current trends in business. Natural language processing models such as ChatGPT provide the ability to compile massive datasets from formerly cumbersome data sources, such as job descriptions, to paint a picture of reality when it comes to industry needs.

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## Biography

**Dr. Thomas Jones** achieved both BS and MS degrees in Industrial Engineering from Wichita State University in 2015 and 2018 respectively. He furthered his Industrial Engineering education at the University of Central Florida where he achieved a PhD in 2023. He is a published researcher specializing in the implementation of Industry 4.0, with emphasis on transitioning theoretical concepts from research into practical applications in the workplace. Dr. Jones' dissertation developed an implementation model from the top down for rolling out Industry 4.0 with quality centered performance goals. He has presented his works at various professional and research conferences, and was invited to present his quality strategic approach at NASA's Quality Leadership Forum. His implementation strategy publishes as a book through The American Society of Quality's Quality Press publishing house in 2025. Dr. Jones is a Senior Member of the American Society of Quality and has contributed to the Body of Knowledge for several certifications, including; The Certified Quality Engineer, The Certified Reliability Engineer, and The Certified Manager of Quality / Organizational Excellence. He is a contributing author on the Certified Reliability Engineering Handbook, 4<sup>th</sup> edition. Dr. Jones maintains a presence in the Industry 4.0 space through continued lectures and education and strives to develop a comprehensive portfolio of publication, research, and case studies on successful Industry 4.0 implementation.