

## Awareness and Readiness for Industry 4.0: Examining Employee Perceptions Toward the Adoption of Emerging Technologies in Gujarat

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### Abstract

Industry 4.0 has revolutionized the manufacturing and service sectors, emphasizing automation, data-driven decision-making, and smart technologies (Schwab, 2016). However, the successful adoption of Industry 4.0 technologies depends on employee awareness, readiness, and training exposure (Lee & Lee, 2020). This study examines the awareness and readiness levels of employees across industries in Gujarat, India. Using 170 responses from professionals across various demographic backgrounds, the study employs non-parametric statistical tests (Mann-Whitney U, Kruskal-Wallis, and Spearman's correlation) to analyse relationships between demographic factors, awareness, readiness, and training exposure. Results indicate significant differences in readiness across gender and age groups and a strong positive correlation between awareness and readiness ( $\rho = 0.72$ ,  $p < .001$ ). Training exposure also moderately correlates with readiness ( $\rho = 0.65$ ,  $p < .001$ ), highlighting the importance of skill development programs (Manyika et al., 2017). These findings suggest that organizations must enhance training and awareness initiatives to ensure a smooth transition to Industry 4.0.

**Keywords-** Industry 4.0, Awareness, Readiness, Training exposure, Employee perception, Gujarat

### 1. Introduction

#### 1.1 Background

Industry 4.0 signifies a paradigm shift in industrial operations, integrating blockchain, IoT, cloud computing, and artificial intelligence to improve efficiency and innovation (Schwab, 2016; Kagermann et al., 2014). This transformation is particularly relevant in emerging economies, where industries strive to modernize and remain competitive (Lee & Lee, 2020; International Labour Organization, 2019). The manufacturing and service sectors in Gujarat play a significant role in economic development, necessitating a workforce equipped with Industry 4.0 skills (Manyika et al., 2017; World Economic Forum, 2020).

#### 1.2 Importance of Awareness and Readiness

The effectiveness of Industry 4.0 adoption depends significantly on workforce awareness and preparedness (Schwab, 2016; Kagermann et al., 2014). Awareness involves employees' understanding of Industry 4.0 technologies, while readiness measures their ability to implement and work with these technologies (Lee & Lee, 2020; Venkatesh et al., 2003). Studies consistently indicate that a lack of awareness and insufficient digital skills are substantial barriers that hinder the adoption process, particularly in traditional industries (Manyika et al., 2017; World Economic Forum, 2020). Addressing these gaps is crucial to ensuring a smooth digital transformation and fostering sustainable industrial growth (Brynjolfsson & McAfee, 2014; International Labour Organization, 2019).

### **1.3 Existing Research and Gaps**

Industry 4.0 integrates advanced technologies to create smart, interconnected systems that enhance operational efficiency and productivity (Schwab, 2016; Kagermann et al., 2014). Employee readiness plays a critical role in the successful adoption of these technologies (Lee & Lee, 2020; Venkatesh et al., 2003). Previous studies suggest that organizational training, employee awareness, and demographic factors such as experience and age significantly impact readiness (Manyika et al., 2017; World Economic Forum, 2020). However, limited studies focus on the regional context of Gujarat, a prominent industrial hub in India (Patel & Shah, 2021; Government of Gujarat, 2022).

Research on Industry 4.0 primarily focuses on technological advancements, with limited studies exploring workforce awareness and readiness (Brynjolfsson & McAfee, 2014; Schwab, 2016). While developed economies have well-established transition plans, emerging markets like India face challenges such as digital skill gaps, limited training opportunities, and resistance to change (International Labour Organization, 2019; World Bank, 2021). This study addresses these gaps by assessing Industry 4.0 awareness and readiness among employees of the manufacturing and service sectors in Gujarat.

## **2. Problem statement**

Despite the transformative potential of Industry 4.0, there exists a significant gap in employee awareness and readiness, particularly in emerging economies like India (Lee & Lee, 2020; International Labour Organization, 2019). The success of Industry 4.0 implementation depends not only on technological advancements but also on the preparedness of the workforce (Schwab, 2016; Kagermann et al., 2014). Employees in both manufacturing and service sectors require technical proficiency, digital literacy, and adaptive skills to engage effectively with these technologies (Manyika et al., 2017; World Economic Forum, 2020).

Gujarat, as one of India's leading industrial regions, has seen a growing emphasis on Industry 4.0 adoption (Patel & Shah, 2021; Government of Gujarat, 2022). However, limited research exists on the current levels of awareness and readiness among employees, making it imperative to explore how demographic factors such as age, gender, work experience, and industry sector influence their preparedness for Industry 4.0 (Venkatesh et al., 2003; World Bank, 2021). Understanding these gaps can help organizations, policymakers, and educational institutions design targeted training programs, skill development initiatives, and policy frameworks that facilitate a smoother transition into Industry 4.0 (Brynjolfsson & McAfee, 2014; ILO, 2019).

## **3. Research Objectives and Hypothesis**

### **3.1 Research Objectives**

Building upon the identified gaps in existing research, this study aims to address the following objectives to provide a comprehensive understanding of Industry 4.0 awareness and readiness in Gujarat.

- ✓ To measure the awareness of respondents across different emerging technologies.
- ✓ To assess the awareness and readiness levels of Industry 4.0 concept amongst employees in Gujarat.
- ✓ To identify differences in awareness and readiness based on sector, job role, age, and experience.
- ✓ To examine the impact of training and awareness on readiness level of employees.
- ✓ To provide recommendations and suggestions for smoother implementation.

### **3.2 Research Hypothesis**

Based on the research objectives and the existing literature on factors influencing Industry 4.0 adoption, the following hypotheses were formulated:

H<sub>1</sub>: There are significance differences in the level of awareness of Industry 4.0 concept across the Industry, Gender, Age and Experience of the respondents.

H<sub>2</sub>: There are significance differences with respect to readiness of employees across the Industry, Gender, Age and Experience of the respondents.

H<sub>3</sub>: There is a positive co-relation between training exposure and readiness of employees.

H<sub>4</sub>: There is a positive co-relation between level of awareness and readiness of employees.

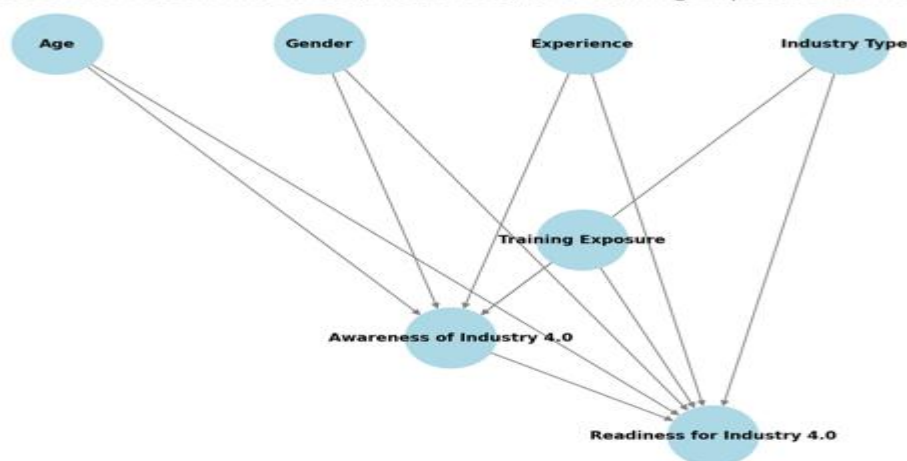
**4. Research Methodology**

This study employed a descriptive research design to accurately and thoroughly characterize the population and circumstances related to Industry 4.0 awareness and readiness. Descriptive research is appropriate for providing a detailed understanding of the current situation (Bryman, 2016). Data was collected from both primary and secondary sources. Secondary data sources included numerous articles, news items, interviews, and reports published online, as well as journals, periodicals, newspapers, textbooks, and Industry reports (e.g., World Economic Forum, 2020; McKinsey Global Institute, 2017). The published literature on awareness and readiness globally was considered to establish a comprehensive background.

The study aimed to examine whether employees' awareness and readiness to work with Industry 4.0 concepts and technologies differ based on gender, Industry type, age group, and work experience. It also investigated the correlation between awareness, training exposure, and employee readiness. Descriptive statistics for both dependent and independent variables are presented in the analysis and interpretation section.

The analysis was conducted on below research model using the SPSS statistical software package. A reliability test (Cronbach's Alpha) was performed to evaluate the internal consistency of the survey responses. Given that normality tests indicated a non-normal distribution of the data, non-parametric statistical tests were employed. Specifically, the Mann-Whitney U test was used for paired comparisons, the Kruskal-Wallis test for comparisons of three or more groups, and Spearman's correlation for examining the relationships between two variables (Field, 2018).

Updated Research Model: Awareness, Readiness, and Training Exposure for Industry 4.0



**Figure 1 Model Developed by the Researchers**

**5. Analysis & Interpretations**

**5.1 Descriptive Statistics**

Table 1 presents the demographic composition of the respondents. The study includes 170 employees from manufacturing and service sectors with diverse backgrounds in terms of gender, age, work experience, and industry type.

**Table 1 Demographic Composition of the respondents**

<b>Respondents' Characteristics</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
<b>Gender of the respondents</b>		

Male	133	78%
Female	37	22%
<b>Age of respondents</b>		
21 to less than 25	16	9%
25 to less than 35	95	56%
35 to less than 45	43	25%
45 and above	16	9%
<b>Work experience of respondents</b>		
Less than 2	11	7%
2 to less than 5	41	24%
5 to less than 10	45	27%
10 to less than 15	30	18%
15 and above	43	25%
<b>Industry of respondents</b>		
Manufacturing	105	62%
Service	65	38%

The demographic profile of the respondents presents key characteristics such as gender, age, work experience, and industry of employment.

Gender of the Respondents: Out of 170 participants, 78% were male (n = 133) and 22% were female (n = 37), indicating a male-dominated sample.

Age of Respondents: The majority of respondents are 56% belonged to the age group of 25 to less than 35 years (n = 95), followed by 35 to less than 45 years i.e. 25% (n = 43). Respondents in the 21 to less than 25 years and 45 years and above age groups were both 9% (n = 16) each.

Work Experience of Respondents: Most respondents had 5 to less than 10 years of work experience i.e. 27% (n = 45), followed by those with 15 years and above i.e. 25% (n = 43). Respondents with 2 to less than 5 years constituted i.e. 24% (n = 41), while those with 10 to less than 15 years accounted for 18% (n = 30). Only 7% (n = 11) had less than 2 years of experience.

Industry of Respondents: The respondents were predominantly from the manufacturing sector i.e. 62% (n = 105), while 38% (n = 65) belonged to the service sector.

**Table 2 Descriptive Statistics results (summated) of major variables used in the study**

Category	N	Summated Mean	Summated SD	Skewness		Kurtosis	
				Stat.	Std. err	Stat.	Std. err
Awareness of Concept	170	3.27	1.277	-0.49	0.186	-0.699	0.37
Awareness about technologies	170	2.86	1.12	-0.063	0.186	-0.962	0.37
Readiness level	170	3.14	1.156	-0.547	0.186	-0.527	0.37

<b>Training Exposure</b>	170	3.05	0.797	-0.217	0.186	-0.012	0.37
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**Awareness of Concept:** The mean score for awareness of the Industry 4.0 concept is 3.27 (SD = 1.277), indicating that respondents possess a moderate level of awareness. The negative skewness value (-0.49) suggests that more respondents reported higher awareness levels than lower ones. The kurtosis value (-0.699) indicates that the distribution is relatively flat compared to a normal distribution.

**Awareness about Technologies:** The mean score of 2.86 (SD = 1.12) indicates a relatively lower awareness level of different Industry 4.0 technologies. The skewness value (-0.063) shows that the data is approximately symmetric, while the kurtosis value (-0.962) suggests a flatter distribution.

**Readiness Level:** The mean score of 3.14 (SD = 1.156) implies that respondents have a moderate level of readiness to work with Industry 4.0 technologies. The negative skewness value (-0.547) reflects that more participants reported higher readiness. The kurtosis value (-0.527) indicates a distribution flatter than normal.

**Training Exposure:** The lowest mean score (2.62, SD = 1.206) among the four variables shows that respondents had limited exposure to organizational training on Industry 4.0 technologies. The positive skewness value (0.207) signifies that more participants reported lower training exposure, while the kurtosis value (-0.92) shows a flat distribution.

**Table 3 Mean & SD table showing awareness about different technologies of Industry 4.0**

<b>Technology</b>	<b>Mean</b>	<b>Standard Deviation</b>
Artificial Intelligence	3.31	1.05
Internet of Things (IoT)	3.27	1.08
Cloud Computing	3.12	1.12
Big Data Analytics	3.05	1.15
Robotics	2.94	1.1
Cybersecurity	2.85	1.14
Augmented Reality/Virtual Reality	2.72	1.2
Additive Manufacturing (3D Printing)	2.68	1.18
Machine Learning	2.5	1.24
Smart Factory/Manufacturing	2.48	1.22
Blockchain	2.45	1.25
Digital Twin	2.31	1.3

The descriptive statistics summarize the respondents' familiarity with various Industry 4.0 technologies on a five-point Likert scale (1 = Not familiar at all, 5 = Very familiar).

**Highest Awareness:** The highest mean score is observed for Artificial Intelligence (AI) (M = 3.31, SD = 1.328), indicating that respondents are most familiar with AI technologies.

**Moderate Awareness:** Technologies like Internet of Things (IoT) (M = 3.12, SD = 1.440), Cybersecurity (CS) (M = 3.17, SD = 1.350), and Smart Factory/Manufacturing (SFM) (M = 2.95, SD = 1.381) indicate moderate familiarity among respondents.

Lower Awareness: Technologies such as Digital Twin (DT) (M = 2.31, SD = 1.264), Augmented Reality (AR) (M = 2.60, SD = 1.325), and Blockchain (BC) (M = 2.68, SD = 1.275) exhibit lower awareness, suggesting that respondents are less familiar with these advanced technologies.

Average Awareness Level: The overall mean score across technologies is 2.86, reflecting moderate awareness levels, with higher familiarity for AI and IoT compared to emerging technologies like Digital Twin and Blockchain.

Key takeaways: The findings indicate that while respondents are relatively aware of widely adopted technologies such as AI, IoT, and Cybersecurity, more awareness and training initiatives are needed for emerging technologies like Digital Twin, Blockchain, and Augmented Reality.

### 5.2 Practicality Analysis

To ensure the appropriateness of data for further analysis, practicality tests such as normality, reliability, and validity were conducted.

To ensure content validity, the questionnaire was developed based on a comprehensive review of existing literature on Industry 4.0 awareness and readiness. Additionally, the questionnaire was reviewed by experts in industrial technology and survey design to ensure that it adequately covered the relevant domains.

The reliability of the survey instrument was evaluated using Cronbach's alpha. The reliability (Cronbach's Alpha = 0.951) testing values for the awareness, readiness and training exposure scale were indicating high internal consistency. This suggests that the survey items reliably measure the intended constructs.

The Normality Test (Kolmogorov-Smirnov Test) was applied to key survey variables (awareness, readiness and training exposure). The significance values (Sig.) were less than 0.05 for all variables, indicating non-normal data distribution. To ensure internal validity, non-parametric tests were selected due to the non-normal distribution of the data. This allowed for accurate analysis of the variable relationships, without the risk of skewed results. Hence, non-parametric tests such as Mann-Whitney U and Kruskal-Wallis tests and Spearman's Correlation were selected for hypothesis testing.

The study's validity is strengthened by the use of expert review and a literature-based questionnaire. However, the cross-sectional nature of the study limits our ability to establish causal relationships. The use of non-parametric tests strengthens the internal validity of this research, however, the heavy male representation in the sample, limits the generalization of the results.

Limitations of this study include the potential for response bias, as participants may have provided socially desirable answers. Additionally, the cross-sectional design does not allow for the examination of changes in awareness and readiness over time.

### 5.3 Hypothesis Testing

To examine the hypothesis, the following tests were conducted:

**Table 4 Mann Whitney U Test results regarding the awareness and readiness of Industry 4.0 with respect to Industry and Gender**

Factors	Comparison	Mean Rank	Sum of Ranks	Mann-Whitney U	Z-Score	p-value (Asymp. Sig. 2-tailed)
Awareness	Manufacturing	86.41	7777	3316.5	0.318	0.75
	Service	84.02	5881.5			
Readiness	Manufacturing	86.95	7827.5	3260	0.512	0.609
	Service	8315	5831			
Awareness	Male	89.49	8410.5	1929.5	2.074	0.038

	<b>Female</b>	71.15	2524			
<b>Readiness</b>	<b>Male</b>	87.95	8261	2134	-1.29	0.197
	<b>Female</b>	76.68	2673.5			

Awareness Differences

Industry (Manufacturing vs. Service): The p-value (0.750) is greater than 0.05, indicating no statistically significant difference in Industry 4.0 awareness between employees in the manufacturing and service sectors. Awareness levels are relatively similar across industries, suggesting that both manufacturing and service employees have comparable familiarity with Industry 4.0 concepts.

Gender (Male vs. Female): The p-value (0.038) is less than 0.05, signifying a statistically significant difference in awareness levels between male and female employees. Males (Mean Rank = 89.49) exhibit a higher awareness of Industry 4.0 compared to females (Mean Rank = 71.15). This suggests that gender differences may influence familiarity with Industry 4.0, potentially due to varying levels of exposure or engagement with technological advancements.

Readiness Differences

Industry (Manufacturing vs. Service): The p-value (0.609) is greater than 0.05, indicating no statistically significant difference in Industry 4.0 readiness between manufacturing and service employees. This implies that Industry type does not significantly affect employees' preparedness for Industry 4.0 technologies.

Gender (Male vs. Female): The p-value (0.197) is greater than 0.05, indicating no significant difference in readiness levels between male and female employees. While males have a slightly higher mean rank (87.95) than females (76.68), the difference is not statistically significant. This suggests that both male and female employees exhibit similar levels of preparedness for Industry 4.0 technologies, despite differences in awareness levels.

Key takeaways: Industry type does not significantly influence awareness or readiness for Industry 4.0. Gender influences awareness but not readiness, as males demonstrate significantly higher awareness levels than females, but both genders exhibit comparable readiness levels. These findings highlight the need for targeted awareness programs, particularly for female employees, to bridge the gap in Industry 4.0 knowledge.

**Table 5 Kruskal-Wallis H Test results regarding the awareness and readiness Industry 4.0 concept with respect to Age and Experience**

Factor	Group (Years)	N	Mean Rank	Sum of Ranks	H Value	df	p-value (Asymp. Sig.)
<b>Awareness (Age)</b>	21 to <25	40	82.53	3301	9.107	3	0.028
	25 to <35	65	79.25	5151			
	35 to <45	45	88.51	3983			
	>45	20	117.5	2350			
<b>Readiness (Age)</b>	21 to <25	40	85.63	3425	2.872	3	0.412
	25 to <35	65	82.2	5343			
	35 to <45	45	85.97	3869			
	>45	20	103.7	2074.5			
	<2	38	81.82	3110			

<b>Awareness</b> (Experience)	2 to <5	42	74.84	3143.5			
	5 to <10	35	76.16	2665.5			
	10 to <15	30	84.43	2532.5			
	>15	25	107.1	2678			
<b>Readiness</b> (Experience)	<2	38	86.41	3283.5	5.384	4	0.25
	2 to <5	42	84.73	3562.5			
	5 to <10	35	79.66	2788			
	10 to <15	30	75.93	2277.5			
	>15	25	98.79	2469.5			

#### Awareness Differences Across Age Groups

The Kruskal-Wallis H test revealed a statistically significant difference in awareness of Industry 4.0 across different age groups ( $H = 9.107, p = 0.028$ ). Employees aged 45 and above had the highest awareness (Mean Rank = 117.50, Sum of Ranks = 2350.00), while the 25 to <35 years age group showed the lowest awareness (Mean Rank = 79.25, Sum of Ranks = 5151.00). This indicates that older employees tend to have a greater understanding of Industry 4.0 concepts compared to younger employees.

#### Readiness Differences Across Age Groups

The Kruskal-Wallis H test found no statistically significant difference in Industry 4.0 readiness across different age groups ( $H = 2.872, p = 0.412$ ). Although employees aged 45 and above had a slightly higher readiness level (Mean Rank = 103.72, Sum of Ranks = 2074.50), the overall variation among groups was not significant. This suggests that age alone does not strongly influence an individual's preparedness for Industry 4.0.

#### Awareness Differences Across Experience Levels

A statistically significant difference in Industry 4.0 awareness was found across different work experience levels ( $H = 12.752, p = 0.013$ ). Employees with more than 15 years of experience had the highest awareness (Mean Rank = 107.13, Sum of Ranks = 2678.00), while those with 2 to <5 years of experience had the lowest awareness (Mean Rank = 74.84, Sum of Ranks = 3143.50). This suggests that more experienced employees are more familiar with Industry 4.0 concepts.

#### Readiness Differences Across Experience Levels

The Kruskal-Wallis H test indicated no statistically significant difference in Industry 4.0 readiness based on work experience ( $H = 5.384, p = 0.250$ ). Employees with 15+ years of experience had the highest readiness level (Mean Rank = 98.79, Sum of Ranks = 2469.50), whereas employees with 10 to <15 years had the lowest (Mean Rank = 75.93, Sum of Ranks = 2277.50). However, since the difference was not significant, work experience alone may not be a decisive factor in readiness.

**Key takeaways:** Awareness with respect to age and work experience significantly impact awareness of Industry 4.0. Older employees (45+) and those with longer work experience (15+ years) exhibit greater awareness. Readiness with respect to age and work experience do not significantly affect Industry 4.0 readiness. Although older and more experienced employees show slightly higher readiness levels, the differences are not statistically significant. Organizations should focus on bridging the awareness gap among younger and less experienced employees to ensure equitable Industry 4.0 preparedness across different workforce segments.

Table 6 Spearman’s Correlation results between Training Exposure, Awareness, and Readiness

Variables	Spearman’s $\rho$	p-value	N
Training Exposure & Readiness	0.496	<0.001	170
Awareness & Readiness	0.594	<0.001	170

#### Training Exposure and Readiness

The correlation coefficient ( $\rho = 0.496$ ,  $p < 0.001$ ) indicates a moderate positive correlation between training exposure and readiness for Industry 4.0. This suggests that employees with greater training exposure tend to feel more prepared to adopt Industry 4.0 technologies. Since the correlation is statistically significant ( $p < 0.001$ ), the relationship is unlikely due to random variation.

#### Awareness and Readiness

The correlation coefficient ( $\rho = 0.594$ ,  $p < 0.001$ ) demonstrates a moderate-to-strong positive correlation between awareness of Industry 4.0 and readiness. This indicates that employees with higher awareness levels are more prepared to implement Industry 4.0 technologies. The correlation is statistically significant ( $p < 0.001$ ), confirming that awareness plays a crucial role in employee preparedness. Additionally, the awareness-readiness correlation (0.594) is stronger than the training exposure-readiness correlation (0.496), suggesting that awareness has a more substantial influence on readiness than training alone.

Key takeaways: The findings highlight the importance of both training exposure and awareness in shaping Industry 4.0 readiness. While training enhances employee preparedness, awareness exhibits a stronger impact, emphasizing the need for organizations to foster knowledge-building initiatives alongside structured training programs. Organizations should integrate both elements to ensure a smooth digital transformation and workforce adaptability to Industry 4.0 technologies.

### 6. Findings and Suggestions

#### 6.1 Findings

The study revealed a workforce heavily skewed towards male representation, with a significant portion employed in the manufacturing sector. The majority of respondents were within the 25-35 age range, possessing 5-10 years of professional experience. Regarding Industry 4.0, respondents demonstrated moderate levels of awareness and readiness, with a notable familiarity with established technologies like Artificial Intelligence and the Internet of Things, contrasting with lower awareness of emerging technologies such as Digital Twin, Augmented Reality, and Blockchain. Statistical analysis indicated significant variations in awareness based on gender, age, and work experience, with males and older, more experienced individuals exhibiting higher levels. Furthermore, both training exposure and overall awareness showed a positive correlation with readiness, with awareness demonstrating a stronger influence.

#### 6.2 Suggestions

To address the identified gaps and enhance Industry 4.0 preparedness, organizations should prioritize the development and implementation of targeted training programs. These programs should specifically address the awareness gap observed among female employees, younger professionals, and those with limited work experience, with a particular focus on emerging technologies. Awareness campaigns, workshops, and the establishment of knowledge-sharing platforms and mentorship programs are crucial for fostering a deeper understanding of Industry 4.0 concepts. Creating inclusive work environments and promoting continuous learning through ongoing training opportunities are also essential for ensuring equitable preparedness across all workforce segments.

### 7. Conclusions

This study examined the awareness and readiness of employees in Gujarat's manufacturing and service sectors regarding Industry 4.0 technologies. The findings revealed significant differences in awareness based on gender, age, and work experience, highlighting the need for targeted interventions. While readiness levels were moderate, they were positively correlated with both training exposure and awareness, emphasizing the importance of both factors.

The results underscore the necessity for organizations to prioritize training and awareness initiatives to bridge the identified gaps, especially for female employees and younger, less experienced workers. The greater correlation between awareness and readiness than training and readiness highlights the importance of building a strong knowledge base. By focusing on targeted training programs and promoting a culture of continuous learning, organizations can enhance employee preparedness and ensure a successful transition to Industry 4.0.

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